

Nouns and Verbs in a Self-Styled Gesture System: What's in a Name?

SUSAN GOLDIN-MEADOW, CYNTHIA BUTCHER, CAROLYN MYLANDER,
AND MARK DODGE

University of Chicago

A distinction between nouns and verbs is not only universal to all natural languages but it also appears to be central to the structure and function of language. The purpose of this study was to determine whether a deaf child who was not exposed to a usable model of a conventional language would nevertheless incorporate into his self-styled communication system this apparently essential distinction. We found that the child initially maintained a distinction between nouns and verbs by using one set of gestures as nouns and a separate set as verbs. At age 3;3, the child began to use some of his gestures in both grammatical roles; however, he distinguished the two uses by altering the form of the gesture (akin to morphological marking) and its position in a gesture sentence (akin to syntactic marking). Such systematic marking was not found in the spontaneous gestures produced by the child's hearing mother who used gesture as an adjunct to speech rather than as a primary communication system. A distinction between nouns and verbs thus appears to be sufficiently fundamental to human language that it can be reinvented by a child who does not have access to a culturally shared linguistic system. © 1994 Academic Press, Inc.

A distinction between nouns and verbs is not only universal to all natural languages but it also appears to be central to the structure and function of language. The purpose of this study was to determine whether a conventional language model is essential to the development of such a distinction. We begin by exploring the universality of the noun-verb distinction and its psychological significance. We then consider how young children treat nouns and verbs in their early language and the role that a language model plays in shaping this treatment. Finally, we describe a study of a deaf child who was not exposed to a usable model of a con-

This work was supported by Grant BNS 8810769 from the National Science Foundation and Grant RO1 DC00491 from NIH. The work has benefited greatly from discussions with Laura Petitto and David McNeill and we thank them for their input. We thank Peder Hans Engbretson, Janellen Huttenlocher, Boaz Keysar, David McNeill, Jenny Singleton, and Jim Stigler for insightful comments on earlier drafts of the manuscript; Bill Goldstein for statistical advice; and Elissa Newport, Lila Gleitman, and an anonymous reviewer for helping us to sharpen our argument and the focus of the paper. Address correspondence and reprint requests to Susan Goldin-Meadow, University of Chicago, Department of Psychology, 5730 S. Woodlawn Avenue, Chicago, IL 60637.

ventional language and ask whether the child, despite the lack of a model, nevertheless incorporated into his self-styled communication system a distinction between nouns and verbs.

The Universality of the Noun-Verb Distinction and Its Psychological Significance

No language wholly fails to distinguish noun and verb. 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 which Sapir (1921, p. 119) considers to be 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 produced in the manual modality (Supalla & Newport, 1978).

The grammatical categories of noun and verb can be identified in a language by the role each plays in the structure of that language (e.g., by the position the category occupies in sentences, and by the set of inflections the category assumes within those sentences). However, these grammatical characteristics vary across languages—what is common across language is the functional roles nouns and verbs play in discourse and the semantic characteristics that have evolved as a function of these discourse roles (Hopper & Thompson, 1984, 1985; Sapir, 1921).

Sapir (1921) grounds the universality of the noun-verb distinction in the basic fact that language consists of a series of propositions. On intuitive grounds, there must be something to talk about and something to be said (or to predicate) of this subject once it is brought into focus. According to Sapir, this particular distinction is of such fundamental importance that languages emphasize it by creating a formal barrier between the two terms of the proposition—the subject of discourse, that is, the noun, and the predicate of the discourse, the verb. "As the most common subject of discourse is either a person or a thing, the noun clusters about concrete concepts of that order. As the thing predicated of a subject is generally an activity in the widest sense of the word, a passage from one moment of existence to another [. . .] the verb clusters about concepts of activity" (Sapir, 1921, p. 119). Thus, across the globe, nouns tend to be names for persons, places, or things (i.e., time-stable percepts, Givon, 1979; or material entities, Bloom, 1990) and form a set distinguishable from verbs, which tend to be names for activities and events.

Note, however, that the subject of the discourse need not always be a prototypical thing (i.e., a palpable material entity). For example, an activity or event can be the focus of attention (e.g., the activity of running

in “running can be dangerous”) and when it is, the activity feels less relational and more static than when it serves as a predicate (as in “Joe was running from an elephant when I last saw him”). In other words, just by being the focus of attention, there is a sense in which the activity has become a “static region of some mental space” (Bloom, 1990) and consequently thing-like. Thus, whether something is or is not a thing has to do with how the referent is perceived by the speaker—a perception which may be influenced as much by the referent’s role in discourse as by its status as a material entity.

Nevertheless, in general, nouns and verbs encode different sorts of meanings and the fact that they do so suggests that they ought to be characterized by different semantic organizations (Kintsch, 1972; Miller & Johnson-Laird, 1976). Indeed, Huttenlocher and Lui (1979) have reported differences in memory for nouns and verbs that appear to reflect different principles of semantic organization in the two categories. Across a variety of paradigms, Huttenlocher and Lui found that the effect of semantic relatedness was greater for nouns than for verbs—an effect which they attribute to the fact that nouns fall into closely related and hierarchically organized domains, whereas verbs form a more matrix-like organization.

In addition, adults (Nagy and Gentner, 1990), as well as children (Brown, 1957), appear to have implicit knowledge of the different constraints on the meanings of nouns and verbs, and they apply that knowledge when they encounter unfamiliar words in context. For example, when the adult subjects in Nagy and Gentner’s (1990) study read a nonsense word as a noun, they stored that word in memory with properties of the object in the context; however, when they read the word as a verb, they stored it with properties of the action. Thus, the subjects used the form class of a new word (its status as either a noun or verb) to determine which aspects of context they encoded as part of the meaning of that word. In general, Gentner (1981) has shown that verbs differ from nouns on a variety of psychological dimensions; for example, verbs are harder to remember, are more broadly defined, are more prone to be altered in meaning when a conflict of meaning occurs, and are less stable in translation across languages than nouns (see also Anglin, 1986). Gentner argues that the fundamental differences between nouns and verbs stem from a basic cognitive distinction that is correlated with the noun–verb distinction—the distinction between object-reference concepts and relational concepts (see also Bloom, 1990).

Do the Child’s First Words Respect Noun–Verb Boundaries?

Given the universality of the noun–verb distinction and its centrality to some of the most basic functions of language, one might expect this

distinction to be among the first acquired by the language-learning child. However, many researchers have argued that the young child's first words are not taxonomically organized and lack a basic distinction between objects and actions and therefore nouns and verbs. Instead, the child's earliest words are claimed to be organized "complexively," with each word representing a combination of habitually co-occurring objects, actions, and locations. Although more recent research suggests that children do indeed distinguish objects and actions in their early words, there is a second issue that is germane to the child's acquisition of nouns and verbs: Does the young child have a grammatical distinction between nouns and verbs, a distinction which is correlated with, but not identical to, the distinction between objects and actions? We address each of these two issues in turn.

Complexive vs taxonomic organizations of objects and actions. It has been claimed that young children use nouns overgenerally and undergenerally and that they do so because they do not have notions of objects of particular kinds but rather have complexive notions of objects and their habitual actions or locations. Piaget (1962), Vygotsky (1962), and Guillaume (1923/1973) each held that children's overgeneralized uses of nouns (e.g., "banana" said to the top of the refrigerator which held no bananas at the time but which habitually does hold bananas) reflect complexive groupings rather than taxonomic groupings. Similarly, children's undergeneralized uses of nouns have also been taken to reflect nonadult groupings; for example, Nelson (1974) maintains that children's early nouns refer to groupings of objects embedded in particular situations (ball as "ball-while-rolling") rather than more general taxonomic groupings not tied to any particular circumstance.

However, Huttenlocher and Smiley (1987) argue that a set of unexamined assumptions underlies the position that children's early nouns have childlike meanings. Some of these assumptions reflect a failure to specify the relation between word meaning and word use (in particular, communicative function), or a failure to recognize that the contexts observed during word use may not reflect the full range of that word's meaning. In addition, Huttenlocher and Smiley argue that the claim of childlike meanings has been made without considering the range of adult words in the language since adult language itself can appear to exhibit "complexive" meaning (e.g., "hammer" in adult English can either function as a noun and encode an object, or as a verb and encode the hammering with that object; "gallop" encodes a particular movement of a type of object, a horse).

Moreover, several researchers have noted that, from the start, most child words *are* used in the presence of the correct range of instances of the same adult word (Bowerman, 1980; Gruendel, 1977; Rescorla, 1980). In an extensive study of production data from 10 children (ages 11 to 25

months) in the single-word period, Huttenlocher and Smiley (1987) systematically examined early word use by recording the aspects of context present at the time of every utterance. They found that certain commonalities characterized large numbers of words and that these words fell into different types: words used mainly in the presence of particular kinds of small objects, words used for events or states, words used for persons, and words used for properties. Importantly, Huttenlocher and Smiley found that the children did *not* use particular words across the bounds of different word types (object words, event words, person words, or property words). With only one minor exception, the words used for objects were nouns and the words used for events were verbs. In other words, the children's use of word categories appeared to be adultlike, particularly in respecting a distinction between nouns and verbs.

The same holds for deaf children acquiring conventional sign language from their deaf parents. Using the same procedures as Huttenlocher and Smiley (1987), Petitto (1992) studied the earliest sign use of three deaf children (two acquiring *Langue des Signes Quebecoise* and one acquiring American Sign Language [ASL]) and compared it to the earliest word use of three hearing children acquiring spoken language from their hearing parents (two acquiring French and one acquiring English). Like Huttenlocher and Smiley, Petitto found that, when the children produced a lexical form, the range of referents over which it was applied formed a particular word (or sign) type, that is, type of object names, type of action/event words, type of property words, etc. For example, four of the six children produced the lexical form "open" (two deaf and two hearing) and used it to refer specifically to the action or event involved in opening a variety of things (e.g., jars, refrigerator doors, boxes)—never as the name for jars or as a name for specific objects that are kept in jars (e.g., cookies). That is, "open" was never used in both a verblike and a nounlike fashion. This finding was true of all of the children's lexical forms.

Macnamara (1982) found the same pattern in a longitudinal study of his son, Kieran. The child, who was observed until he was 21 months, used nouns for classes of objects and also honored intercategory distinctions; that is, he did not use his nouns for actions, nor did he use his verbs for objects. Moreover, in an analysis of one of the subjects in Brown's (1973) longitudinal study (Sarah), Macnamara (1982) found that 97% of the nouns Sarah used between 22 and 24.5 months were applied to physical objects and that 90% of her verbs, which comprised a different set of words, were applied to activities.¹ Thus, Sarah maintained the semantic

¹ Because context was not included in Brown's (1973) corpus, Macnamara (1982) used three different types of evidence to determine whether a particular word was used as a noun or verb in Sarah's speech: (1) mother's usage of the word as either noun or verb, (2) the syntactic context in which the word occurred in Sarah's speech, and (3) the general context

integrity of the two categories that Kieran did. In fact, even though Sarah did at times produce words that can be used as both nouns and verbs in adult English (e.g., comb, hammer), when Sarah used these words she used them for only one function (i.e., either to refer to the object comb, or to refer to the act of combing, but not both).

On the basis of these data, Macnamara (1982) argues that children arrange their earliest words into taxonomic categories that have a semantic basis—the principal categories being words for objects (nouns), words for actions (verbs), and words for properties (adjectives). His primary evidence for this claim is that children show flexibility in using a word within a semantic category but not across category boundaries (e.g., “shoe” is used in nounlike fashion to refer to boots, shoes, sandals but not to refer to any action, i.e., not like a verb). Findings of this sort provide evidence that the child’s words do not stand for a complexive object-in-action notion. However, the findings do not necessarily mean that the child has a grammatical distinction between nouns and verbs.

A grammatical distinction between nouns and verbs. When children first use grammatical devices, they tend to use those devices differently for nouns and verbs. In particular, they produce different inflections for their nouns (object words) than they do for their verbs (action words; Cazden, 1968; Macnamara, 1982; Miller & Ervin, 1964), and they produce sentences in which their nouns have different privileges of occurrence than do their verbs (Macnamara, 1982). Moreover, as early as 2 to 3 years, children are able to use grammatical markings (e.g., whether a nonsense word is preceded by an article, a noun inflection) to make inferences about whether an unknown word is an object or action (Brown, 1957; Gelman & Markman, 1985; Gelman & Taylor, 1984; Katz, Baker & Macnamara, 1972; Taylor & Gelman, 1988).

Note, however, that even after children begin to use inflections and word order to distinguish nouns and verbs, there is still no evidence that the children have a noun-verb distinction that is distinct from an object-action distinction *if* (as tends to be the case) all of their nouns refer to objects and all of their verbs refer to actions. In other words, there is no evidence that the children have a grammatical distinction that is different from the semantic distinction between objects and actions. What is needed to prove the point are instances where the child treats a word referring to an action as though it were a noun in terms of grammatical devices (e.g., the child says “dancing is fun,” using the word “dance” which refers to an activity in a syntactic slot reserved for nouns). Conversely, the child might treat a word referring to an object as though it

in the conversation as one participant picked up the topic from the other which often suggested that the word was being used as either noun or verb.

were a verb in terms of grammatical devices (e.g., the child says "I'm going to hat you" [= put a hat on you], thus using the word "hat" which refers to an object in a syntactic slot reserved for verbs. Clark (1982) has found that children produce such apparent mismatches between semantic category and grammatical category as early as age 3. It is difficult to pinpoint the moment in development when a child unequivocally can be said to have a noun-verb distinction that is not grounded in an object-action distinction. Nevertheless, we can say with assurance that, early in language development, children use their words in ways that do not violate the intercategory distinctions between noun and verb that are found in adult language. The question we next address is whether linguistic input plays a role in fostering (or hindering) the development of these intercategory distinctions.

The Role of Linguistic Input in Fostering the Noun-Verb Distinction

Children's initial categories of noun and verb appear to be based on a semantic distinction between objects and actions. In fact, children maintain this semantic distinction more rigorously than do the adults who provide the children with their linguistic input. For example, Brown (1957) presents evidence showing that young children's nouns are more likely to name concrete things than are adult nouns, and that young children's verbs are more likely to name actions than are adult verbs. In his analysis of Sarah's early word use, Macnamara (1982) found that, although Sarah rigorously maintained the semantic integrity of the noun and verb categories in her language, the adults who spoke to her did not. The transcripts were full of adult remarks like "do you want a good spanking?" where the verb "to spank" has been nominalized and, though a noun, it still refers to an action. Moreover, the adults who spoke to Sarah used words which can serve as both nouns and verbs in English (e.g., brush, catch, comb, etc.) and routinely used those words in both of their senses. Macnamara looked at Sarah's response to these dual-function words and found that she often made no response at all. Even when she herself used one of these words modeled by the adult, she did not adopt the adult's flexibility in her own word use until much later in development. Indeed, it was not until Sarah was 2½ years old that she first used the same word for an object and an activity; nowhere in the transcripts before age 2½ did she violate the semantic category boundary. Thus, children's initial reliance on a semantic basis for their noun-verb distinction is not forced upon them and may not even be facilitated by their parents' style of talking to them.

Note, however, that eventually children do pull away from a semantic grounding for their noun and verb categories, coming to rely (as do adults)

on a grammatical definition. Just as the child's linguistic input cannot adequately explain why children begin with a rigorously held semantic distinction between nouns and verbs, linguistic input is also inadequate to explain the child's transition from a semantic to a grammatical distinction between nouns and verbs. For example, Macnamara (1982) has found that the linguistic input a child receives before and during this transition does not change—adults are equally flexible in their use of words in both noun and verb contexts throughout the transition. Thus, adults do not increase their use of the same word in both a noun and verb role at a particular point in a child's development, despite the fact that such uses, with appropriate grammatical markings, might serve to highlight the grammatical distinction between nouns and verbs rather than the semantic distinction between the two.

As a result, the way adults talk to children does not appear to explain when and how children take their developmental steps toward mastery of an adult noun-verb distinction. In particular, linguistic input cannot fully explain either the child's initial dependence on a semantic basis for the noun-verb distinction or the child's eventual move to a grammatical basis for the distinction. Nevertheless, it is certainly possible that some exposure to input from a conventional language model may be essential both for children to initially come upon the idea of distinguishing between objects and actions in their communications and for them to eventually grammaticize the division into a noun-verb distinction. After all, the input language does display a noun-verb distinction and a roughly correlated, if not exact, object-action distinction.

This possibility is difficult to explore simply because most children are surrounded by language-using adults who routinely provide them with models of a distinction between nouns and verbs with both semantic and grammatical correlates. There are, however, children who are unable to make use of the conventional language model that surrounds them: deaf children whose hearing losses prevent them from taking advantage of the spoken language model around them and whose hearing parents have chosen not to expose them to a conventional manual language such as American Sign Language (ASL) or to a manual code of a spoken language such as Signed English. In previous work, we have shown that deaf children of this sort, despite their lack of a usable conventional language model, develop gesture systems that have many of the properties of language, particularly when compared to the linguistic systems developed by comparably aged children exposed to language models (Goldin-Meadow & Mylander, 1990a). We have studied the gesture systems of 10 deaf children of hearing parents and found compelling structural similarities between their gestural systems and conventional languages at lexical

(Feldman, Goldin-Meadow & Gleitman, 1978), syntactic (Goldin-Meadow 1982, 1987; Goldin-Meadow & Feldman, 1977; Goldin-Meadow & Mylander, 1984), and morphological (Goldin-Meadow & Mylander, 1990b; Goldin-Meadow, Mylander & Butcher, 1993; Singleton, Morford & Goldin-Meadow, 1993) levels.

There is no doubt that the deaf children in our studies were able to distinguish objects and actions in their non-linguistic worlds. By 18 months, both deaf and hearing children have mastered Piagetian object permanence and thus are able to treat objects as distinct from the actions performed on them (Best & Roberts, 1976). Nevertheless, it is possible that the deaf children in our study did not find it necessary to incorporate and grammaticize such a distinction in their communication systems. Indeed, the noun-verb distinction may be one whose presence across all natural languages has been maintained by tradition, rather than by its centrality to the structure and function of language. The purpose of this study is to determine whether the deaf child's self-styled gesture system respects the noun-verb distinction that is universally found in natural languages or, alternatively, whether a distinction between nouns and verbs is acquired only with exposure to a model of a conventional language, one that is shared within a community of users and passed down from generation to generation.

The final issue we explore in this study is whether the deaf child, in addition to using gestures as nouns and verbs, also uses gestures as adjectives. Although all languages appear to distinguish nouns and verbs, only certain languages make a further distinction between nouns and verbs and a third class, the class of adjectives (Schachter, 1985). In fact, Thompson (1988) has argued that adjectives (or what Thompson calls property concept words) share the predicating function with verbs and the referent-introducing function with nouns.² As a result, adjectives will sometimes be categorized with morpho-syntactic properties similar to those of verbs and sometimes with morpho-syntactic properties similar to those of nouns, thus sharing features with both nouns and verbs cross-linguistically. We consequently ask whether the deaf child used gestures as adjectives and, if so, how these gestures are patterned in relation to gestures used as nouns or verbs.

We explore these issues in Study 1 and ask whether the one deaf child

² Thompson (1988) gives the following example of an adjective serving a referent-introducing function. The speaker begins with "there's something really sad that happens" and, in successive discourse, goes on to describe the sad thing. Thus, it is the adjective, by identifying the referent as sad, which carries the burden of tagging that new referent for subsequent use in the later discourse.

whose gesture system has been most completely described maintained a distinction among nouns, verbs, and adjectives in that system. The deaf child in this study had not been exposed to an accessible conventional language model. Nevertheless, he saw the spontaneous gestures that hearing adults typically produce along with their speech (cf. Bekken, 1989; McNeill, 1992; Shatz, 1982). Thus, in Study 2, we describe the gestures this deaf child saw in his home, focusing particularly on whether the child's mother respected a distinction among nouns, verbs, and adjectives in her spontaneous gestures.

STUDY 1

We have previously reported that the deaf child's gesture system, although productive at both the level of the word and the sentence, is an indexical and iconic system of representation. The "lexicon" of the deaf child's gesture system contains both pointing gestures and characterizing gestures. Pointing gestures were used to indicate objects, people, places, and the like in the surroundings. Characterizing gestures were stylized pantomimes whose iconic forms varied with the intended meaning of each gesture (e.g., a fist pounded in the air to indicate that someone was hammering). The child combined these gestures into strings that functioned in a number of respects like the sentences of early child language and were consequently labeled "gesture sentences." Within these gestural sentences, relationships between gestures corresponded to certain properties of words within a sentence. For example, the child's gesture sentences expressed the semantic relations typically found in early child language (in particular, action and attribute relations); in these sentences, characterizing gestures were assumed to represent the predicates and pointing gestures the arguments playing different thematic roles in the semantic relations (Goldin-Meadow & Mylander, 1984). As an example, the child produced a pointing gesture at a bubble jar (representing the argument playing the patient role) followed by the characterizing gesture "twist" (representing the act predicate) to request that the experimenter twist open the bubble jar.

Note that the deaf child's pointing gesture serves an important discourse function played by the noun in conventional languages: It serves to single out an entity which can then be commented upon. However, the pointing gesture does not fulfill all of the functions served by the noun, and in fact appears to function more like a pronoun than a noun. In particular, although the pointing gesture can indicate which object is the focus of attention, it does not categorize that object as one of a type; that is, it does not classify an entity in terms of its relationship to other entities of the world (cf. Stachowiak, 1976). Nouns do serve this function in conventional languages. Moreover, even though the deaf child was able to

use the pointing gesture to refer to objects that are not present in the room (e.g., pointing at the empty bubble jar to refer to the full bubble jar which was not in the room, see Butcher, Mylander & Goldin-Meadow, 1991), this function is not easily filled by the point, and its effectiveness depends crucially on the communication partner's willingness to interpret the present object as a symbol for the nonpresent object. In contrast, nouns allow the communicator to easily make reference to nonpresent objects.

In addition to the pointing gesture, however, the deaf child also produced characterizing gestures which, by virtue of their iconic form, have the potential to serve a categorizing function and thus call nonpresent objects to the attention of a communication partner. The question we ask whether in the deaf child's gesture system, characterizing gestures, in addition to serving a predicate function, might also serve some of the functions typically filled by nouns in conventional languages. If so, we further ask whether the child makes formal distinctions between characterizing gestures serving nounlike functions and characterizing gestures serving verblike functions.

The difficulty facing us is how to tell whether a gesture is serving a nounlike function or a verblike function. For example, the child might produce a "beat" gesture in response to a picture of a drum. One might assume, since there is no beating activity taking place in the picture or the immediate context, that the child is using his gesture as though it were the *noun* "drum." However, it is also possible that the child is commenting on the fact that he has, at times, beaten objects of this sort, thus using his gesture as though it were the *verb* "drum" (note that a similar coding problem would arise if a hearing child in the one-word stage were to say "drum" in this context). In this instance, the non-linguistic context is consistent with both interpretations and therefore cannot readily be used to arbitrate between the two. In general, words describe specific perspectives taken on objects and events by the speaker, perspectives that are not "in the events" in any direct way (Gleitman, 1990). As a result, the meanings of words (let alone their grammatical category) cannot be extracted solely by observing objects and events.

In previous work, we found this problem sufficiently daunting that we arbitrarily assigned all characterizing gestures a predicate function. Those characterizing gestures whose forms resembled actions were assigned an act predicate function (e.g., a twisting movement was assumed to represent the predicate "twist") and those whose forms resembled attributes were assigned an attribute predicate function (e.g., a round circle formed by the fingers in the air was assumed to represent the predicate "round"). We made this simplifying assumption because we reasoned that the form of the gesture was likely to have a special status for the child since the child himself had created the gesture (just as the form of a word holds

special meaning for the inventor of that word, e.g., the first user of "skyscraper" was no doubt aware of the relationship between the celestially aspiring object and its name and presumably selected the name to emphasize just that relationship, see Goldin-Meadow & Mylander, 1984, p. 25, and Feldman et al., 1978, for further discussion of this issue). Nevertheless, as one observes the deaf child gesturing, the intuition is very strong that sometimes when the child uses a gesture like "twist" he is using it as though it were a noun. Our decision in the present study was to trust these intuitions and, indeed, use them to begin the search for a noun-verb distinction in the deaf child's gestures. We describe the structure of our argument and the role that intuitions play in it below.

The grammatical categories noun and verb, although correlating with the semantic categories object and action, are in fact defined not in terms of these semantic categories, but rather in terms of the distinct roles they play within the grammatical system. The problem for us in discovering a noun-verb distinction in the deaf child's gesture system lies in entering the system. Because there is no established language model toward which the deaf child's system is developing, there are no hints from a conventional system that might guide our search for the formal properties of nouns and verbs. Consequently, the process necessarily becomes a bootstrap operation. It begins with preliminary guesses, based on our intuitions, as to whether a gesture was used as a noun, verb, or adjective. Having established preliminary coding decisions, we then tested the utility of our tentative decisions for describing regularities of the system in two ways.

First, we asked if the coding decisions were reliable and established reliability by comparison of judgments made by two independent coders. The agreement score between two coders was found to be quite high for our noun, verb, and adjective classifications (94%, see below), confirming coding reliability.

Second, we asked if these particular decisions resulted in a coherent description of the deaf child's gesture system. The claim made here is that if a description based on these particular decisions is coherent, this fact is evidence for the validity of the categories themselves. Consider the following example from our previous work. In our initial studies, we guessed that the categories "patient" and "act" might be viable constructs within the deaf child's gestures, and we coded the child's gestures using these categories. We then discovered a pattern within the gestures which was based on these categories—a gesture-ordering pattern in which patients reliably precede acts in two-gesture sentences. Note that the existence of the pattern confirms the utility of the categories since the former is formulated in terms of the latter. Thus, we have internal evidence from the child's own gestures for the utility of the categories "patient" and "act"

in the deaf child's gesture system. In the current study, we follow the same bootstrap operation. We begin by tentatively classifying characterizing gestures as "nouns," "verbs," or "adjectives." If a description based on these classifications turns out to be coherent, we then take this fact as evidence for the utility of a noun-verb-adjective construct in describing the deaf child's gesture system.

There are, however, two potential difficulties with the bootstrap procedure. First, the categories we identify, although viable within the deaf child's gesture system, may in fact have little to do with nouns, verbs, and adjectives as defined in natural languages. We return to this issue and attempt to resolve it at the end of Study 1. Second, the categories we identify may be products of the experimenter's mind rather than the child's. In this regard, it is important to note that our study is no more vulnerable to this possibility than are studies investigating hearing children who are learning spoken languages. Adult experimenters may be incapable of finding anything but language-like structure in a child's communications (although there are communicative situations in which we have failed to find language-like structure, as we will see in Study 2 where we analyze the gestures of the deaf child's hearing mother). Even though this problem can never be completely avoided, the following assumption allows us to proceed: If a category turns out to "make sense of," or organize, the child's communications (e.g., by forming the basic unit of a pattern), we are then justified in isolating that category as a unit of the system and in attributing that category to the child. Thus, the consistency of the results presented here lends credence to the noun, verb, and adjective coding decisions made initially on intuitive grounds.

Method

Subject

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, that is, 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 or 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 a very reduced oral linguistic capacity (Conrad, 1979; Meadow, 1968). Moreover, although many hearing parents of deaf children send their children to schools in which one of the manually coded systems of English is taught, some 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.

The subject of this study, David, is profoundly deaf (>90 dB bilateral hearing loss) and his hearing parents chose to educate him using an oral method. At the time of our observations, David 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, David had not been exposed to ASL or to a manual code of English. As a preschooler in an oral school for the deaf, David spent very little time with the older deaf children in the school who might have had some knowledge of a conventional sign system (the preschoolers only attended school a few hours a day and were not on the playground at the same time as the older children). Moreover, David's family knew no deaf adults socially and interacted only with other hearing families, typically those with hearing children. One of the primary reasons we were convinced that David had had no exposure to a conventional sign system at the time of our observations was that he did not know even the most common lexical items of ASL or Signed English (i.e., when a deaf native signer reviewed our tapes, she found no evidence of any conventional signs; moreover, when we informally presented to David common signs such as those for mother, father, boy, girl, dog, we found that he did not understand any of these signs).

David was videotaped in his home during free-play sessions which lasted as long as the child was cooperative, typically an hour or two. A large bag of toys, books, and puzzles served as the catalyst for communication (see Goldin-Meadow, 1979). We videotaped David seven times over a period of 2 years beginning when he was 2;10 (years:months) and ending when he was 4;10.

Coding Procedures: Criteria for Identifying and Interpreting a Gesture

David's videotapes were coded initially according to a gesture transcription system described in detail in Goldin-Meadow (1979). Our criteria for isolating gestures grew out of a concern that the gestures meet the minimal requirements for a communicative symbol and were as follows: (1) The gesture must be directed to another individual; that is, it must be communicative. In particular, we required that the child establish eye contact with a communication partner in order for the child's act to be considered a gesture.³ (2) The gesture must not itself be a direct manipulation of some relevant person or 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 excluded all acts that were done on objects; thus, if a child picked up a toy hammer and pretended to hit an object, that act would not be considered a gesture. (3) The gesture must not be part of a ritual act (e.g., to blow a kiss as someone leaves the house) or a 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 stereotyped contexts of use clearly did not have this flexibility and thus were not considered gestures.⁴

³ Strict application of this criterion breaks down in the few instances where David was found to gesture with no one else around, that is, as though he were gesturing to himself. The fact that the child was found to use his gestures to "talk" to himself indicates that his gesture system can take on additional functions of language beyond communication with others.

⁴ 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

Particularly because the deaf child's gesture system was not a conventional system shared by a community of users, our interpretations of the child's gestures necessarily remain tentative and represent our best guesses at the child's intended meaning. Context played a central role in shaping these interpretations. For example a point at a cookie on a plate followed by an "eat" characterizing gesture might be interpreted as a request for a cookie if the child had no cookie but wanted one, as an invitation to the experimenter to take a cookie if the child already had a cookie and was offering the plate, or as a report of a past event if the child showed no interest in the cookie at hand but, according to his mother, was recounting the cookie-eating the dog had done earlier that day (it may be worth pointing out that similar problems arise when coding the sentence "eat cookie" uttered by a hearing child). Note that for the deaf child, although there may be several interpretations possible for the same gestures, each of these interpretations is likely to include the same core information (in this example, reference to a cookie and to eating) which is derived to some extent from the form of the gestures themselves (see Goldin-Meadow & Mylander, 1984, pp. 24-26, for discussion of the role that form plays in the interpretation of gestures).

The task of gesture interpretation was, in general, made easier by the fact that we included as part of the context any responses the interlocutor made to the child's gestures and the child's reactions to those responses. On occasion, the interlocutor responded in several different ways until a response was finally accepted by the child. It is important to note that this process of negotiation between the deaf child and his interlocutor is no different from the negotiations that take place between young hearing children and their communication partners, particularly when the subject of the conversation is a non-present object or event (cf. Sachs, 1983; Sperry & Sperry, 1989). Indeed, researchers routinely include the give-and-take between the child and his or her interlocutor as part of the context when attempting to identify and describe talk in young hearing children. For example, Miller & Sperry (1988) were able to reliably code young hearing children's talk about past events even when the children did not produce explicit past tense markers by using contextual support of the sort outlined here.

Gesture interpretation was also facilitated by the fact that we were familiar with the toys and the activities that typically occurred during the taping sessions, and by the fact that the parents frequently shared their intimate knowledge of the child's world with us during the taping sessions. Not only did we bring the same set of toys to each taping session but also this set was accessible to the coders when they transcribed the tapes, a procedure which allowed the coders to verify, for example, that a particular toy did indeed have wheels or that the cowboy in a particular picture was in fact holding a gun. In addition, the parents were familiar with the child's own toys and activities outside the taping session and, if we were puzzled by a child's gestures, we asked the parents during the session what they thought the child was looking for, commenting on, etc. The parents' comments, as well as our own, were therefore on tape and were accessible even to coders who were not at the original taping session. Thus context, bolstered by the parents' and our own knowledge of the child's world, constrained the possible interpretations of the child's gestures and helped to disambiguate the meanings of those gestures.

Of course, at times the child moved too far afield for his gestures to be interpretable even in context; these gestures were coded as ambiguous. We coded David's gestures for semantic and syntactic relations according to the system described in Goldin-Meadow and My-

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).

lander (1984) and found that only 5% of David's characterizing gestures and 6% of his pointing gestures were ambiguous. (Recall that for the analyses described here, characterizing gestures are the primary focus of attention, with pointing gestures included only in the syntactic analyses presented later.) In general, reliability between two independent coders was 93% for assigning lexical meaning to gestures, 87% for assigning semantic relations to single gestures, and 100% for assigning semantic relations to gesture sentences (see Goldin-Meadow & Mylander, 1984).

In addition, we coded each characterizing gesture that David produced in terms of components of form (cf. Goldin-Meadow & Mylander, 1990b). We described each gesture in terms of its handshape form (e.g., Fist, O hand, C hand) and its motion form (e.g., Linear Path, Arc To & Fro). In addition, we described the place where each gesture was articulated: If the gesture was produced on the body (e.g., on the mouth, the top of the head), we noted the particular body part near which the gesture was produced (gestures produced near the chest were considered to be in neutral space); if the gesture was produced away from the body and toward something in the room, we noted the particular object or location toward which the gesture was produced.

We next described the meaning of each characterizing gesture along two dimensions. First, we described the action represented by the gesture in terms of its type (e.g., transferring to a new location, reorienting in place, moving back and forth, rotating) and whether or not the action affected an object (akin to a transitive-intransitive distinction). Occasionally, the gesture did not represent an action but rather the shape or an attribute of an object (e.g., an arc tracing the shape of a dog's tail); if so, we described that shape or attribute. Second, we described the object (or objects) involved in the action represented by the gesture. Each object was described in terms of its type (e.g., animate, vehicle), its shape (e.g., round, straight), and the size of its width (small, large) and length (short, long). In addition, we assigned a placement meaning but only to those gestures representing actions that must be produced on the body. For example, eating actions must be done at the mouth; we therefore assigned such actions a meaning specified for place (i.e., we assigned eating actions the meaning "reorient a small object at mouth" rather than the less specified meaning "reorient a small object").

Reliability was established by having a second observer independently code a randomly selected portion of the videotapes. Interrater agreement ranged between 83 and 95% for coding the forms and meanings of the characterizing gestures.

Results

The Stability of the Form-Meaning Pairs in the Child's Lexicon Over Time

Our first task was to determine whether David's characterizing gestures formed a stable lexicon, that is, to determine whether one form was used to convey the same meaning throughout the period observed. The initial step in addressing this question was to establish a prototypical form for each of the meanings David conveyed. We did this differently for the two types of characterizing gestures David produced: *componential* gestures which are composed of combinations of a limited set of forms, each associated with a particular meaning (cf. Goldin-Meadow & Mylander, 1990b), and *holistic* gestures which are not decomposable into parts and thus are comparable to the "frozen" signs of ASL, signs whose stems are unanalyzable and monomorphemic (cf. Kegl, 1985).

For the componential gestures, we could predict the appropriate prototypical form for each meaning David conveyed. For example, the meaning "twist" (as in twisting a wide jar lid, i.e., rotate a large object around an axis) could be broken down into two parts: "large object" and "rotate around an axis." Each of those parts was typically associated with a particular form in David's gestures. The meaning "large object" was typically associated with a C handshape form, and the meaning "rotate around an axis" was typically associated with a Circular motion form. We therefore assumed "C hand + Circular motion" was the prototypical handshape + motion form for the combined meaning "rotate a large object around an axis." We then calculated variability of the actually occurring forms with this meaning in relation to the "C hand + Circular motion" prototype. As a second example, the meaning "eat" (i.e., reorient a small object at mouth) could be broken down into three parts: "small object," "reorient," and "at mouth." The meaning "small object" was typically associated with the O hand form in David's gestures, and the meaning "reorient" was typically associated with the Short Arc motion form. We therefore assumed that "O hand + Short Arc motion" was the prototypical handshape + motion form for this combined meaning. We added place of articulation to the prototypical form of a meaning if that meaning conveyed an action performed on the body; thus, we included the place-of-articulation 'mouth' as part of the prototypical form for "eat." We then calculated variability of the actually occurring forms produced with this meaning in relation to the norm, "O hand + Short Arc motion + mouth place."

In contrast to his componential gestures (which comprise approximately 70% of the gestures David produced), David's holistic gestures could not be broken down into meaningful parts. For example, the gesture "break" (produced by holding two fists side-by-side and then arcing the fists away from one another in the air) appeared to be a frozen form in David's system—he used this particular handshape + motion combination for all acts of breaking (whether or not the hands were actually used to do the deed) and for all objects (whether or not the broken object could actually fit in a fist). In other words, this gesture could not be decomposed into a meaningful motion component plus a meaningful handshape component. For holistic gestures of this sort, we used frequency of occurrence to determine prototypical forms, and considered the form most frequently used to convey a meaning to be the prototypical form for that meaning.⁵ For example, the meaning "transfer an object to a new loca-

⁵ It is worth noting that the componential system used to determine prototypical forms for David's pantomimic gestures is also a frequency-based system. The particular handshape or motion form that David used most frequently to represent a particular object or action

tion" was conveyed most frequently by the form "Palm hand + No motion" in David's gestures; we therefore calculated variability for this meaning in terms of this prototypical form.

Using this procedure, we found that David produced 190 different lexical items (that is, 190 different form-meaning pairs) over the 2-year period.⁶ Our next step was to determine how much variability occurred around the prototypical forms associated with particular meanings in David's gestures. If David created his gestures anew each time he wished to convey a particular meaning, we might expect to find some consistency of form simply because David's gesture system is iconic and iconicity constrains to some degree the set of forms that might be used to convey a meaning. However, in this event, we might also expect a great deal of variability around the prototype—variability engendered by the differences among the particular situations that each gesture was created to capture. If, on the other hand, David had a stable lexicon of gestures, we might expect to find relatively little variability in the set of forms he used to convey a particular meaning.

For the purpose of calculating how much variability there was around the prototype, we set aside two types of variations that did not, on intuitive grounds, appear to affect the lexical meaning of the gesture:

(1) *Reduction in handshape or motion form.* With respect to handshape, a gesture typically produced with two hands was sometimes produced with only one (e.g., a "beat" gesture which, in its prototypical form, is produced with two fist hands alternately arcing to and fro but, in this variation, is produced with only one hand). With respect to motion, a gesture typically produced with bi-directional movement was sometimes reduced to uni-directional movement (e.g., a "beat" gesture produced with two hands arcing down only once rather than arcing to and fro repeatedly) or a gesture typically produced with uni-directional movement was sometimes reduced to no motion at all (e.g., an "eat" gesture which, in its prototypical form, is produced with an O hand arced toward the mouth but, in this variation, is produced with an O hand held at the mouth).

(2) *Variation in place of articulation.* A gesture typically produced either in neutral space or at a particular place on the body is, in this variation, produced toward an object or location in the room (e.g., a "twist" gesture, in its prototypical form, is a C hand rotated at the chest,

meaning was taken to be the prototypical form for that meaning (see Goldin-Meadow & Mylander, 1990b).

⁶ Note that 190 lexical items is a rather small lexicon for a child of David's age. However, if we consider David's pointing gestures to be part of his lexicon, his system appears to be similar in scope to a young hearing child's (see Feldman et al., 1978).

i.e., in neutral space, but in this variation is a C hand rotated near a jar in the room). Gestures were placed toward objects, people, and locations in the room which appeared to augment the meaning of the gesture (e.g., in the "twist" example, the jar was the patient upon which the child wanted the action performed).

These two types of variation appeared to modulate the lexical meaning of a gesture rather than alter it in a fundamental way. As a result, we did not count either a reduction in handshape or motion form, or an addition of place as a variation when we calculated how much variability from the prototype there was in David's system. In fact, both types of variation were found to pattern systematically not in terms of lexical meaning, but at other levels within David's gesture system; we return to these two types of variations and their role in the gesture system later in the results.

Of David's 190 lexical items, 81 were used only once; thus, there was no opportunity to observe variability in these gestures. The remaining 109 lexical items were produced more than once during the period of observation and accounted for 706 gesture tokens.⁷ We found that only 73 (10%) of these 706 gestures varied from the prototype; these gestures varied either in handshape (e.g., a Fist hand was used in the gesture rather than the C hand from the prototype) or in motion (e.g., a Short Arc motion was used in the gesture rather than the Long Arc motion from the prototype). For example, David conveyed the "break" meaning 15 times over the 2-year period: 14 times he conveyed this meaning using the form we considered to be his prototype (i.e., 2 Fist hands + Short Arc motion), and once he used an "incorrect" motion (he used a "2 Fist hands + Long Arc motion" form). As a second example, one showing variation in terms of handshape, David conveyed the "swing" meaning 9 times over the 2-year period: 7 times he conveyed this meaning using the form we considered to be his prototype (i.e., O hand + Arc To & Fro motion), and twice he used an "incorrect" handshape (he used a "C hand + Arc To & Fro motion" form once and a "Fist hand + Arc To & Fro motion" form another time). Note that David's incorrect forms were not dramatically different from his prototypical form; the forms he used did capture an aspect of the intended meaning—if not, we would not have been able to attribute any sort of meaning to the gesture in the first place. In this regard, it is important to recall that we were not forced to eliminate many gestures because they were uninterpretable; only 5% of the characterizing gestures David produced could not be assigned a meaning and were therefore eliminated from our analyses. Thus, the data base we used to assess

⁷ For 128 of David's gestures (15% of the 834 gestures that he used more than once), it was impossible to see the entire gesture on the videotape; these gestures were therefore eliminated from this analysis.

variability in David's gestures did not come from a restricted sample of David's gestures.

Overall, then, 90% of the 706 gesture tokens David produced more than once conformed to prototype. Indeed, in 73 (67%) of the 109 lexical types produced more than once in David's system, there was *no* variability from prototype in any of the tokens of that lexical item. Thus, David essentially used the same form to convey a particular meaning throughout the 2-year period he was observed, suggesting that his gesture system adhered to standards of form (albeit standards which were idiosyncratic to him rather than shared by a community of language users).

Assigning Tentative Grammatical Categories to Gestures in David's Lexicon

We have found that David used a stable gestural lexicon over a 2-year period. The next question we ask is whether that lexicon could be divided into the grammatical categories, noun, verb, and adjective. As described above, we first made this division tentatively on the basis of our intuitions as to whether a gesture was used as a noun, verb, or adjective. Here we describe our procedures for making these assignments. Subsequently, we will examine whether these tentative categorizations are accompanied by grammatical distinctions.

In the lexicon of an English-speaker, many lexical items fall into a single grammatical category (e.g., "potato" and "tooth" serve only as nouns, "sit" and "mow" serve only as verbs). However, some lexical items are classified in more than one grammatical category (e.g., "hammer," "brush," and "comb" serve as nouns in some contexts but as verbs in other contexts). We therefore wanted to allow for the possibility that a lexical item in David's gestures might fall into more than one grammatical category. As a result, we examined each individual gesture token that David produced and made a judgment as to whether that particular token was serving a nounlike function, a verblike function, or an adjectivelike function. As described earlier, the difficulty in making these decisions (for us and for any experimenter) is that the notions noun and verb have to do with the way referents are construed by the speaker (or, in our case, the gesturer) rather than with the real-world referents themselves. We therefore were forced to make educated guesses at what might be in the mind of the child when he produced a gesture, guesses based essentially on the communicative context in which that gesture was produced.

As in categorizing the early words of a hearing child (cf. Macnamara, 1982, p. 106), we found it easier to actually do the categorizing than to articulate how we did it. Nevertheless, as an approximate description of how we categorized gestures, 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 and adjectives to be the predicates of the discourse (i.e., what is said of this something). Thus, if the child used a characterizing gesture to focus attention on an entity, it was coded as a noun, but if he used the gesture to say something about that entity (i.e., to predicate something of the entity), it was coded as either a verb or an adjective, depending upon whether the gesture depicted an action or an attribute.⁸ Not surprisingly, material entities (cf. Bloom, 1990) turned out to be the most common subjects of the discourse—the nouns—and relations (actions and attributes) turned out to be the most common predicates of the discourse—the verbs and adjectives. For example, if the child used the “flap” 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 as an entity rather than to comment on wing-flapping), the gesture would be coded as a *noun*. In contrast, if the “flap” gesture had been used to describe a toy penguin that had been wound and was flapping its wings, the gesture would be coded as a *verb* (although, as described above, we do recognize that the child could have been commenting on the presence of the bird itself). As a second example, if the child used the “high” gesture (a flat palm held horizontally in the air) to comment on the fact that a cardboard chimney typically stands in the corner at Christmas time (i.e., to focus attention on the chimney as an entity rather than to comment on the chimney’s height), the gesture would be coded as a *noun*. In contrast, if the “high” gesture had been used to describe the temporary height of the tower before urging his mother to hit it with a hammer and topple it, the gesture would be coded as an *adjective*.

There were, of course, occasions when it was particularly difficult to decide whether a gesture was a noun, verb, or adjective. In order not to force our intuitions into categorical decisions when none seemed just right, we classified such gestures as “unclear”: 12% of the 915 gestures David produced could not unequivocally be assigned a grammatical category and thus were placed in this unclear category. Whatever the validity of our coding decisions, it is important to note that we were able to make these decisions reliably. Reliability was established by having a second observer independently code a randomly selected portion of the

⁸ It is important to note that the child often produced characterizing gestures alone and not in a gesture sentence. In these instances, our decisions about what was the subject and predicate of the discourse were obviously not based on a gesture’s position within a string of gestures. Moreover, even when a characterizing gesture did occur in combination with other gestures in a sentence, we did not base our decisions about the focus of the discourse on the gesture’s position within that sentence.

videotapes. Interrater agreement between the two coders was 94% for determining whether a gesture was a verb, adjective, noun, or unclear.

Nouns, verbs, and adjectives in David's lexicon. Using these procedures for gesture assignment, we found that David used characterizing gestures in each of the three grammatical roles, as nouns as well as verbs and adjectives. Overall, 40% of David's 805 characterizing gestures were used as nouns, whereas 49% were used as verbs, and 11% were used as adjectives. Note, however, that although David did use all three grammatical categories during our initial observation session at age 2:10, his nouns were extremely infrequent at this age and did not become a frequent part of his system on a consistent basis until age 3:5 (see Fig. 1A which presents the proportion of characterizing gestures that David used as nouns vs verbs and adjectives at each of the seven observation sessions). The paucity of characterizing gestures used as nouns during the initial observation session validates an assumption made in our earlier work—that characterizing gestures serve predicate functions (as verbs

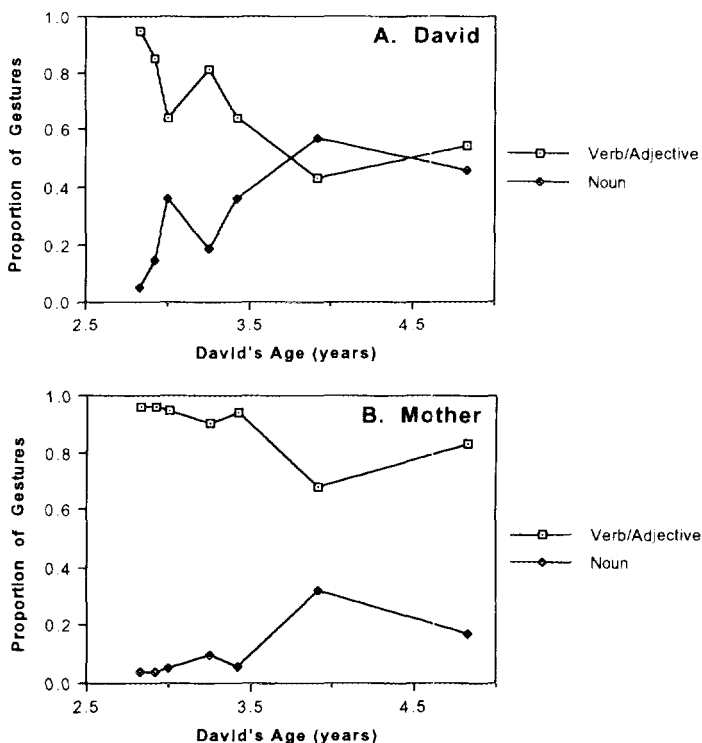


FIG. 1. Proportion of characterizing gestures used as verbs or adjectives vs nouns by the deaf child, David (A) and his mother (B) at each of the seven observation sessions.

and adjectives) and that pointing gestures are the only gestures serving nominal functions (Feldman et al., 1978; Goldin-Meadow & Mylander, 1984; for discussion, see Bates & Volterra, 1984, and the reply by the authors in Goldin-Meadow & Mylander, 1984, pp. 146–147). The data presented here suggest a developmental progression: Initially David used characterizing gestures as verbs and adjectives, with points serving nominal functions. Over development, David began to use characterizing gestures as nouns as well as verbs and adjectives, with points continuing to serve nominal functions.

The question we now ask is whether David used the same characterizing gesture for more than one grammatical function as, for example, both a noun and a verb. Looking over the 2-year period, we found that 78% of the lexical items David produced fell into a single grammatical category: 53 of the 177 lexical items in David's lexicon that could be assigned a grammatical category were always coded as verbs, 23 were always coded as adjectives, and 62 were always coded as nouns. However, 22% of the lexical items in David's lexicon were *not* restricted to a single grammatical category and were used in more than one grammatical role: 36 of these were lexical items used as both nouns and verbs (akin to the noun-verb pairs found in ASL, cf. Supalla & Newport, 1978), 2 were used as both nouns and adjectives, and 1 was used as both a verb and an adjective.⁹ We pay particular attention to these lexical items used in two grammatical roles (particularly to the noun-verb pairs since there were a sizable number of them) when describing our results simply because these pairs themselves may constitute a violation of intercategory boundaries *unless* they are distinctively marked (as they are in ASL, cf. Supalla & Newport, 1978).

Do David's earliest gestures respect intercategory boundaries? An early lexical distinction. Words that can be used in two different grammatical roles—words like "hammer" and "comb"—exist in the English lexicon and may even be found in the earliest lexicons of young language-learning children. Nevertheless, Macnamara (1982) has shown that, when young children use such words at the earliest stages of language acquisition, they use them in only one role. For example, a child might use "comb" to describe what she does to her doll's hair, but then would not

⁹ The two lexical items used as both adjectives and nouns were "high" (used to describe the height of a tower [an adjective] and to stand for a chimney [a noun]) and "upturned" (used to describe the arc of a toy's nose [an adjective] and to stand for the nose itself [a noun]). The one lexical item David used as both verb and adjective was "break" (two fists held together at chest level and broken apart in the air) used to describe the act of breaking a toy in this particular manner (a verb), and used to describe an already broken toy, one that had not been destroyed by this particular method (an adjective).

also use "comb" to refer to the instrument involved in this activity. It is not until later in development that the child begins to use the same word in two different roles (Macnamara, 1982).

Does David show the same constraint language-learning children show; that is, at the earliest stages of development, does he use a particular characterizing gesture in only one grammatical role, thus respecting a boundary akin to the noun-verb boundary? We found that initially David did indeed restrict his use of a particular characterizing gesture to a single role. David did not use the same gesture as both a noun and a verb until the fourth observation session (age 3:3), after which time he used many at each session. Moreover, he also did not begin to use a gesture as both a verb and an adjective until the fourth observation session, and did not use a gesture as both a noun and an adjective until the sixth observation session (age 3:11). Thus, like young children learning conventional languages, David did *not* violate intercategory boundaries at the earliest stages of development. His first inclination appeared to be to respect intercategory boundaries in his self-styled gesture system and to maintain that distinction lexically (that is, by using separate lexical items as nouns, verbs, and adjectives).

Note, however, that hearing children learning English eventually do learn words that cross the noun-verb boundary. Moreover, when they do, they treat the noun uses of the word differently from the verb uses: (1) the noun uses are marked with different inflections than the verb uses (i.e., they are marked differently with respect to morphology), and (2) the noun uses appear in different positions within a sentence than the verb uses (i.e., they are marked differently with respect to syntax). In the next section, we ask whether David treated the noun uses of his gestures differently from the verb uses. We ask whether David used different markings on a gesture depending upon its grammatical category (akin to a morphological distinction), and then whether David placed a gesture in a different position in the gesture sentence depending upon its grammatical category (akin to a syntactic distinction). Before turning to this question for gestures used as both nouns and verbs, however, we must ask whether David shows a more general morphologic and/or syntactic distinction between nouns and verbs. In other words, we ask whether David shows a truly grammatical distinction, and not just a lexical one, between his linguistic categories.

Morphological Distinctions for Nouns, Verbs, and Adjectives:

Markings on Nouns and Adjectives

Reduction of handshape or motion: Derivational abbreviations. We begin with those variations of form which involve a reduction in the form of a prototype, either a reduction in handshape (from two hands to one)

or a reduction in motion (from bi-directional motion to uni-directional motion or from uni-directional motion to no motion). We found that, in general, the proportion of abbreviations in David's gestures was quite small: 9% of David's 805 gestures were abbreviated. However, David did appear to use abbreviations to discriminate between gestures in different grammatical roles ($\chi^2(2) = 22.97, p < .001$, Fig. 2A). Using a posterior partitioning χ^2 technique (Smith, 1966), we were able to examine the three individual pairwise comparisons: noun vs verb, adjective vs verb, and noun vs adjective. David was more likely to abbreviate nouns than verbs ($\chi^2(2) = 21.15, p < .001$) and more likely to abbreviate adjectives than verbs ($\chi^2(2) = 6.89, p < .05$). Note, however, in Fig. 2A that David did *not* use abbreviations to distinguish between nouns and adjectives ($\chi^2(2) = .12, p > .90$).

Moreover, and at some level more importantly, even those particular gestures which David used at times as a noun and at other times as a verb were more likely to be abbreviated when used as nouns (22% of the 164

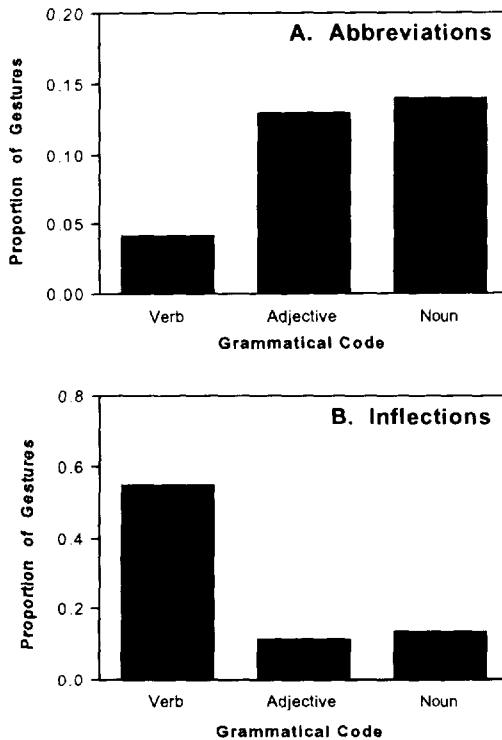


FIG. 2. Proportion of characterizing gestures used as verbs, adjectives, or nouns that were abbreviated (A) or inflected (B) in David's system.

gestures) than when used as verbs (4% of the 149 gestures, $\chi^2(1) = 21.59$, $p < .001$). In fact, the nouns in these noun-verb pairs were particularly likely to be abbreviated (22% of the nouns in pairs were abbreviated vs 14% for nouns overall). In addition, although David did use some abbreviations during the early sessions and tended to use them more often on nouns and adjectives than on verbs, it was not until the fifth observation session—the session immediately after the onset of noun-verb pairs in David's repertoire—that he consistently used abbreviations to distinguish between verbs and nouns or adjectives.

The fact that abbreviation served to distinguish nouns from verbs in noun-verb pairs in David's gestures is reminiscent of a similar phenomenon in ASL described by Supalla and Newport (1978). There are nouns and verbs in ASL which form pairs (the noun referring to an object is related in form to the verb for the action performed with this object). Supalla and Newport showed that these nouns and verbs, although similar in form at a lexical level, differ consistently from one another in their morphological marking. In particular, nouns differ from verbs in both frequency of movement (nouns are always repeated, whereas verbs are either single or repeated) and manner of movement (nouns are always restrained in manner, whereas verbs are either hold or continuous).

The derivational morphology distinguishing nouns from verbs in ASL, although similar to David's use of abbreviations to distinguish nouns from verbs, differs in several important respects from David's system. First, while nouns are repeated in ASL, they are abbreviated in David's system.¹⁰ Intuitively, this reduction of form in nouns in David's system makes some sense. If a gesture is used as a verb to represent an action, it would seem important to reproduce all aspects of the action in the gesture. In contrast, if the same gesture is used as a noun to represent an object, it would seem less important that the action be reproduced veridically since it is the object that is the focus of the gesture. It is of interest that David made the same distinction in his system that is made in a conventional sign language (i.e., a distinction between nouns and verbs) and even utilized the same dimension (i.e., repetition) to draw this distinction, yet utilized the dimension in a different way. Second, the derivational morphology that marks nouns and verbs in ASL is obligatory. In contrast, in David's system, nouns in noun-verb pairs were marked differently from their verbs only 22% of the time. Thus, if abbreviation is functioning as a derivational marker in David's system, it is functioning as

¹⁰ Although nouns in ASL are repeated, they are also produced with a restrained manner (i.e., a tightening of the muscles, Supalla & Newport, 1978). Restrained manner has the effect of reducing the movement in the sign so that the sign is often a less veridical representation of the action from which it is derived than the verb to which it is related.

an non-obligatory marker—its presence signals the fact that the gesture is a noun or adjective, but its absence does not necessarily mean that the gesture is a verb.

Markings on Verbs

Variation in place of articulation: Inflectional markings on the verb. In conventional sign languages such as ASL, inflectional systems have been described in which spatial devices are used to modify verbs to agree with their noun arguments (e.g., the sign “give” is moved from the signer to the addressee to mean “I give to you,” but from the addressee to the signer to mean “you give to me,” Padden, 1983). As described above, David at times altered the placement of his gestures, producing them near particular entities or locations in the room rather than producing them in neutral space or relative to the body (e.g., a “twist” gesture produced near a jar rather than in neutral space in front of the body). If David is using place of articulation as in ASL (that is, to indicate an entity playing a thematic role in the action represented by that gesture; in a sense, modifying the verb to “agree with” one of its arguments), we would expect him to be more likely to alter the placement of his verbs than the placement of his nouns.¹¹

We found that, overall, 33% of David’s 805 gestures were produced near an entity or location in the room and in this sense were “inflected.” Moreover, David used these inflections differentially depending upon the grammatical role of the gesture ($\chi^2(2) = 161.22, p < .001$, see Fig. 2B). Using a posterior partitioning χ^2 technique (Smith, 1966), we were able to examine the three individual pairwise comparisons. David used inflections significantly more often on verbs than on nouns ($\chi^2(2) = 138.24, p < .001$) and significantly more often on verbs than on adjectives ($\chi^2(2) = 63.96, p < .001$). Note, however, in Fig. 2B that David did *not* use inflections to distinguish between gestures used as nouns and adjectives ($\chi^2(2) = .15, p > .90$). Moreover, even those particular gestures which could be used as both nouns and verbs were more likely to be inflected

¹¹ Note that pointing gestures are always oriented toward the entity to which they are referring and, in this sense, might be considered inflected. However, orientation is not precisely the same as place of articulation, the variation that we have considered to be an inflection. In addition to being oriented toward its referent, a pointing gesture can also be displaced toward its referent, e.g., a point toward a toy could be made in neutral space or the point could be extended toward the toy; it is the extended point which would be comparable to the displaced characterizing gestures that we have coded as inflected. We have not yet examined the frequency with which pointing gestures are displaced, nor how such displacements might function within David’s system. However, since deictic pointing gestures function more like pronouns than nouns in David’s system, they might well turn out to pattern differently from nouns in the system.

when used as verbs (43% of the 148 gestures) than when used as nouns (14% of the 160 gestures, $\chi^2(1) = 33.23$, $p < .001$), although not more so than nouns and verbs that were not paired (43% of the verbs in noun-verbs pairs were inflected vs 55% of verbs overall).

In addition, David began using inflections more frequently on verbs than on nouns or adjectives during the initial observation session, and continued to do so consistently throughout the seven observation sessions. Thus, in the earliest sessions, in addition to having a lexical distinction between nouns, verbs, and adjectives (i.e., separate sets of lexical items to serve each of these grammatical roles), David also had a morphological distinction (inflections) marking verbs differently from nouns and adjectives.

Inflections and the thematic roles of the verb. In ASL, verbs are inflected to agree with arguments playing particular thematic roles. For example, a verb such as "give" can agree with two arguments; agreement with the indirect object (the recipient) is obligatory, whereas agreement with the subject (the agent) is optional (Meier, 1987). We found that David also used his inflections systematically to mark a particular thematic role for a given verb. For verbs representing transitive actions, the gesture was typically displaced toward the entity playing the patient role (i.e., the object acted upon); for example, David produced his "beat" gesture near a toy drum in the room, thereby marking the drum as the patient of the action predicate. 90% of David's 179 inflected verbs representing transitive actions were displaced toward entities playing the patient role. In contrast, for verbs representing intransitive actions involving a change of location, the gesture was typically displaced toward the entity playing the recipient role (i.e., the location or goal toward which the action was directed); for example, David moved his "go" gesture (a Palm hand moved in linear path across space) toward the open end of a car-trailer to indicate that cars go into the trailer, thereby marking the trailer as the recipient of the predicate. 58% of David's 26 inflected verbs representing intransitive actions involving a change of location were displaced toward entities playing the recipient role. Finally, for verbs representing intransitive actions which did not involve crossing space, the gesture was typically displaced toward the place where the action occurred; for example, David produced a "flip-over" gesture (a Point hand rotated in place) in the spot where a toy had flipped over. 67% of David's 6 inflected verbs representing intransitive actions not involving a change of location were displaced toward the place where the action occurs. Gestures were very rarely displaced toward the actor of either transitive or intransitive actions.

It is worth noting that David's verb marking system is similar to ASL in that objects, either the direct object (the patient) or the indirect object (the

recipient), are preferentially marked over subjects (the actor); indeed, there is a marking hierarchy in ASL such that the subject can be marked only if the object is also marked (Supalla, 1992). However, David's system differs from ASL in that, in verbs representing transitive actions involving both types of objects (i.e., both a patient and a recipient), it is the indirect object (the recipient) that is marked in ASL (Meier, 1987) but the direct object (the patient) that is marked in David's system. In addition, while double-marking of certain verbs is possible in ASL (e.g., the verb "give" can be marked for both the recipient and the agent, Meier, 1987), David was never observed to mark two thematic roles on a single verb.

Finally, as in ASL, it was not necessary that an entity be in the room for David to mark it morphologically via displacement (cf. Butcher et al., 1991). David could produce his verb near an entity that was similar to the entity he wished to mark (e.g., a "twist" gesture produced near an empty jar of bubbles to indicate that he wanted the full jar of bubbles in the kitchen, i.e., the patient, twisted open), just as deaf children learning ASL at times mark their verbs by displacing them toward an entity in the room that resembles the intended absent entity (cf. Newport & Meier, 1985). Seven percent of the 211 verbs that David inflected were marked for entities that were not present in the room.¹²

Inflections and the predicate structure of the verb. We found that David was more likely to inflect verbs than nouns or adjectives. Nevertheless, David did not inflect his verbs 100% of the time. Although in natural languages, an inflection need not appear on every verb, there is typically some aspect of the grammatical system that conditions the appearance of the inflection. For example, certain verbs in ASL agree with only a single argument and must be inflected for that argument; others agree with two arguments, only one of which is obligatory and must be inflected; still others do not permit agreement at all and are never inflected (Padden, 1983). If David's gesture system is operating as a natural language, we might expect to find some aspect of his grammatical system that predicts when inflections will and will not occur.

Indeed, we found that the predicate structure of verbs functioned in just

¹² Nouns were not supposed to be inflected in David's system; nevertheless, David did inflect 13% of the nouns he produced. It is interesting to note that the majority of these (incorrectly) inflected nouns were marked for non-present entities. For example, David used the "swing" gesture to focus attention on a Donald Duck toy that swings on a trapeze (i.e., he used the gesture as a noun) and he produced the gesture, not near the actual Donald Duck toy, but near a Donald Duck toy that resembled the one he intended to refer to. 62% of David's 39 inflected nouns were marked for non-present entities, as opposed to 7% of David's 211 inflected verbs ($\chi^2(1) = 72.78, p < .001$). Thus, almost two-thirds of the exceptions to the "nouns are not inflected" rule fell into this special category.

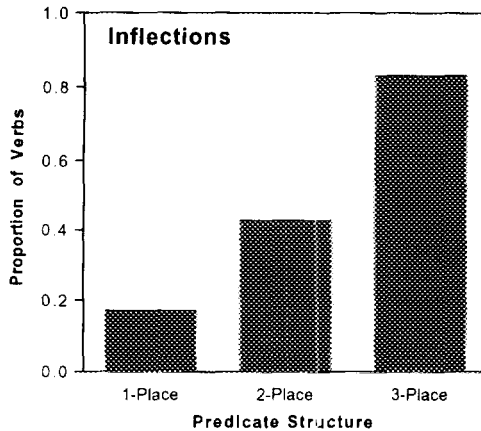


FIG. 3. Proportion of verbs with 1-place, 2-place, or 3-place predicate structure that were inflected in David's system.

this way in David's gesture system (see Goldin-Meadow, 1985, for evidence that the deaf child's gestures can, in fact, be characterized in terms of predicate structure, and for a discussion of how predicate structure is decided for a given gesture). The likelihood that a given verb was inflected in David's system was determined by the predicate structure of that verb. In particular, David was more likely to inflect a verb if the verb represented a predicate involving many arguments, than if the verb represented a predicate involving few arguments ($\chi^2(2) = 12.32, p < .01$). Partitioning the χ^2 , we were able to examine the individual pairwise comparisons. David was more likely to inflect a verb conveying a three-place predicate (e.g., "give" which involves three arguments, an actor, a patient, and a recipient; 83% of his 136 gestures) than he was to inflect a verb conveying a two-place predicate (e.g., "twist" which involves an actor and a patient, or "go" which involves an actor and a recipient; 43% of his 213 gestures, $\chi^2(2) = 53.18, p < .001$). Moreover, he was more likely to inflect a verb conveying a two-place predicate (43% of his 213 gestures) than he was to inflect a verb conveying a one-place predicate (e.g., "sleep" which involves only the actor; 17% of his 36 gestures, $\chi^2(2) = 11.80, p < .01$, see Fig. 3).¹³

Note that the likelihood that a verb conveying a three-place predicate was inflected in David's system was quite high (.83). Thus, there were conditions in David's gesture system under which verbs were inflected at

¹³ Note that, in ASL, whether a verb is inflected is determined, not by the argument structure of the verb (as in David's gesture system), but by the lexical class to which that verb belongs (Padden, 1983).

a rate approaching 100%. This finding suggests, not only that inflection is obligatory in verbs with three-place predicates in David's gestures, but also that David's gesture system may be a rule-governed system rather than a probabilistic one.

Inflections and deictic pointing gestures. Further evidence that inflection is obligatory in David's verbs with three-place predicates comes from the way in which he used inflections and deictic pointing gestures together. In 18% of the 391 verbs he produced, David marked the verb with an inflection and produced a deictic along with that verb; in half of these verbs, the inflection and deictic conveyed the *same* thematic role (typically the patient, e.g., the "transfer" verb was extended toward the cookie and was produced in combination with a pointing gesture at the cookie). We found that David inflected the patient of verbs with three-place predicates at a high rate, independent of whether a deictic pointing gesture for the patient was produced along with the verb: 78% of David's 36 verbs with three-place predicates which were accompanied by a deictic for the patient were inflected for the patient, compared to 81% of his 103 verbs with three-place predicates which were *not* accompanied by a deictic for the patient. In other words, David marked the patient of his three-place predicate verbs via inflection whether or not the patient was conveyed via a pointing gesture.

In contrast, in David's verbs in which inflection did not appear to be obligatory (i.e., in his verbs with two-place predicates), the likelihood that the verb was inflected for a role *did* appear to be affected by the presence of a deictic for that role: 20% of the 30 transitive verbs with two-place predicates which were accompanied by a deictic for the patient were inflected for the patient, compared to 44% of the 102 transitive verbs with two-place predicates which were *not* accompanied by a deictic for the patient ($\chi^2(1) = 4.72, p < .05$). In other words, David was significantly less likely to mark the patient of a transitive verb with a two-place predicate via inflection if it were already accompanied by a deictic indicating the patient, than if it had no deictic for the patient. Thus, for verbs in which inflection was not obligatory, the presence of an inflection for a particular role was conditioned not only by predicate structure of the verb but also by the presence of a deictic pointing gesture for that role.

Essentially what we see in David's transitive verbs with two-place predicates is a trade-off between inflections and deictics—a pattern comparable to the pattern found in agreeing verbs in ASL which allow null arguments (i.e., the absence of a deictic in David's system) if the argument is marked morphologically (Lillo-Martin, 1986). Stated in these terms, David was significantly less likely to produce a deictic for the patient if the patient were already marked via inflection, than if the patient were *not* marked via an inflection (12% of his 51 transitive verbs with

two-place predicates with a patient inflection were produced with a deictic for the patient, compared to 30% of his 81 transitive verbs with two-place predicates without a patient inflection, $\chi^2(1) = 4.72$, $p < .05$). In other words, as in ASL, it was permissible for David to omit a deictic gesture for a thematic role if that role were already marked morphologically via inflection.¹⁴

In addition to the instances where inflections and deictics specified the same thematic role, there were also instances in David's system where the inflection and the deictic each specified a *different* thematic role; half of the 72 verbs David produced with both an inflection and a deictic were of this sort. The most common pair of thematic roles conveyed in this manner was a patient role (typically conveyed by the inflection) and a recipient role (typically conveyed by the pointing deictic); for example, the "transfer" verb extended toward the entity to be transferred (the patient) plus a pointing gesture at the place to which the entity is to go (the recipient). This combination or its reverse (i.e., the recipient conveyed by the inflection and the patient conveyed by the deictic, e.g., the "transfer" verb extended toward the recipient plus a pointing gesture at the patient) occurred in 27 of the 36 verbs. In another 4 verbs, the patient and the actor were conveyed by inflection and deictic; in 3 verbs, the patient and the place were conveyed by inflection and deictic; and in 2 verbs, the actor and the recipient were conveyed by inflection and deictic. Thus, perhaps not surprisingly given the tendency for patients to be marked in transitive relations in David's system, patients were indicated either by inflection or by deictic in 94% of the 36 verbs, all but one of which were transitive.

In sum, David used inflections preferentially on verbs rather than nouns or adjectives. Thus, along with abbreviations, inflections served to distinguish verbs from nouns and adjectives in David's system. Abbreviations were used to mark nouns and adjectives, and inflections were used to mark verbs. In this regard, it is important to note that only 7 of the 915 gestures in David's corpus (i.e., less than 1%) were produced with both an abbreviation and an inflection, providing further evidence that abbreviations and inflections were markings whose use was restricted to different grammatical categories in David's system. Moreover, when David used

¹⁴ There were, however, many instances in which David failed to specify an argument either via inflection or via a deictic gesture (e.g., note that 70% of his 81 transitive verbs with 2-place predicates were produced without either inflection or deictic). In fact, Lillo-Martin (1986) argues that there is a set of non-agreeing verbs in ASL which allow null arguments even if there is no morphological marking for the argument. The omission of an argument in these verbs appears to be the result of topic-deletion. Further analysis is needed to determine whether David's extensive omission of arguments can be explained by topic deletion.

abbreviations on his nouns and inflections on his verbs, he did so in a manner consistent with natural languages, particularly signed languages. His use of abbreviations to distinguish nouns from verbs in noun-verb pairs was comparable to derivational morphology in ASL, and his use of inflections on verbs was comparable to inflectional morphology in ASL. Specifically, David conditioned the appearance of an inflection on a verb in his system as a function of the predicate structure of that verb, and he used inflections to mark particular thematic roles on the verb and did so in conjunction with deictic points (the other device in David's system for signaling thematic roles).

Syntactic Distinctions for Nouns, Verbs, and Adjectives

In our previous work (Goldin-Meadow & Feldman, 1977), we found that David's gesture sentences conformed to simple gesture order patterns based on semantic categories such as patient, act, recipient, etc. For example, David was found to have a reliable Patient-Act ordering pattern, where the patient was conveyed by a pointing gesture indicating the object which played the patient role, and the act was conveyed by an action characterizing gesture (e.g., point at grape followed by the "eat" gesture, used to comment on the fact that we were all eating grapes). We ask here whether characterizing gestures, when used as nouns, occupy the same position in a gesture sentence as characterizing gestures used as verbs and adjectives. If, for example, David were using his "eat" gesture as a name for the grape, would he again produce the "eat" gesture after the point at the grape, or would he distinguish the noun from the verb, perhaps by placing it before the point.

We looked at David's characterizing gestures used as nouns, many of which were used in sentences with pointing gestures that indicated the object named in the gesture (akin to a naming sentence in child language, e.g., "that a giraffe"). We found that in sentences of this type, David tended to produce the characterizing gesture *before* the pointing gesture, e.g., he produced a "blow" gesture followed by a point at a picture of a horn in a sentence used to identify the horn (66% of the 44 gesture sentences containing noun characterizing gestures plus points at the objects they named conformed to this characterizer-before-point pattern, see Fig. 4).

In contrast, the predominant pattern for both adjective characterizing gestures (in combination with entities) and verb characterizing gestures (in combination with patients) was point-before-characterizer. David's sentences with adjective gestures conformed to an Entity-Adjective ordering pattern; for example, point at block followed by the "curved" gesture, used to comment on the fact that the block had a curved arc on one side (84% of the 31 gesture sentences containing only entities and

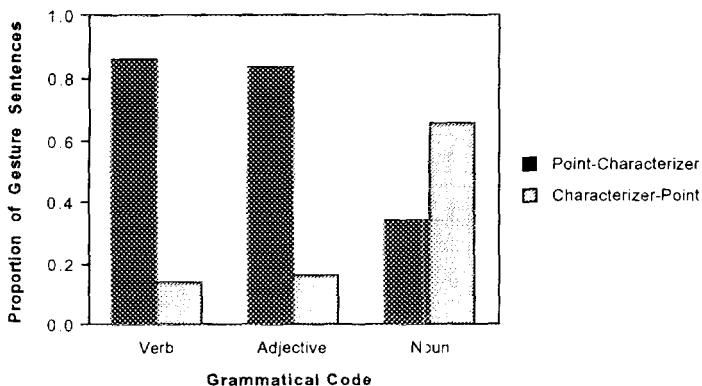


FIG. 4. Proportion of gesture sentences containing a pointing gesture plus a characterizing gesture, classified according to the characterizing gesture's grammatical role (verb, adjective, or noun) and according to the ordering of the two gestures (point before characterizer vs characterizer before point) in David's system.

adjectives with no repetitions conformed to this pattern, Fig. 4). Similarly, David's sentences with verb gestures conformed to a Patient-Verb ordering pattern; for example, point at horn followed by the "blow" gesture, used to request mother to blow the horn (86% of his 43 gesture sentences containing only patients and verbs with no repetitions conformed to this pattern, Fig. 4). Thus, while 29 of the 44 noun characterizers conformed to the characterizer-before-point pattern, only 6 of the 43 verb characterizers ($\chi^2(1) = 24.41, p < .001$) and only 5 of the 31 adjective characterizers ($\chi^2(1) = 18.19, p < .001$) conformed to this pattern.

In addition, it is important to note that in the few instances where nouns and verbs were combined within a single sentence in David's system, the gestures adhered to the syntactic rules of the system. David produced noun characterizing gestures playing a patient role before verb characterizing gestures, just as he produced deictic pointing gestures playing a patient role before verb characterizing gestures. For example, David produced an "eat" gesture coded as a noun—perhaps better glossed as "food"—followed by a "give" gesture coded as a verb, in order to request that a toy grape (which he knew was not edible) be given to him. In this instance, "food" was used to identify the grape, which was playing the patient role in the "give" proposition. If David were following his normal syntactic pattern established on the basis of deictic pointing gestures (akin to pronouns) and verbs, "food" ought to precede the verb "give," as it did. David produced five sentences in which noun and verb characterizing gestures were combined, all of which conformed to the Patient-Verb order established on the basis of his deictic pronouns and verbs. Thus, when nouns were produced in sentences with verbs, they

took over the slot typically filled by deictic pronouns, suggesting that the grammatical categories noun and verb were part of David's syntactic system and were governed by the rules of that system.

In sum, David used both morphological and syntactic devices to distinguish nouns from verbs in his gesture system in general. Moreover, he used these devices to distinguish the same gesture when it was used as a noun or as a verb. Specifically, gestures used as nouns were distinguished from those used as verbs in three different ways: Nouns were more likely to be abbreviated than verbs, were less likely to be inflected than verbs, and tended to precede pointing gestures while verb gestures tended to follow them. Note that gestures used as adjectives were treated like nouns with respect to morphology (i.e., adjectives tended to be abbreviated but not inflected), but like verbs with respect to syntax (i.e., adjectives tended to follow pointing gestures). Thus, David's adjective gestures appear to behave as adjectives do in natural languages—at times categorized with morpho-syntactic properties similar to those of verbs, and at other times with morpho-syntactic properties similar to those of nouns (Thompson, 1988).

The Problem of Circularity

We attempted to make our initial decisions about a gesture's status as noun, verb, or adjective on the basis of the gesture's role in the communicative situation: Gestures used to focus attention on an entity rather than to say something about that entity were considered nouns; gestures used to say something about the entity were considered verbs or adjectives. Using these noun, verb, and adjective categories, we then discovered formal properties of the gestures (both morphological and syntactic properties) that distinguished among the three grammatical roles. Thus, we first classified gestures into three categories on the basis of their role in communicative discourse, and then discovered formal characteristics that distinguished the categories from one another. However, since our categorizations were based on contextual cues that are difficult to pinpoint, is it possible that we unknowingly used the formal properties of a gesture as the basis for deciding that gesture's status as a noun, verb, or adjective? In other words, is it possible that our discovery process was circular?

We think that circularity of this sort is unlikely for several reasons. First, note that the formal properties we have isolated as distinctive markers on nouns, verbs, and adjectives in David's system (i.e., abbreviations, inflections, and gesture order) cannot always be used as reliable cues to the gesture's grammatical status. Abbreviations were relatively infrequent in David's gestures and, although when present they signaled a gesture's status as a noun or adjective, the absence of an abbreviation provided no information about the gesture's grammatical status. Simi-

larly, inflections occurred with near certainty on only a limited subset of verbs, verbs with three-place predicates. Verbs with two-place predicates were inflected less than half the time, and verbs with one-place predicates were inflected very infrequently; thus, for these verbs, inflections could not be used as a reliable cue to grammatical status. Finally, the majority of characterizing gestures occurred alone and not in combination with other gestures; thus, for the gestures, gesture order could not be used to determine grammatical status. As a result, the grammatical classifications for many gestures could not have been done on the basis of formal characteristics and had to have been based instead on contextual cues.

In addition, it is worth noting that we coded the data for syntax several years before the noun-verb-adjective coding decisions were made on the data. Thus, these two passes through the data were done independently and separated by a long period of time. Moreover, we coded the aspects of form that were eventually isolated as morphological markers (i.e., place of articulation, motion, handshape) several years before we even began to think that nouns and verbs might be treated differently in David's system; that is, the data were *not* coded with this particular hypothesis in mind. Finally, the decision that a gesture was an abbreviation was not made at the time that the individual noun-verb-adjective decisions were made, but was derived subsequently on the basis of the entire data base. A gesture was classified as an abbreviation if it was reduced relative to its prototype, and prototypes were determined on the basis of the characterizing gestures produced over the entire two-year period. In other words, one needed to know the prototypes in David's system in order to recognize a particular form as an abbreviation. Thus, coders were not asked to decide whether a gesture was an abbreviation, and it is therefore unlikely that they used abbreviation as the basis for deciding a gesture's grammatical status.

Finally, it is important to point out that, no matter how we arrived at our categories (i.e., no matter what we used to break into the system), if the categories we used were determined reliably (as they were), the description based on those categories can be taken as an accurate description of David's gesture system. To the extent that the description has internal coherence, and to the extent that this internal structure resembles the structure of natural language, we can feel increasingly confident that David's gesture system is language-like and that the categories upon which the system is based are valid.¹⁵ We take as evidence for the internal

¹⁵ Note that internal coherence is not a particularly effective argument against circularity if coherence is based on patterns within a single formal property; for example, the fact that inflections pattern systematically with nouns and verbs in David's system is not, in and of itself, a compelling argument against circularity simply because inflection could have been

coherence of David's system the fact that the noun-verb-adjective distinctions drawn in terms of inflections and abbreviations were concordant with the noun-verb-adjective distinctions drawn in terms of syntactic ordering. Moreover, comparing David's system to conventional sign language, we find that David made many of the same distinctions and even used the same dimensions to draw these distinctions (e.g., he used repetition to distinguish nouns from verbs, as does ASL; he used the placement of his verb to mark particular thematic roles on the verb, as does ASL). We take this as evidence that David's system is not only internally coherent but is also coherent when evaluated against natural language. Finally, the fact that David's system resembled ASL in the distinctions it made but differed in the details of the machinery used to make those distinctions (e.g., David reduced the form of a noun to distinguish it from a verb, whereas ASL repeats it; David marked the patient in his three-place predicate verbs while ASL marks the recipient) makes it unlikely that David learned his language-like system from a conventional language model, and suggests that it is indeed a self-styled system.

Are David's Nouns and Verbs Grammatical Categories or Names for Objects and Actions?

We began our search for a noun-verb distinction in David's gesture system with an intuitive guess as to which of his characterizing gestures were nouns and which were verbs. Using these noun and verb categories, we found both morphological (i.e., variations within the gesture itself) and syntactic (i.e., variations across a string of gestures) patterns that distinguished between nouns and verbs in David's system. As described above, we take these formal patterns to be evidence for the noun and verb categories we coded in David's gestures since the former (the patterns) are formulated in terms of the latter (the categories). The question then arises—what are these categories that we have called “nouns” and “verbs” in David's gestures? The evidence that we have presented thus far argues only that the categories we have isolated are real, not that the categories are necessarily nouns and verbs. To pursue this question, we decided to go back to the videotapes and explore more carefully the contextual conditions under which the categories noun and verb were coded. We used recent work exploring the contexts in which young English-learning children produce nouns and verbs as a guide in determining which aspects of context ought to be coded.

used to divide gestures into nouns and verbs in the first place. However, to the extent that internal coherence is determined across several formal properties (e.g., inflection, abbreviation, and gesture order all work together to systematically distinguish nouns from verbs), the case against circularity is considerably strengthened.

In their work on children's early uses of nouns and verbs in English, Huttenlocher and Smiley have found that certain contextual conditions tend to co-occur with the child's use of nouns (1987) and others tend to co-occur with the child's use of verbs (1989). In particular, Huttenlocher and Smiley (1989) found that children ranging in age from 11 to 24 months produced words that are verbs in the adult lexicon in contexts in which the action represented by that word is actually occurring or is being requested. On average, 91% of the 10 verbs that were produced most frequently by the children were produced under these conditions. In contrast, Huttenlocher and Smiley (1987) found that these same children produced words that are nouns in the adult lexicon in contexts in which the object represented by that word is present and visible. An action may occur in the context but it is not the same action which occurs across all uses of the word; that is, for nouns, what is constant about the context for a given word is the object rather than the action. On average, 89% of the 25 nouns that were produced most frequently by the children were produced under these conditions.

On the basis of these findings, we coded the context for each gesture in terms of whether the action portrayed in the gesture was taking place in the immediate context, and in terms of whether an object associated with that action could be found in the immediate context. We divided our contextual codes into three major categories: (1) The action which was portrayed in the gesture occurred on an object in the immediate context; the action was either portrayed in a picture, occurred at the same time as the gesture, occurred immediately prior to the gesture, or occurred immediately after the gesture. (2) The action which was portrayed in the gesture did not occur in the immediate context, but an object associated with the action was present; the object was either the actual object referred to in the gesture, an object similar to the actual object, a toy replica of the object, or a picture of the object. (3) The action which was portrayed in the gesture did not occur in the immediate context, and an object associated with the action was not in the context; the object either was hidden from view or was not present at all. We did this contextual coding for the 10 most frequent gestures that David used as both nouns and verbs (i.e., for the 10 most frequent noun-verb pairs in David's gestures). David produced each of these gestures a minimum of 10 times, and the average number of occurrences per gesture was 17.3. Half of the gestures whose context we explored were used as verbs ($N = 89$) and half were used as nouns ($N = 89$).

Table 1 displays each occurrence of these 10 gestures, classified first according to whether it was coded as a verb or noun, and second according to the context in which it was produced. The data displayed in Table 1 are summarized in terms of the three major divisions in our contextual

Gestures Coded as Verb or Noun Classified According to the Context in Which They Were Produced^a

Lexical item	Action & object present in context				Action absent, object present				Action & object both absent	
	Action in picture	Action at same time as gesture	Action before gesture	Action after gesture	Actual object	Similar object	Toy object	Picture of object	Hidden object	Absent object
Coded as verbs										
Beat				1						
Beat vertically	1		3				3			
Eat	1	1	1	2	1			1		2
Fly		1	1							
Hold at mouth		1	5	2	1					
Move I		1	6	4	4		1	1		
Move II		3	3	1	2		3	3		
Move overhead		1	1	1			2	1		1
Move to & fro in parallel			3				2			
Twist		1	1	15						
Coded as nouns										
Objects associated with:										
Beating		1				2	2	1	3	3
Beating vertically						5	3			
Eating										1
Flying		1					11	4	1	2
Holding at mouth							4	3		2
Moving I										1
Moving II							5	1		1
Moving overhead		1						2		1
Moving to & fro in parallel							4	9	7	5
Twisting			1							2

^a The gestures included in this table are the 10 most frequent gestures which were at times coded as verbs and at other times coded as nouns. Each gesture was produced a minimum of 10 times, and the average number of occurrences per gesture was 17.8. Context is divided into three major categories: (1) The action which was portrayed in the gesture occurred on an object in the immediate context; the action was portrayed in a picture, occurred at the same time as the gesture, occurred immediately prior to the gesture, or occurred immediately after the gesture. (2) The action which was portrayed in the gesture did not occur in the immediate context, but an object associated with the action was present; the object was the actual object referred to in the gesture, an object similar to the actual object, a toy replica of the object, or a picture of the object. (3) The action which was portrayed in the gesture did not occur in the immediate context, and an object associated with the action was not in the context; the object either was hidden from view or was not present at all.

TABLE 2
Proportion of Gestures Occurring in Each of Three Contexts Classified According to
Whether They were Coded as Verbs or Nouns

Grammatical code	Contextual code		
	Action and object both present when gesture produced (N = 65)	Action absent object present when gesture produced (N = 81)	Action and object both absent when gesture produced (N = 32)
Gesture coded as verb	.94	.31	.09
Gesture coded as noun	.06	.69	.91

codes in Table 2. As can be seen most clearly in Table 2, at times, our contextual codes and our grammatical codes carved out precisely the same categories. When a gesture was produced in a context in which *both* the action and the object were present, we were almost certain to code that gesture as a *verb* (94% of the 65 gestures occurring in this context were coded as verbs). On the other hand, when a gesture was produced in a context in which *neither* the action nor the object was present, we were almost certain to code that gesture as a *noun* (91% of the 32 gestures occurring in this context were coded as nouns).¹⁶ Thus, in these two instances, our contextual codes and our grammatical codes agree and, as a result, make the same predictions about how the formal devices described earlier ought to pattern. In particular, the gestures that are coded as verbs and occur in contexts in which both action and object are present ought to behave like verbs (i.e., they ought to be inflected but not abbreviated, and they ought to occur in sentences in which pointing gestures precede characterizing gestures). In contrast, the gestures that are coded as nouns and occur in contexts in which neither the action nor the object is present ought to behave like nouns (i.e., they ought to be abbreviated but not inflected, and they ought to occur in sentences in which pointing gestures follow characterizing gestures).

However, note in Table 2 that our grammatical codes and our contex-

¹⁶ Given Huttenlocher and Smiley's (1987) findings on the contexts in which the young child's earliest nouns occur, it may be somewhat surprising that David produced so many gestures coded as nouns in situations in which the object was not present. However, it is important to note that David was significantly older than the children in Huttenlocher and Smiley's study who were not observed beyond two years of age. In contrast, David was 2 years, 10 months at our first observation session and was observed until he was 4 years, 10 months old. Thus, during the period of observation, David was certainly capable of referring to objects which were not present in the immediate context (cf. Butcher *et al.*, 1991) and appeared to do so fairly often.

tual codes are not in agreement for the third set of gestures, that is, for gestures produced in contexts in which the action was not present but the object was: 31% of these gestures were coded as verbs, and 69% were coded as nouns. In a sense, these gestures are the most interesting since they present us with the opportunity to explore whether the formal devices described above pattern according to context, or according to grammatical category. If we are correct in arguing that the morphological and syntactic devices described earlier function to distinguish the grammatical categories of noun and verb, the devices ought to pattern according to the grammatical code rather than the contextual code when the two disagree. Thus, independent of context, nouns ought to behave like nouns with respect to both morphology and syntax, and verbs ought to behave like verbs. However, if the morphological and syntactic devices we have described in fact function to distinguish objects and actions rather than nouns and verbs, we might then expect the devices to pattern according to the contextual code rather than the grammatical code when the two disagree. Thus, independent of grammatical category, gestures that are produced in contexts in which the action is absent and the object is present ought to behave alike, perhaps intermediate between the other two contexts (those in which both the action and object are present, and those in which neither is present).

The relevant data are found in Table 3 which presents the morphological and syntactic characteristics of a gesture as a function of its grammatical code and its contextual code. Note first that, not surprisingly, when grammatical code and contextual code agree, the morphological and syntactic patterns were as expected: (1) Verbs occurring in contexts in which both the action and object were present were likely to be inflected,¹⁷ unlikely to be abbreviated, and (although the numbers of relevant gesture sentences in this sample are small) likely to occur in sentences in which points precede characterizing gestures. (2) Nouns occurring in contexts in which neither the action nor the object is present were unlikely to be inflected, relatively likely to be abbreviated, and likely to occur in sentences in which points follow characterizing gestures.

The interesting question, however, is what happens when the grammatical code and the contextual code disagree. In other words, what happens to gestures occurring in contexts in which the action is absent and the object is present? Do they all behave in the same way as context (action absent, object present) would predict, or do they differ depending upon whether they have been coded grammatically as nouns or verbs? The data

¹⁷ The gestures coded as verbs in Table 3 were inflected at the relatively low rate of 40% primarily because many of the verbs included in this sample had two-place predicate structures; a 40% rate of inflection is typical for verbs of this type (cf. Fig. 3).

TABLE 3
Morphological and Syntactic Characteristics of a Gesture as a Function of Its Grammatical Code and Its Contextual Code^a

Grammatical code	Coded as verbs		Coded as nouns	
	Action & object both present when gesture produced	Action absent object present when gesture produced	Action absent object present when gesture produced	Action & object both absent when gesture produced
Morphological marking				
Proportion of inflections	.41 (61)	.40 (25)	.13 (56)	.10 (29)
Proportion of abbreviations	.07 (61)	.04 (25)	.27 (56)	.21 (29)
Syntactic ordering				
Proportion of point-characterizer sentences	.60 (5)	.50 (2)	.11 (9)	.13 (8)

^a The gestures described in this table are the gestures whose context of use is displayed in Table 1. The numbers in parentheses represent the total number of relevant gestures in each category. The numbers for syntactic ordering are small because there were very few two-gesture sentences in this sample.

presented in Table 3 are quite clear. The morphological and syntactic devices we have described pattern according to the grammatical code of a gesture rather than its contextual code. Note first that gestures occurring in contexts in which the action is absent and the object is present behave differently if they are coded as verbs than if they are coded as nouns ($\chi^2(1) = 6.31, p < .02$ for inflections; $\chi^2(1) = 4.31, p < .05$ for abbreviations; the numbers are too small to test for significance for syntax). In addition, when gestures occurring in this context are coded as nouns, they behave like other nouns (i.e., there are no significant differences between nouns occurring in contexts in which the action is absent and the object is present and nouns occurring in contexts in which neither the action nor the object is present; $\chi^2(1) = .004, p > .90$, for inflections; $\chi^2(1) = .12, p > .70$, for abbreviations; $\chi^2(1) = .44, p > .50$ for syntax). Similarly, when gestures occurring in this context are coded as verbs, they behave like other verbs (i.e., there are no significant differences between verbs occurring in contexts in which the action is absent and the object is present and verbs occurring in contexts in which both the action and object are present; $\chi^2(1) = .03, p > .80$ for inflections; $\chi^2(1) = .002, p > .95$ for abbreviations; the numbers are too small to test for significance for syntax). Thus, the morphological and syntactic devices we have

described appear to distinguish the grammatical categories of noun and verb, rather than to distinguish among contexts which vary in the presence and absence of object and actions.

From a developmental point of view, it is worth noting that none of the gestures whose grammatical code differed from the contextual code in Tables 1 and 2 were produced during David's earliest sessions. During the first three observation sessions, David produced verbs only in contexts in which both the action and object was present. Moreover, he produced nouns only in contexts in which the action was absent but the object was present. Thus, just as children learning English may initially distinguish between nouns and verbs on the basis of a semantic rather than a grammatical distinction (Macnamara, 1982), David's first categories may also have been based on a semantic distinction rather than a grammatical distinction. It was not until session four at age 3:3 (the session when David first used the same gesture in both a noun and verb role) that David began to use the gestures whose grammatical code did not match their contextual code. In session four, David produced some of the verbs in this sample in contexts in which the action was absent but the object was present (he produced no nouns in this sample in session four) and, after this session, he produced both nouns and verbs in all three contexts. Moreover, as described above, he marked nouns as nouns independent of the context in which they occurred, and verbs as verbs independent of the context in which they occurred (cf. Table 3). Thus, by age 3:3, David appeared to have developed a division between nouns and verbs based, not on a semantic distinction between objects and actions, but on a grammatical distinction.

Do the data in Table 3 guarantee that the categories we have isolated are truly the grammatical categories of noun and verb rather than the semantic categories of object and action? In fact, the data in Table 3 suggest only that the noun and verb codes we have used to describe David's gestures are not reducible to one particular set of contextual codes. Given the bootstrap nature of our coding procedure, we can never prove beyond a doubt that the categories we have isolated are indeed the grammatical categories of noun and verb. Nevertheless, the fact that the categories we have isolated are not reducible to aspects of context that have been associated with objects and actions in previous research (cf. Huttenlocher & Smiley, 1987; 1989) makes it more likely that these categories are not just names for objects and actions.

In addition, the fact that the categories we have isolated pattern in many respects as do nouns and verbs in natural language provides further evidence that these are indeed grammatical categories rather than semantic categories. First, recall that there was coherence between the mor-

phological and syntactic devices in David's system. The morphological devices worked together to distinguish the grammatical categories of noun and verb: Inflections marked verbs, abbreviations marked nouns, and virtually no gestures were produced with both markings. Moreover, nouns and verbs occupied different positions in gesture sentences, verbs occurring after the pointing gesture and nouns occurring before the pointing gesture. Second, the particular way in which the morphological and syntactic devices were used to distinguish adjectives from nouns and verbs is reminiscent of patterns found in natural languages. In particular, adjectives in David's system behaved like nouns morphologically (they were abbreviated rather than inflected) but like verbs syntactically (they occurred after the pointing gesture), as do adjectives in some natural languages (cf. Thompson, 1988). Finally, in the few instances where nouns and verbs were combined within a single sentence in David's system, the gestures adhered to the syntactic rules of the system. David produced noun characterizing gestures playing a patient role before verb characterizing gestures, just as he produced deictic pointing gestures playing a patient role before verb characterizing gestures. In other words, when nouns were produced in sentences with verbs, they took over the slot typically filled by deictic pronouns. Thus, the grammatical categories noun and verb were elements within David's syntactic system and, as such, were governed by the rules of that system, just as nouns and verbs are governed by the rules of syntax in natural language.

Discussion

A distinction between nouns and verbs is found in all natural languages. The data from this study suggests that such a distinction is sufficiently central to human communication that it can appear even in a self-styled gesture system created by a deaf child with no language model.

The deaf child in this study had developed a lexicon of gestures which were stable in form throughout the two year period of observation. Moreover, even during our initial observation session when the child was 2:10, his lexicon contained gestures which were used as nouns, as well as gestures which were used as verbs and adjectives. What changed over development, however, was the way in which the child distinguished nouns from verbs and adjectives.

Initially, David used pointing gestures to serve nominal functions and characterizing gestures to serve predicate functions (as verbs and adjectives). Thus, at this moment in David's development, a distinction between nouns and verbs/adjectives was achieved through a gross distinction in form: The stationary and directed index finger signaled nominal functions; all other gesture forms signaled predicate functions.

Sometime after age 2:10, David increasingly began to use characterizing gestures, not only as verbs and adjectives but also as nouns. However, David continued to maintain a distinction between nouns, verbs, and adjectives by having a lexicon in which certain characterizing gestures served as nouns, others served as verbs, and still others served as adjectives (just as hearing children in the earliest stages of acquisition do with their words, Macnamara, 1982). In other words, the distinction between nouns, verbs, and adjectives was maintained lexically.

Finally, at age 3:3, David began to use the same characterizing gesture in more than one grammatical role as, for example, both noun and verb. However, when he did so, he used morphological and syntactic techniques to distinguish the different uses. Thus, David continued to maintain a distinction between nouns, verbs, and adjectives but, beginning at age 3:3, he did so *grammatically* rather than lexically.

It is worth noting that, at the same point in development, David's gesture system could, for the first time, be characterized as having two levels of structure—structure across gestures within a sentence, akin to syntactic structure, and structure within each gesture, akin to morphological structure. Before this age, there was evidence for structure across gestures in the deaf child's gesture system, but no evidence that the child had broken his gestures into component parts. At 3:3, however, David began to systematize his lexicon, changing it from a collection of gestures, each treated as a whole, into a system in which the component parts of each gesture contrasted in a meaningful way with the component parts of the other gestures in the lexicon (Goldin-Meadow & Mylander, 1990b). In order to be able to systematize his lexicon, David must have been able to treat his gestures as parts of a symbolic system. We speculate that it may be this same ability to distance himself from his gestures that allowed David, not only to use the same gesture as both a noun and a verb, but to use the morphological and syntactic devices of his system to maintain a distinction between the two uses.

In David's system, nouns were more likely to be abbreviated than verbs, were less likely to be inflected than verbs, and tended to precede pointing gestures while verbs tended to follow them. Note, however, that the usual evidence for a distinction between nouns and verbs is not that they are probabilistically different but that they are categorically different: Nouns may take certain inflections or word order positions which verbs cannot take, and vice versa. In this regard, it is important to note that, in David's system, verbs were very rarely abbreviated (.04), nouns were infrequently inflected (.13), and essentially no gestures had both an inflection and an abbreviation, suggesting that inflections and abbreviations were indeed markings whose use was restricted to different grammatical categories (verbs and nouns, respectively). Moreover, even

though David did not produce inflections on 100% of his verbs, there were certain types of verbs (verbs with three-place predicates) which were inflected at a very high rate (.83), suggesting that inflection was obligatory in some (grammatically appropriate) component of David's system.

In addition, there could be several reasons why David's system might appear probabilistic even though the system was, in fact, rule-governed. First, the data that we used to determine David's system were gesture production, as opposed to, for example, grammatical judgments. It is possible that errors of production made the child's gestures imperfect exemplars of the rules of his system; if so, patterns might have appeared probabilistic even though, at another level, they were governed by rules. Second, our subject was a child and children are particularly susceptible to production errors, more so than adults. Finally, we are not native users of David's language. As a result, our classifications may at times have been incorrect and such misclassifications could easily have obscured the rules of the system. In other words, David's system might appear probabilistic because of our inadequacies rather than his. Given these difficulties, it is impressive that we do find circumstances in David's system where his production approached 100% (e.g., 83% of his verbs with three-place predicates were inflected; 86% of his sentences containing patients and verbs and 84% of his sentences containing entities and adjectives were ordered "correctly"), suggesting that the system may indeed have been characterized by rules rather than probabilistic tendencies.

David thus appeared to respect intercategory boundaries between nouns and verbs in his self-styled gesture system. However, this adherence to intercategory boundaries does not appear to be a characteristic of all spontaneous gestures. Petitto (1992) analyzed the spontaneous gestures produced by three hearing children learning spoken language and three deaf children learning sign language, observed between 8 and 20 months; that is, she observed the "nonlinguistic" gestures that the children produced along with the conventional symbols they were learning (words for the hearing children and signs for the deaf children). Petitto found that, unlike David's gestures, the gestures that the hearing and deaf children produced were inconsistent in form (i.e., the form used for the same meaning varied within a child) and were used in restricted ways (i.e., only in the presence of a referent and only to request). Moreover, when the hearing and deaf children in Petitto's study produced a gesture, the range of referents over which that gesture was applied did not form particular types or kinds of object names, event words, etc. Throughout the period observed, it was common for a child to use a particular gesture in relation to, for example, a known type of related object in one context and, in another context, to use the same gesture in relation to objects from

a different type or to an action. Thus, unlike David, who at the early observation sessions had a set of gestures which were used exclusively as nouns, another set used exclusively as verbs, and a third set used exclusively as adjectives, at no time did the children in Petitto's study routinely restrict their use of a gesture to a single role.

Note that the children in Petitto's study were considerably younger than David; thus they may have used gesture more flexibly than David simply because they were at a different, and earlier, developmental stage. However, it is worth noting that the children in Petitto's study did *not* show the same type of flexible use in the words (or signs) they were learning. In fact, even when modality was held constant (i.e., for the deaf children in the study whose linguistic lexical items and nonlinguistic gesture were in the same modality), the lexical items did not cross type boundaries while the gestures often did. Two of the deaf children (age 20 months) produced the gesture "twist" in relation to jars at the same time that they produced the fully articulated adult sign "open." Whereas the sign "open" was used exclusively to convey the action of opening, the gesture "twist" was used not only to request that a jar be opened but also to refer to the jar itself. Moreover, unlike our findings for David, Petitto did not report any aspects of gesture form that might have been used systematically to distinguish among these various uses. Interestingly, gestures appeared to be used by the children in Petitto's study only after a word or sign had failed to get a response from an adult, e.g., the "twist" gesture was used as an apparent "last resort" to emphasize and augment primary linguistic information.

Indeed, McNeill (1992) and Goldin-Meadow (1993) have argued that the gesture which accompanies speech has a special role relative to that speech—it augments and supplements and generally serves an adjunct role in relation to speech. According to McNeill (1992), gesture and speech in hearing individuals form a single integrated system (cf. Goldin-Meadow, Alibali & Church, 1993), even very early in development (e.g., Morford & Goldin-Meadow, 1992). However, gesture and speech play very different roles in this system: Speech assumes the primary burden of communication and is structured in language-like ways, while gesture serves as an adjunct to speech and does *not* assume language-like structure—as Petitto has shown, not even adhering to the distinction found in all natural languages between object-referring and action-referring terms.

It is only when gesture is divorced from speech and must itself assume the full burden of communication that it has the potential to become language-like (e.g., Goldin-Meadow, McNeill & Singleton, 1993; Singleton, Goldin-Meadow & McNeill, 1993). Note that for the deaf child who has not yet been exposed to sign language and who cannot hear spoken

language, gesture is the sole means of communication. Indeed, the gestures produced by a deaf child in these circumstances appear to have many of the properties of language—including the important noun–verb distinction found in all natural languages.

STUDY 2

The child described in Study 1 did not have access to a conventional language model. Nevertheless, he did see the spontaneous gestures his hearing parents produced when they spoke to him, and these gestures might have provided a model for the noun–verb distinction the child developed. Although in previous work, we have shown that the spontaneous gestures David's mother produced were either less structured or structured differently from her child's gestures, both in terms of syntactic structure (Goldin-Meadow & Mylander, 1983, 1984) and morphological structure (Goldin-Meadow & Mylander, 1990b), Mother's gestures might have displayed a distinction between nouns and verbs which served as a model for David. We examined the spontaneous gestures that David's mother produced to explore this possibility.

Method

The subject for this study was David's primary caretaker who was his mother. We coded the gestures Mother produced during the seven free-play sessions described for David, using the system outlined in Study 1.

Results

The Stability of the Mother's Lexicon over Time

Interpretability of gesture. Unlike David's characterizing gestures, only 5% of which could not be assigned a meaning, 25% of Mother's 579 characterizing gestures could not be assigned a meaning when analyzed without speech and were coded as ambiguous. Thus, a quarter of Mother's gestures had to be eliminated from our analyses, suggesting from the start that Mother's gestures were less like a lexicon than David's.

Variability in the form–meaning pairs. Using the procedure described in Study 1, we found that Mother used 159 different form–meaning pairs during the observation period (David used 190 form–meaning pairs during the same period). Our next step was to determine whether there was variability around the prototypical forms associated with particular meanings in Mother's gestures. Of Mother's 159 lexical items, 85 were used only once; thus, there was no opportunity to observe variability in these gestures. The remaining 74 lexical items were produced more than once

during the period of observation and accounted for 290 gestures.¹⁸ We found that only 59% of these 290 gestures conformed to prototype in Mother's gestures (compared to 90% in David's 706 gestures, $\chi^2(1) = 131.19, p < .001$).¹⁹ In fact, we found variability from prototype in at least one of the tokens of 65% of the 74 lexical items in Mother's system (compared to 33% of the 109 lexical items in David's system, $\chi^2(1) = 17.992, p < .001$). Thus, unlike David who used essentially the same form to convey a particular meaning throughout the 2-year period he was observed, Mother's gesture use was much more variable and inconsistent, again suggesting that her gestures were less like a lexicon than David's.

Nouns, Verbs, and Adjectives in Mother's Lexicon

We ask here whether, like David, Mother used her characterizing gestures in all three grammatical roles, as nouns, verbs, and adjectives. We found that Mother did indeed use her characterizing gestures as nouns as well as verbs and adjectives, but did so less often than David. Overall, 10% of Mother's 353 characterizing gestures were used as nouns (compared to David's 40%), whereas 73% were used as verbs and 17% were used as adjectives (compared to David's 49% and 11%, respectively). Moreover, Mother did not begin to use nouns with any great frequency until session six when David was 3:11, whereas David began to consistently use a large proportion of nouns 6 months earlier at age 3:5 (see Fig. 1 which presents the proportion of characterizing gestures that David and Mother used as nouns vs verbs and adjectives at each of the seven observation sessions). Thus, David may have gotten the idea that characterizing gestures could be used as nouns as well as verbs and adjectives from Mother. However, David appears to have incorporated this type of use for his characterizing gestures into his system well before Mother—indeed Fig. 1 suggests that Mother is following David's lead.

We looked also to see whether David and Mother had many lexical items in common; that is, whether they used the same forms to convey the same meanings and, if so, whether the gestures they had in common were

¹⁸ For 59 of Mother's gestures (17% of the 349 gestures that she used more than once), it was impossible to see the entire gesture on the videotape; these gestures were therefore eliminated from this analysis.

¹⁹ The χ^2 statistic we have used for our mother-child comparisons requires two independent samples. Since mother and child were partners in the same conversational situation, some aspects of their gesture interaction (e.g., the number of turns each takes) might not be independent of one another and therefore might not warrant use of this statistic. However, we believe that the particular aspects of mother and child gesture that we have focused on for this and for subsequent analyses were independent of one another. Thus, the mother and child samples on the particular measures of interest to us are likely to meet the requirement of independence necessary for the χ^2 statistic.

used in the same grammatical roles. We found that Mother and David had 18 lexical items in common. These 18 lexical items represent only 11% of Mother's 159 lexical items and 9% of David's 190 lexical items. Moreover, we found that only 9 of these 18 lexical items were used in precisely the same grammatical roles by both Mother and David (7 were used by both Mother and David exclusively as verbs, 1 exclusively as a noun, and 1 exclusively as an adjective). Thus, Mother and David did not have the same gesture vocabularies, nor did they necessarily use the few gestures they did have in common in precisely the same ways.

Do Mother's Gestures Respect Intercategory Boundaries?

We found that 95% of the lexical items Mother produced fell into a single grammatical category: 88 of the 142 lexical items in Mother's lexicon that could be assigned a grammatical category were always coded as verbs, 24 were always coded as adjectives, and 23 were always coded as nouns. Moreover, like David, Mother did at times use a particular characterizing gesture in more than one grammatical role (she used 1 gesture as both nouns and verbs, 3 gestures as both nouns and adjectives, and 3 gestures as both verbs and adjectives), although she crossed boundaries significantly less often than David: 5% of her 142 lexical items were used in more than one grammatical role, compared to 22% of David's 177 ($\chi^2(1) = 17.32, p < .001$).

However, Mother was observed to use a particular gesture in more than one grammatical role earlier than David. Mother used a gesture as both a noun and a verb during the third observation session when David was 3:0; David did not begin until age 3:3. Moreover, Mother used a gesture as both a noun and an adjective during the fourth observation session when David was 3:3; David did not begin until age 3:11. Thus, David may have learned to violate intercategory boundaries by imitating his Mother's gesture use. We now ask whether Mother used the same type of morphological and syntactic markings that David used to distinguish the different uses of a gesture.

Morphological Distinctions for Nouns, Verbs, and Adjectives

Reduction in handshape or motion: Derivational abbreviations. We found that Mother produced no abbreviations and therefore obviously did not distinguish noun uses of a gesture from its verb uses via abbreviation. That is, Mother never produced a two-handed gesture with only one hand, and never abbreviated a bidirectional or a unidirectional motion. Thus, this particular "derivational" marking is one David is not likely to have learned from his Mother.

Variation in place of articulation: Inflectional markings on the verb. Mother did, however, vary the place of articulation of her gestures. In

fact, like David, she used inflections differentially depending upon the grammatical role of the gesture ($\chi^2(2) = 83.0, p < .001$). Partitioning the χ^2 we were able to examine the pairwise comparisons and here we found that Mother resembled David in some respects but differed in others. Like David, Mother used inflections significantly more often on verbs (34% of her 254 gestures) than on nouns (8% of her 36 gestures, $\chi^2(2) = 9.97, p < .01$). However, unlike David, she did not use inflections reliably more often on verbs (34%) than on adjectives (21% of her 58 gestures, $\chi^2(2) = 3.97, p > .10$). Finally, like David, Mother did not use inflections to reliably distinguish between nouns and adjectives: 8% (of 36 gestures) for nouns vs 21% (of 58 gestures) for adjectives ($\chi^2(2) = 1.65, p > .10$). In terms of noun-verb pairs, Mother produced only one gesture which was used as both a noun and a verb. Although she did inflect this gesture 5 of the 8 times it was used as a verb, she also inflected the gesture the one time it was used as a noun. Thus, she did not use inflections to distinguish the noun from the verb in her pair, as David did in his pairs.

In addition, Mother did not use her inflections to mark thematic roles as distinctively or as consistently as David. For transitive actions, David typically displaced the verb toward the entity playing the patient role: 90% of the relevant 179 verbs were displaced toward entities playing the patient role for David, whereas for Mother only 57% of her 56 verbs were displaced toward the patient ($\chi^2(1) = 27.47, p < .001$). Similarly, for intransitive actions involving a change of location, David typically displaced the verb toward the entity playing the recipient role: 58% of the relevant 26 verbs were displaced toward entities playing the recipient role for David, while for Mother none of her 13 verbs were displaced toward the recipient ($\chi^2(1) = 12.19, p < .001$). Only for intransitive actions which did not involve crossing space did Mother and David treat the verbs alike. Both tended to displace the verb toward the place where the action occurs: 67% of David's 6 verbs and 71% of Mother's 7 verbs were displaced toward the place where the action occurs. However, Mother's displaced verbs showed an overall tendency to be oriented toward the place where the action occurs regardless of the particular action: Across all action types (including both transitive and intransitive actions), 45% of Mother's 76 displaced verbs were oriented toward the place of the action (compared to 9% of David's 211 displaced verbs, $\chi^2(1) = 45.47, p < .001$). Mother also rarely displaced her verbs toward entities that stood for other entities; none of the 76 verbs that she inflected were marked for entities that were not present in the room, compared to 7% of David's 211 inflected verbs ($\chi^2(1) = 5.30, p \leq .02$).

Moreover, although Mother did inflect verb types at different rates depending upon their predicate structure ($\chi^2(2) = 12.32, p < .01$), Mother did not condition her use of inflections on the verb's predicate structure in

precisely the same way as David did. Partitioning the χ^2 , we examined the pairwise comparisons and found that, like David, Mother was more likely to inflect a verb conveying a three-place predicate than she was to inflect a two-place predicate (65% of 26 predicates vs 34% of 155 predicates, $\chi^2(2) = 9.87, p < .01$). However, unlike David, Mother was no more likely to inflect a verb conveying a two-place predicate than she was to inflect a verb conveying a 1-place predicate (34% of 155 predicates vs 26% of 27 predicates, $\chi^2(2) = 2.05, p > .30$). In contrast, David inflected 83% of his 3-place predicates, 43% of his 2-place predicates, and 17% of his 1-place predicates (cf. Fig. 3). Moreover, Mother's use of inflections never really approached 100% usage even in 3-place predicates, as it did in David's gestures. Thus, Mother's system appears to be, at best, a probabilistic system rather than a rule-governed system like David's.

Finally, David's inflectional system worked hand-in-hand with his deictic system. He often produced a deictic pointing gesture along with an inflected verb, and he used the two marking systems in a coordinated fashion. In contrast, Mother produced a deictic pointing gesture along with an inflected verb only three times (2% of her 198 verbs occurred with both a deictic and an inflection, compared to 18% of 391 for David, $\chi^2(1) = 32.28, p < .001$). Thus, although David's use of place of articulation on verbs appeared to function in many of the ways that inflections function on verbs in ASL, Mother's did not.

Syntactic Distinctions for Nouns, Verbs, and Adjectives

Unlike David who frequently produced his characterizing gestures in combination with pointing gestures, Mother produced very few such combinations. She produced no combinations of adjectives plus pointing gestures in the first five sessions (the last two sessions were not coded for Mother's syntax), and she produced only one combination of a noun plus a pointing gesture. Moreover, in that combination, Mother violated David's order for noun characterizing gestures: She produced the pointing gesture before the noun characterizing gesture rather than after it. Mother produced only two combinations containing verbs and pointing gestures; both combinations followed David's point-before-characterizer order.

The morphological and syntactic characteristics of Mother's gestures are summarized in Table 4. Although Mother's use of inflections does resemble David's at least in part, it is quite clear that David could not have learned this use of abbreviations or his syntactic ordering patterns from his Mother since these devices were virtually nonexistent in her gestures.

Discussion

One-quarter of the gestures Mother produced were uninterpretable to

TABLE 4
Summary of Morphological and Syntactic Characteristics of Mother's Gestures^a

	Grammatical code		
	Verb	Adjective	Noun
Morphological marking			
Proportion of inflections	.34 (254)	.21 (58)	.08 (36)
Proportion of abbreviations	.00 (254)	.00 (58)	.00 (36)
Syntactic ordering			
Proportion of point-characterizer sentences	1.00 (2)	— (0)	1.00 (1)

^a The numbers in parentheses represent the total number of relevant gestures in each category.

us. Moreover, within the remaining interpretable gestures, Mother tended to be inconsistent in the forms she used to convey a particular meaning. Thus, perhaps not surprisingly, given that Mother has a spoken vocabulary with which she can express herself, Mother's gestures did not appear to form a particularly stable lexicon. The stability we found in David's gestures in Study 1 apparently was not inspired by his Mother's gestures.

However, David may have learned that characterizing gestures can be used as nouns from his Mother. Both David and Mother used a small proportion of characterizing gestures as nouns at the initial observation session. Nevertheless, David made noun characterizing gestures a substantial part of his system several months before Mother did (indeed, noun gestures never accounted for half of the gestures in Mother's system during our observations but they did for David).

David may also have learned that the same gesture can be used as both a noun and a verb from his Mother, who was in fact the first of the dyad to cross intercategory boundaries in gesture. Just like children learning a spoken language who presumably learn that the same word can be used as both a noun and a verb from hearing their parents use a word like "comb" in both roles, David may have acquired this type of flexibility in his gestures as a result of Mother's gestural model. Mother's model may, in fact, have been essential—particularly given that David's first inclination appeared to be to respect intercategory boundaries in his gestures and to use certain gestures as nouns and others as verbs.

When hearing children learn that a word can serve as both a noun and a verb, they also learn that the two functions need to be distinguished in some formal way. They hear their parents use the word as a noun in a different morpho-syntactic context from the one in which they hear the word used as a verb (e.g., "give momma the comb" vs "are you combing the baby's hair?"). Thus, they learn that when a word crosses intercat-

egory boundaries, grammatical markings must be used to distinguish the two different uses.

Did David learn that intercategory violations must be grammatically marked from his Mother? Certain of the variations David used to distinguish nouns from verbs either were not used at all or were not used distinctively by Mother—his abbreviations and his gesture order patterns. These variations were therefore likely to have been initiated by David. However, David might have learned to alter the place of articulation of verbs (rather than nouns) from his Mother—although David's use of place of articulation patterned systematically with the predicate structure of the verb and consistently marked entities playing particular thematic roles in those predicates, while Mother's did not. Thus, there was evidence that David's place alterations functioned as part of an inflectional system, but no evidence that Mother's place alterations did so. David seemed to have taken the input he received about place of articulation from Mother and fashioned it into an integral part of his gestural system, grammaticizing it as he did so.

Although there were similarities between David's and Mother's gestures, David's gestures appeared to be more language-like than Mother's—having stability of form and a coherent set of grammatical devices to mark gestures in their roles as nouns, verbs, or adjectives. What accounts for the lack of language-like features in Mother's gestures? The gestures Mother used when she communicated with David are, in fact, just like the spontaneous gestures hearing individuals typically use along with their speech. According to McNeill (1992), the gestures hearing individuals produce along with speech are context-sensitive: Each gesture is created at the moment of speaking and highlights what is relevant; thus the same referent can be—and often is—represented by gestures that change their form. This property of context-sensitivity contrasts with the stability of lexical forms in a conventional linguistic system (McNeill, 1992) and also with the stability of lexical form in David's self-styled gestural system.

In addition, speakers typically produce one gesture to a clause, pausing between the gestures and relaxing the hand (McNeill, 1992). Thus, the gestures of hearing individuals are rarely combined with one another in what we would call a gesture string (our criterion for a gesture string is that the hand cannot be relaxed at any point within the string; i.e., there can be no pauses between the gestures that comprise the string, Goldin-Meadow & Mylander, 1984). Mother's lack of gesture combinations is consequently not surprising given that almost all of her gestures were produced along with speech.

Mother's gestures appeared to have been shaped by the fact that they occurred in combination with speech. Forming an integrated system with

speech, these gestures were, in a sense, not "free" to take on a different, more language-like, form. Although it is likely that David made use of his mother's gestures in fashioning his own, he seems to have gone beyond the model provided by Mother. Perhaps because David's gestures were his sole means of communication and were thus forced to assume the full burden of communication, they became more language-like than Mother's—including a stability of form and a grammatical systematicity not found in Mother's gestures but reminiscent of natural languages.

CONCLUSION

A distinction between nouns and verbs is universal to all natural languages. The findings we present here suggest that the deaf child's gesture system also has a distinction between nouns and verbs, one that initially may have been based on a semantic distinction between objects and actions but that eventually became grounded in a grammatical distinction. David maintained a distinction between noun and verb gestures at first by using gestures that differed in form for each purpose; specifically, he used pointing gestures as nouns and characterizing gestures as verbs. He then began to use characterizing gestures as both nouns and verbs but maintained a distinction between nouns and verbs lexically by restricting a given gesture to one use; that is, he had one set of characterizing gestures which he used as nouns and a distinct set which he used as verbs. Finally, at age 3:3 (when his gesture system began to be characterized by a morphological structure, cf. Goldin-Meadow & Mylander, 1990b), David first used a particular characterizing gesture as both a noun and a verb. However, he continued to maintain a distinction between nouns and verbs but now did so grammatically; specifically, he distinguished the noun use of a gesture from the verb use by altering the form of the gesture itself (akin to a morphological marking) and by altering the position of the gesture in a sentence (akin to a syntactic marking). Moreover, the grammatical devices David used did not appear to pattern with the context in which a gesture was produced but rather with its role as either a noun or a verb. Thus, even a human communication system that has been developed by a child without the benefit of a conventional language model appears to involve distinctions between nouns and verbs. The fact that a noun-verb distinction was found to be a property of the rather simple gestural system that the deaf child used to communicate reinforces the claim that this distinction is indeed a fundamental property of human language.

Our data suggest that it is not necessary to be exposed to a usable conventional language model in order to develop a communication system with a noun-verb distinction. Nevertheless, it is possible that the spontaneous gestures produced by the child's hearing mother may have been crucial to the development of the communication system in general, and

the noun-verb distinction in particular. If so, it is important to recognize that the child did not copy his mother's gestural model as a whole, but rather made selective use of the gestures he saw. David appeared to be quite sensitive to infrequent uses in his mother's gestures. For example, Mother used very few gestures as nouns at the beginning of our observations; if David needed a model for this type of gesture use, an infrequent one seemed to have been sufficient. Moreover, David also seemed able to ignore very frequent uses in his mother's gestures. For example, when Mother altered the place of articulation of her verb gestures, she frequently displaced the gesture toward the location of the action represented by that gesture; David used this place of articulation infrequently, preferring instead to displace his gesture toward entities playing particular thematic roles in the action represented by the gesture. Thus, David seemed to have made selective use of the gestural model provided by his mother—if he used that model at all.

In addition, David went beyond the gestural input provided by his mother in constructing a grammatical system. Mother's gestures were more variable in form than David's, which appeared to function as a stable lexicon. Mother had only one distinction between her nouns and verbs (alteration of place) which she failed to use systematically with different predicate structures. David not only had several distinctions but he integrated those distinctions into a coherent marking system which he used to distinguish between nouns and verbs. Thus, David fashioned a *system* out of the input he received from Mother—one that shares many properties with the grammatical systems of natural languages.

It is worth noting that a distinction between objects and actions is hardly specific to language. Indeed, it is a distinction fundamental to a human view of the world. Although there is debate over whether a human child must learn such a distinction or is born with it (cf. Spelke, 1991), there is no disagreement that a distinction between objects and actions is part of a young child's conceptual framework by the age of 18 months. Thus, it may not be surprising that the deaf child in our study incorporated a distinction between objects and actions into his gesture system. However, there are many useful real-world distinctions that could potentially be incorporated into a self-styled communication system. The fact that the deaf child in our study not only incorporated this particular distinction into his gesture system but also grammaticized the distinction suggests that it is a distinction which is fundamental—not only to human thought—but more particularly to human communication.

Given that a distinction between nouns and verbs is so fundamental to communication, why might such a distinction not be found in the spontaneous gestures of hearing individuals? We suggest that it is only when gesture must assume the full burden of communication, including pred-

ication—that is, when it must isolate the object to be talked about from what is to be said about it—that such a distinction will be made. The gestures produced by hearing individuals serve as an adjunct to speech, which itself assumes the primary burden of communication. Unlike words, which are organized into combinations according to rules of syntax and morphology, gestures that accompany those words are rarely combined (each spoken clause being accompanied by a single gesture, McNeill, 1987) and are not themselves decomposable (each gesture serving as a holistic depiction, like a picture or an enactment, presented in a single moment of time, Kendon, 1993). In our view, this holistic representation is adequate precisely because gesture is framed by the speech it accompanies; that is, speech supplies the focus and context that allows interpretation of the accompanying gesture.

In contrast to the gestures of hearing and speaking individuals, the gestures produced by the deaf child in our study assume the burden of a primary communication system and thus, in a sense, must frame themselves. To better understand this distinction, consider how holistic gesture of the type that typically accompanies speech might fare as a primary communication system. It is possible to depict an event, for example, "eating an apple," by enacting that event (i.e., one might move a hand shaped as though holding an apple toward one's open mouth). However, given this holistic representation, how would one request someone else to eat the apple, or comment on the fact that the apple had been eaten in the past, or warn a hopeful eater that this apple is wormy? It becomes increasingly difficult to fulfill the diversity of communicative functions that language typically serves without being able to isolate certain elements of the event and comment on those elements specifically; that is, to predicate (cf. Condillac, as described in Harris & Taylor, 1989). It appears as if gesture must be both decomposable and combinatorial in order to function as a primary "linguistic" communication system. In our previous work, we have shown that the deaf child's gestures do indeed serve as elements in gesture strings (forming a simple syntax, Goldin-Meadow & Mylander, 1984) and are themselves composed of recombineable elements (forming a simple morphology, Goldin-Meadow & Mylander, 1990b). We suggest here that the basic elements of predication—nouns and verbs—are part of the deaf child's combinatorial system as well. It is precisely this type of combinatorial system which appears to be necessary for language to fulfill the range of functions it typically serves and which gives the deaf child's gesture its language-like quality.

We have previously referred to the language-like properties found in the deaf children's gestures as "resilient" (Goldin-Meadow, 1982)—properties that appear in children's communication despite extensive variation of the learning conditions (such as no exposure to an established

language). Properties displayed under such extreme conditions are evidently among the most basic and indispensable for a structured system of human communication, and they should spontaneously appear in any deliberate communication of meaning (cf. McNeill, 1992). That these same resilient properties are not systematically found in the spontaneous gestures accompanying the speech of hearing individuals underscores (and continues to clarify by contrast) the language-like nature of the deaf child's gestures.

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