Chapter 14

Getting a handle on language creation*

Susan Goldin-Meadow
University of Chicago

In 1866, the Linguistic Society of Paris declared a moratorium on research into the origins of language, asserting that the crucial studies could not be done. Although it is certainly true that we cannot go back in time to observe the birth of language, we can watch language as it changes over historical and ontogenetic timespans. And getting a sense of where language comes from over the short-term may, in the end, offer insight into where it came from originally.

We can watch language as it changes over historical time. Languages that already have grammatical structure create new structure and often do so in similar ways. For example, grammatical structure can grow out of lexical items, and the same lexical items often give birth to the same grammatical structures across various unrelated languages (Bybee 1998). Grammatical structure can even grow out of very limited structure. Pidgin languages, which typically arise in colonial situations and initially are used as trade languages, are simple systems with little structure. Creole languages develop out of these simple pidgins, and each creole has a more expanded vocabulary and a more complex grammatical structure than the pidgin out of which it emerged. Indeed, not only do all creoles have grammatical structure, but they may all have the same grammatical structure, despite having evolved out of very different pidgins (Bickerton 1990, 1999).[1]

In addition to observing language change across generations, we can also observe language change within a single individual over ontogenetic time. When children are exposed to a model for language (as most children are), they learn that language, though not all at once. The steps children follow in progressing from a one-word stage to a multi-word and multi-proposition stage have the potential to offer insight into mechanisms of language change in general (cf. Givón 1998:101). But, of course, the nature and direction of the changes that children experience as they learn language are determined in large part by the language to which they are exposed. Although children's creative tendencies are at times visible in the act of language-learning, those creative acts are greatly constrained by the to-be-learned language and can easily be masked.

A potentially more revealing way to explore language creation in individual children is to observe children who are exposed to language models that are not intact. For example, Singleton and Newport (2002) describe language-learning in a deaf child whose deaf parents were late-learners of sign and thus produced signs that provided an incomplete model of the morphological structure in American Sign Language (ASL). The child, exposed only to this imperfect model of ASL, nevertheless developed a sign language with morphological structure more complex than that of his parents, and comparable in many respects to the morphological structure developed by other deaf children exposed to complete models of ASL. He changed the language as he learned it.

We find comparable creativity when deaf children are not exposed to ASL but rather to Manually Coded English (MCE). MCE is the name for a set of sign systems which map English surface structure onto the visual/gestural modality. MCE was invented by educators to teach English to deaf children and, as such, is not a "natural" language system spontaneously developed by language users. Unlike ASL, which uses simultaneous spatial devices to mark morphology, MCE uses invented signs that are designed to map onto the morphologic structure of English. English-like sequential structure within a sign is apparently very difficult to process. Indeed, deaf children exposed only to MCE alter the input they receive, innovating forms that systematically use space to convey meaning, as do many of the grammatical devices of ASL (Gee and Goodhart 1985; Goodhart 1984; Livingston 1983; S. Supalla 1991; Suty and Friel-Patti 1982). Thus, when provided with input that is difficult to process, children change that input, creating new structures out of old.

Children have perhaps the greatest opportunity to create language when they are exposed to no language model whatsoever. It is rare that children find themselves in such situations, but it does happen. For example, many children who are congenitally deaf have hearing losses so severe that they are unable to acquire spoken language, even with intensive instruction. If these deaf children are not exposed to sign language input until adolescence, they will be for all intents and purposes deprived of a usable model for language during early childhood — although, importantly, they are not deprived of other aspects of human social interaction. Despite their lack of linguistic input, deaf children in this situation use gestures to communicate. These gestures, called "homesigns," assume the form of a rudimentary linguistic system, one that displays structure at both word and sentences levels and is used for many of the functions served by conventional language.

My goal here is to describe the steps that deaf children follow in fashioning their homesign gesture systems — in other words, to observe language-creation over the ontogenetic timespan. I begin by providing the background on deafness and language-learning that is necessary to understand the unusual language-

learning circumstances in which homesigners find themselves. I then briefly summarize the properties of language that we have found in the deaf children's gesture systems. These are linguistic properties that children can invent *de novo* without explicit guidance from a language model — the "resilient" properties of language. In the next two sections, I examine the developmental steps deaf children take when creating their homesign gesture systems. I focus first on the parts of the system that do change over time, and then on the parts of the system that don't. I then explore what we can learn about language-creation from a controlled experimental study conducted with adults.

Deaf children generating their own gesture systems are in a unique language-creation situation in that they are doing their creating without a communication partner who is willing to participate with them in the process of language invention. As a result, their gesture systems cannot achieve the level of arbitrariness or automaticity found in other natural language situations. In the final section, I consider the implications of this difference for language creation.

1. Background on deafness and language-learning

Deaf children born to deaf parents and exposed from birth to a conventional sign language such as American Sign Language (ASL) acquire that language naturally; that is, these children progress through stages in acquiring sign language similar to those of hearing children acquiring a spoken language (Newport and 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 and 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 of hearing parents, or to the acquisition of sign by deaf children of deaf parents. By age 5 or 6, and despite intensive early training programs, the average profoundly deaf child has limited linguistic skills in speech (Conrad 1979; Mayberry 1992; K. 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 ten children in our studies are severely (70–90 dB bilateral hearing loss) to profoundly (>90dB bilateral hearing loss) deaf, and their hearing parents chose

to educate them using an oral method. At the time of our observations, the children ranged in age from 14 months to 4 years, 10 months and had made little progress in oral language, occasionally producing single words but never combining those words into sentences. In addition, at the time of our observations, the children had not been exposed to ASL or to a manual code of English. As preschoolers in oral schools for the deaf, the children spent very little time with the older deaf children in the school who might have had some knowledge of a conventional sign system (i.e., the preschoolers only attended school a few hours a day and were not on the playground at the same time as the older children). In addition, the children's families 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 the children in our studies had had no exposure to a conventional sign system at the time of our observations was that they did not know even the most common lexical items of ASL or Signed English (i.e., when a native deaf signer reviewed our tapes, she found no evidence of any conventional signs; moreover, when we informally presented to the children common signs such as those for mother, father, boy, girl, dog, we found that they neither recognized nor understood any of these signs).

Under such inopportune circumstances, these deaf children might be expected to fail to communicate at all, or perhaps to communicate only in non-symbolic ways. This turns out not to be the case. Studies of deaf children of hearing parents in general have shown that these children spontaneously use gestures — "homesigns" — to communicate even if they are not exposed to a conventional sign language model (Fant 1972; Lenneberg 1964; Moores 1974; Tervoort 1961). Given a home environment in which family members communicate with each other through many different channels, one might expect that the deaf child would exploit the accessible modality (the manual modality) for the purposes of communication. The question is whether the gestures the deaf child uses to communicate are structured in language-like ways. In the next section, I describe the properties of the deaf child's gestures that can be considered language-like.

2. The resilient properties of language

The linguistic properties that appear in the deaf children's gesture systems are resilient — likely to crop up in a child's communications whether or not that child is exposed to a conventional language model. Table 1 lists the properties of language that we have found in the deaf children's gesture systems. There may, of course, be many others — just because we haven't found a particular property in the deaf children's homesign gesture system doesn't mean it's not there. The table lists properties at the word- and sentence-levels, as well as properties of language

Table 1. The resilient properties of language

The resilient property	As instantiated in the deaf children's gesture systems
Words	
Stability	Gesture forms are stable and do not change capriciously with changing situations
Paradigms	Gestures consist of smaller parts that can be recombined to produce new gestures with different meanings
Categories	The parts of gestures are composed of a limited set of forms, each associated with a particular meaning
Arbitrariness	Pairings between gesture forms and meanings can have arbitrary aspects, albeit within an iconic framework
Grammatical Functions	Gestures are differentiated by the noun, verb, and adjective grammatical functions they serve
Sentences	
Underlying Frames	Predicate frames underlie gesture sentences
Deletion	Consistent production and deletion of gestures within a sentence mark particular thematic roles
Word Order	Consistent orderings of gestures within a sentence mark particular thematic roles
Inflections	Consistent inflections on gestures mark particular thematic roles
Recursion	Complex gesture sentences are created by recursion
Redundancy Reduction	Redundancy is systematically reduced in the surface of complex gesture sentences
Language use	
Here-and-Now Talk	Gesturing is used to make requests, comments, and queries about the present
Displaced Talk	Gesturing is used to communicate about the past, future, and hypothetical
Narrative	Gesturing is used to tell stories about self and others
Self-Talk	Gesturing is used to communicate with oneself
Meta-language	Gesturing is used to refer to one's own and others' gestures

use, and details how each property is instantiated in the deaf children's gesture systems.

2.1 Words

The deaf children's gesture words have five properties that are found in all natural languages. The gestures are *stable* in form, although they needn't be. It would be

easy for the children to make up a new gesture to fit every new situation (and, indeed, that appears to be what hearing speakers do when they gesture along with their speech, cf. McNeill 1992). But that's not what the deaf children do. They develop a stable store of forms which they use in a range of situations — they develop a lexicon, an essential component of all languages (Goldin-Meadow, Butcher, Mylander and Dodge 1994).

Moreover, the gestures they develop are composed of parts that form *paradigms*, or systems of contrasts. When the children invent a gesture form, they do so with two goals in mind — the form must not only capture the meaning they intend (a gesture-world relation), but it must also contrast in a systematic way with other forms in their repertoire (a gesture-gesture relation). In addition, the parts that form these paradigms are *categorical*. For example, one child used a *Fist* handshape to represent grasping a balloon string, a drumstick, and handlebars — grasping actions requiring considerable variety in diameter in the real world. The child did not distinguish objects of varying diameters within the *Fist* category, but did use his handshapes to distinguish objects with small diameters as a set from objects with large diameters (e.g., a cup, a guitar neck, the length of a straw) which were represented by a *CLarge* hand. The manual modality can easily support a system of analog representation, with hands and motions reflecting precisely the positions and trajectories used to act on objects in the real world. But, again, the children don't choose this route. They develop categories of meanings that, although essentially iconic, have hints of *arbitrariness* about them (the children don't, for example, all have the same form-meaning pairings for handshapes, Goldin-Meadow, Mylander and Butcher 1995).

Finally, the gestures the children develop are differentiated by *grammatical function*. Some serve as nouns, some as verbs, some as adjectives. As in natural languages, when the same gesture is used for more than one grammatical function, that gesture is marked (morphologically and syntactically) according to the function it plays in the particular sentence (Goldin-Meadow *et al.* 1994).

2.2 Sentences

The deaf children's gesture sentences have six properties found in all natural languages. Underlying each sentence is a *predicate frame* that determines how many arguments can appear along with the verb in the surface structure of that sentence. Moreover, the arguments of each sentence are marked according to the thematic role they play. There are three types of markings that are resilient: (1) *deletion* — the children consistently produce and delete gestures for arguments as a function of thematic role; (2) *word order* — the children consistently order gestures for arguments as a function of thematic role; and (3) *inflection*[2] — the children mark with inflections gestures for arguments as a function of

thematic role (Goldin-Meadow and Mylander 1984; Goldin-Meadow *et al.* 1994).

In addition, *recursion*, which gives natural languages their generative capacity, is a resilient property of language. The children form complex gesture sentences out of simple ones. They systematically combine the predicate frames underlying each simple sentence, following principles of sentential and phrasal conjunction. When there are semantic elements that appear in both propositions of a complex sentence, the children have a systematic way of *reducing redundancy*, as do all natural languages (Goldin-Meadow 1982, 1987).

2.3 Language use

The deaf children use their gestures for five central functions that all natural languages serve. They use gesture to make requests, comments, and queries about things and events that are happening in the situation — that is, to communicate about the *here-and-now*. Importantly, however, they also use their gestures to communicate about the non-present — *displaced* objects and events that take place in the past, the future, or in a hypothetical world (Butcher, Mylander and Goldin-Meadow 1991; Morford and Goldin-Meadow 1997).

In addition to these rather obvious functions that language serves, the children use their gestures to tell stories about themselves and others — to *narrate* (Phillips, Goldin-Meadow and Miller 2001). They use their gestures to communicate with themselves — to *self-talk* (Goldin-Meadow 1997). And finally, they use their gestures to refer to their own or to others' gestures — for *metalinguistic* purposes (Singleton, Morford and Goldin-Meadow 1993).

All of the properties listed in the table are resilient in the sense that they can be developed by children without guidance from a language model. Interestingly, however, some of these properties take time to develop, others do not. If we are interested in observing changes in a linguistic system — changes that are *not* brought about by a conventional language model — an excellent place to look is at those aspects of the deaf children's gesture systems that develop over time.

3. Properties of the homesign gesture system that change over time

3.1 An utterance grows in size and scope

The most obvious developmental change in the deaf children's homesign gesture systems is that the children's utterances grow in size and scope. We first observed some of the children in what might be called a "one-gesture" period akin to the one-word stage found in children learning conventional languages (e.g., Bloom 1973). Although two of the children in our studies, Kathy and Abe, were gesturing

during their first observation session, neither one produced more than one gesture at a time. Some of their gestures were pointing gestures and some were iconic gestures, but at no time during these early sessions did the children combine two gestures into a single sentence.

Why might a *hearing* child be limited to producing one word at a time? One possibility is that young children find it hard to remember two different words at one time. Another is that it is motorically difficult for young children to produce two different words as a single unit. But these explanations won't work for gesture. It seems easy enough to combine one pointing gesture with another pointing gesture — there is little strain on either memory or motor function. The one-unit constraint found in all young communicators may therefore stem from deeper causes, ones tied to neither the modality nor the arbitrariness of the language.

The fact that the deaf children experience a one-gesture period comparable to the one-word period of children learning conventional languages suggests that the deaf children are following a *language* trajectory — their early gestures have the same constraints as early words. Moreover, their later steps are also in synchrony with children learning conventional languages. Kathy and Abe first began producing two-gesture sentences at ages 1;6 and 2;5, respectively — around the same time as English-learning children first produce two-word sentences (Brown 1973), and only slightly later than ASL-learning children first produce two-sign sentences (Bonvillian, Orlansky, and Novack 1983). These early two-gesture sentences, for the most part, convey only one proposition, and do so using structures found in early child language learned from conventional models.

In addition, four of the deaf children in our sample began producing more than one proposition within the bounds of a single sentence — complex sentences, having the important property of recursion — during our observation sessions (the other six produced complex sentences when we first observed them). Mildred and Kathy first produced complex sentences at 2;2, Abe began at 2;5, and Donald began sometime between 3;1 and 3;11 (we did not observe Donald during this time period; when we resumed observations, he was already producing complex sentences). Children learning spoken (Brown 1973) and signed (Hoffmeister 1978) languages first produce sentences conveying more than one proposition around these same ages.

Thus, the deaf children's sentences grow in the same way as sentences do when children are exposed to conventional language models. They first experience a one-word period during which they are limited to one gesture at a time. They then combine those gestures into two-word sentences characterized by simple structural properties. Finally, they produce longer sentences which convey two or more propositions and thus exhibit recursion. The deaf children's gesture sentences never get as consistently long as the sentences English-learners produce —

they are closer in length to sentences produced by children whose language permits a great deal of ellipsis (e.g., Japanese or Sinhalese). Yet they do grow in patterned ways.

3.2 The onset of morphological structure

3.2.1 *The morphological system*

The deaf children's gestures not only formed parts of longer sentence-units but they themselves were made up of smaller parts. For example, to request the experimenter to lay a penny down flat on a toy, one of the deaf children, David, produced a short downward arcing motion with his hand shaped like an O (with thumb and fingers touching). In itself this could be a global gesture presenting the shape and trajectory as an unanalyzed whole. The experimenter pretended not to understand and, after several repetitions, the child factored the gesture into its components: first he statically held up the gesture for a round object (the *OTouch* handshape) and then, quite deliberately and with his hand no longer in the *OTouch* shape but exhibiting a flat *Palm,* made the *Short Arc* trajectory for downward movement. The original gesture was thus decomposed into two elements. This example hints at the presence of a system of linguistic segments in which the complex meaning of "round-thing-moving-downward" is broken into components which are then combined into a gesture. Although the experimenter's feigned lack of understanding was undoubtedly important in getting David to decompose his gesture at that particular moment, the point I want to stress here is that when David did break his gesture into parts, those parts were elements of a wider system — one that accounted for virtually all of the gestures that David produced (Goldin-Meadow and Mylander 1990).

Thus, David had devised a morphological system in which each gesture was a complex of simpler gesture elements (Goldin-Meadow and Mylander 1990). Systematic compositionality of gestures within a system of contrasts can only come about by segmentation and combination. As an example of how this child's gestures formed a system of contrasts, a *CMedium* handshape (the hand shaped in a C with the fingers 1–3 inches from the thumb) meant 'handle an object 2–3 inches wide,' and a *Revolve* motion meant 'rotate around an axis.' When combined, these two components created a gesture whose meaning was a composite of the two meanings — 'rotate an object 2–3 inches wide' (e.g., twist a jar lid). When the same *CMedium* handshape was combined with a different motion, a *Short Arc* (meaning 'reposition'), the resulting combination had a predictably different meaning — 'change the position of an object 2–3 inches wide' (e.g., tilt a cup). As a result, the child's gestures can be said to conform to a framework or system of contrasts.

We have analyzed the gesture systems of four children (David, Marvin, Kathy, Abe) at this level (Goldin-Meadow *et al.* 1995), and have found that the gestures of all four children could be characterized by paradigms of handshape and motion

combinations. Each child (1) used a limited set of discrete handshape and motion forms; (2) consistently associated each handshape or motion form with a particular meaning (or set of meanings) throughout the corpus; and (3) produced most of the handshapes with more than one motion, and most of the motions with more than one handshape. Each handshape and motion was an independent and meaningful morpheme that could combine with other morphemes in the system to create larger meaningful units — the system was combinatorial.

Although similar in many respects, the gesture systems produced by these four children were sufficiently different to suggest that the children had introduced relatively arbitrary — albeit still iconic — distinctions into their systems. For example, in contrast to David and Marvin who used the *CMedium* handshape to represent objects 2–3 inches in width (e.g., a cup or a box), Kathy and Abe used the same *CMedium* handshape to represent objects that were slightly smaller, 1–2 inches in width (e.g., a banana or a toy soldier, Goldin-Meadow *et al.* 1995). The fact that there were differences in the ways the children defined a particular morpheme suggests that there were choices to be made (although all of the choices still were transparent with respect to their referents). Moreover, the choices that a given child made could not be determined without knowing that child's individual system. In other words, one cannot predict the precise boundaries of a child's morphemes without knowing that child's individual system. It is in this sense that the deaf children's gesture systems can be said to be *arbitrary*.

3.2.2 *The parts grow out of wholes*

At the very earliest stages of development, children acquiring conventional languages initially learn words as rote wholes (MacWhinney 1978). They then realize — relatively quickly in some languages, e.g., K'iche' Maya (Pye 1992), Turkish (Aksu-Koch and Slobin 1985), West Greenlandic (Fortescue and Olsen 1992) and more slowly in other languages, e.g., English (Bowerman 1982), ASL (Newport 1984) — that those wholes are composed of meaningful parts and begin to use those parts as productive morphemes. Since the deaf children in our study are not learning their gestures from adult models, we might expect them to show a different developmental pattern — that is, to use the sub-gesture hand and motion components that we have just described productively even at the earliest stages of development. If so, we would then conclude that children begin by learning words as wholes rather than as combinations of parts *only* when they learn their words from a conventional language model.

On the other hand, it is possible that, even without a conventional language model, the child's first representation of an event is not in terms of parts, but rather in terms of the event as a whole. If so, the deaf child's first lexical items would not be composed of component parts but would instead be unanalyzed wholes which map (as wholes) onto an event. For example, the gesture *OTouch+*

Revolve may, early in development, be used in the context of twisting a small key and for no other objects or actions, and thus may function as an unanalyzed label for key-twisting. Later, perhaps when the child has accumulated a sufficient number of gestures in the lexicon, the child may begin to consider his or her gestures in relation to one another and organize the gestures around any regularities that happen to appear in the lexicon (i.e., the child treats his or her own gestures as a "problem space" that needs systematization, cf. Karmiloff-Smith 1992). For example, over time the child may add an *OTouch+Short Arc* combination used exclusively for hat-putting-on, and a *CLarge+Revolve* combination used exclusively for jar-twisting, to his or her repertoire. At some point, the child then pulls back and considers the relation between these three gestures: *OTouch+Revolve, OTouch+Short Arc* and *CLarge+Revolve*. The child notices that the *OTouch* handshape recurs across the gestures, as does the *Revolve* motion. These recurring forms are then, for the first time, separated out from the wholes and treated as component parts, allowing the construction of new combinations (e.g., *Clarge+Short Arc*, meaning reorient a large object, as in putting a lid on a box). The transition is from a state in which the child considers a gesture only in relation to the situation conveyed — that is, a gesture-*world* relation — to a state in which the child begins to consider gestures in relation to other gestures in the system — a gesture-*gesture* relation (see Table 2).

If the deaf children were to follow this developmental path, we would expect that a particular handshape/motion combination, when still an undecomposed whole, might be used exclusively for a single object/action pairing. Later, when the parts of the gesture have been isolated, that same combination would be used for a variety of related objects and a variety of related actions. This is precisely the pattern we find. The *OTouch+Revolve* gesture is used first to refer uniquely to "key-twisting," and only later to refer to "knob-rotating" and "dial-spinning" as well. That is, the *OTouch* handshape in this and in other gestures is now used in

Table 2. Changes in how handshapes and motions map onto objects and actions over time

(i) Whole gestures mapped onto events in their entirety		
OTouch + Revolve	=	Key/Twist
OTouch + Short Arc	=	Hat/Put-on
CLarge + Revolve	=	Jar/Twist
(ii) Handshapes mapped onto classes of objects, and motions mapped onto classes of actions		
OTouch	=	Small Object
CLarge	=	Large Object
Revolve	=	Rotate
Short Arc	=	Reorient

relation to a variety of related objects (keys, knobs, dials — all of which are narrow in diameter), and the *Revolve* motion in this and in other gestures is used in relation to a variety of related actions (twisting, rotating, spinning — all of which involve revolving around a point). We found this developmental pattern in three of the four children — David, Kathy, and Marvin (Goldin-Meadow *et al.* 1995). The fourth child, Abe, was already using a large number of handshape/motion combinations for a variety of object and actions from the first of his observations sessions. We may not have caught Abe early enough to observe the first steps he took in fashioning a morphological system — or Abe may have begun his gesture system, not with representations of events as wholes, but with representations of parts of events.

What I am suggesting is that the deaf children induce their morphological systems from the earliest gestures they themselves create. Indeed, the first holistic gestures that the children used seemed to set the stage for the system each child eventually generated. For example, in session I, David used the *OTouch+No Motion* combination to describe holding a bubble wand, a narrow *long* object. In addition, he also used the *OTouch+Circular* combination to describe twisting a small key, a narrow *short* object. If these examples are representative of the gestures David used at the time, he would infer that the *OTouch* handshape is used for objects that have relatively narrow diameters but that can be either long (like the wand) or short (like the key). Thus, on the basis of *his own* gestures, David would infer a form/meaning pairing in which the *OTouch* form is associated with the meaning "handle an object <2 inches in width and any length".

In contrast, the first time David produced the *Fist* handshape, he used it in session II combined with *No Motion* to describe holding a bubble wand; that is, the *Fist+No Motion* combination was used for the same event as the *OTouch+No Motion* combination. However, the *Fist* was *not* used to describe any other objects during the early sessions. On the basis of these gestures, David ought to infer that the *Fist* handshape is used for objects that have narrow diameters and *long* lengths. In fact, he did. When he began to consistently use gestures in relation to a variety of objects and actions in session IV, David used the *Fist* (combined with the *Arc To and Fro* and the *Short Arc* motions) to describe a set of objects, all having narrow diameters (<2 inches) and long lengths (>3 inches), e.g., the handle of a hammer, the handlebars of a bike, a newspaper, and the brim of a hat — precisely the range of objects eventually seen for this form in his gesture system.

The earliest gestures that Kathy and Marvin created also set the stage for the categories they eventually settled on in their gesture systems (Goldin-Meadow *et al.* 1995: 241–2) — and thus set the stage for the similarities and differences seen across the children's systems. Before each child began to consistently use a handshape/motion combination in relation to a variety of objects and actions, the child had already used that handshape in different gestures in relation to precisely

the range of objects that would eventually fall within a given morpheme type in that child's system. Thus, when the child was ready to survey his or her gestures and analyze them to extract handshape and motion components, the outlines of the system were already present.

Just as children provided with a conventional language model induce rules and categories from the input they receive, the deaf children in this study induce the structure of their categories from their input — the difference is that the deaf children are forced by their circumstances to provide, and reflect upon, their own gestures as input.

3.3 The onset of grammatical categories

3.3.1 *Identifying nouns, verbs, and adjectives in gesture*

The children combined handshapes and motions to create gestures which they then used to refer to objects, actions, and attributes. The next question we ask is whether there is any reason to believe that these gestures functioned like the grammatical categories nouns, verb, and adjectives. We addressed this question by examining the gestures produced by David, our most prolific gesturer, over a two-year time period, from ages 2;10 to 4;10 (Goldin-Meadow *et al.* 1994). Our challenge was to figure out how to break into David's system of grammatical categories without knowing the properties of that system (or even whether the system existed).

Languages vary in the way nouns and verbs manifest themselves — the syntactic positions they occupy, and the morphological inflections they assume. What is common across languages 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 and Thompson 1984, 1988; 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.

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 David uses an iconic gesture to focus attention on an object, it is coded as a noun, but if he uses the gesture to say something about that object (i.e., to predicate something of the object), it is coded as either a verb or an adjective, depending upon whether the gesture depicts an action or an attribute.

Table 3. Progression of techniques used to distinguish noun gestures from verb gestures over time

		Noun gestures	Verb gestures
I.	Distinct forms	Point at jar	TWIST
II.	Distinct lexicons	ROUND	TWIST
III.	One lexicon with grammatical distinctions	TWIST [+abbreviation] [1st position]	TWIST [+inflection] [2nd position]

For example, if David uses 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 rather than to comment on wing-flapping), the gesture is considered a *noun*. In contrast, if the "flap" gesture is used to describe a toy penguin that is at that moment flapping its wings, the gesture is considered a *verb* (although we do recognize that David could be commenting on the presence of the bird itself). As a second example, if David uses 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 rather than to comment on the chimney's height), the gesture is considered a *noun*. In contrast, if the "high" gesture is used to describe the temporary height of the tower before urging his mother to hit it with a hammer and topple it, the gesture is considered an *adjective*. Not surprisingly, material entities (cf. Bloom 1990) turn out to be the most common subjects of the discourse — the nouns — and relations (actions and attributes) turn out to be the most common predicates — the verbs and adjectives.

We found that David distinguished nouns from verbs throughout the two-year period. Thus, like all natural languages, David's gestures have a noun-verb distinction. Interestingly, however, the way in which David maintained the distinction between nouns and verbs changed over time, becoming more and more linguistically sophisticated with age (see Table 3). I describe the three stages David traversed in the next section.

3.3.2 *From separate forms, to separate lexicons, to separate grammatical markings and positions*

Initially, David used pointing gestures to fill noun roles and iconic gestures to fill verb and adjective roles. Thus, at the earliest stage, David distinguished nouns from verbs and adjectives through a gross distinction in gesture form: The stationary and directed index finger signaled nominal functions; iconic gesture forms signaled predicate functions.

Sometime after age 2;10, David started to use iconic forms as nouns, while

continuing to use these forms as verbs and adjectives. The question is whether he found some other way to distinguish between nouns, verbs, and adjectives now that gesture *form* no longer served the purpose. English-learners, at the earliest stages, maintain inter-category boundaries by having distinct lexicons for nouns, verbs, and adjectives. And they do so despite the fact that the English language does *not* have distinct lexicons. In other words, there are words in English that cross noun-verb boundaries, but young learners don't seem to notice. For example, "comb" can be both a noun and a verb. Although young English-learners do use words like "comb" at the earliest stages of language-learning, they use these words in only one role (Macnamara 1982). A child might use "comb" to describe what she does to her doll's hair, but then would *not* 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.

David showed this same constraint. He restricted his use of a particular iconic gesture to a single role. For example, David used his "laugh" gesture as a noun (to refer to Santa Claus) and never as a verb. He violated these boundaries for the first time at age 3;3, when he used the same gesture as a noun and a verb. He did not use the same gesture as a noun and an adjective until age 3;11. Thus, like young children learning conventional languages, David did *not* violate inter-category boundaries at the earliest stages of development. His first inclination was to respect these boundaries as do all young communicators. When gesture form (i.e., pointing vs. iconic forms) no longer served to distinguish nouns from verbs and adjectives in David's gesture system, he maintained the distinction lexically, that is, by using separate lexical items as nouns, verbs, and adjectives.

Eventually, however, English-learning children do learn words that cross the noun-verb boundary, that is, they use words like "comb" for both their noun and verb meanings. But when they do, they (like adult English-speakers) treat the noun uses of the word differently from the verb uses: (1) Noun uses appear in different positions within a sentence than do verb uses; that is, they are marked differently with respect to syntax, e.g., "I *comb* my hair" vs. "The *comb* is lovely." (2) Noun uses are marked with different inflections than are verb uses; that is, they are marked differently with respect to morphology, e.g, "I *combed* my hair" vs. "The *combs* are lovely."

David began to use the same iconic gesture as both noun and verb at age 3;3. And, like children learning conventional languages, when he did, he used morphological and syntactic techniques to distinguish the different uses. Nouns were more likely to be abbreviated and less likely to be inflected (morphological distinctions) than verbs in David's system. In addition, nouns were more likely to precede pointing gestures and verbs were more likely to follow them (a syntactic distinction) in David's system. For example, if using a "twist" gesture as a noun to mean "jar," David produced the gesture with only one rotation rather than several (with abbreviation), produced it in neutral space (without inflection), and produced it

before a pointing gesture at the jar (pre-point). In contrast, if using the gesture as a verb to mean "twist," he produced the gesture with several rotations (without abbreviation), produced it near the jar (with inflection), and produced it *after* the pointing gesture at the jar (post-point).

Interestingly, adjectives were a mixed category in David's system, as they are in many languages (Thompson 1988; Dixon 1994). In David's gestures, adjectives resembled nouns in terms of morphological markings, but verbs in terms of syntactic position. For example, when David used the adjective "broken," he produced only one breaking-apart motion rather than several or the motion with only one hand rather than two (with abbreviation), and produced the gesture in neutral space (without inflection) — that is, he treated it like a noun. However, when positioning it in a sentence, David produced "broken" *after* a pointing gesture at the broken object (post-point) — that is, he treated it like a verb. David thus maintained a distinction between nouns, verbs, and adjectives, but he did so *grammatically* rather than lexically.

3.3.3 *Are the 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 iconic gestures are nouns and which are 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. We take these formal patterns to be evidence for the noun and verb categories we code 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 call *nouns* and *verbs* in David's gestures? Are they truly grammatical categories that are part of a linguistic system, or are they semantic categories naming objects and actions? After all, as is the case in all natural languages and particularly child language (Brown 1958), most of David's nouns turned out to refer to objects, and most of his verbs turned out to refer to actions.

To pursue this question, we recoded David's gestures, this time assessing whether they referred to objects or actions (Goldin-Meadow *et al.* 1994). We then asked whether David's noun-verb categories could be reduced to these object-action categories. We found that they could *not*, particularly after age 3;3. Before age 3;3, coding David's gestures in terms of nouns and verbs resulted in precisely the same categories as coding them in terms of objects and actions. However, after age 3;3, the two sets of categories were distinguishable and, impressively, David's morphological and syntactic devices patterned according to noun-verb grammatical categories rather than object-action semantic categories (Goldin-Meadow 2002a; Goldin-Meadow *et al.* 1994: 300–1).

3.4 Reorganization across the system

To recap David's trajectory — after abandoning a distinction between nouns, verbs, and adjectives based purely on gesture form, David used separate sets of lexical items as nouns, verbs, and adjectives. Thus, he persistently respected inter-category boundaries in his early lexicon, as do children learning conventional languages, be they spoken (Huttenlocher and Smiley 1987) or signed (Petitto 1992). At 3;3, David changed once again. He began to use some of his lexical items for more than one function, most commonly using the same gestural form as a noun and a verb. However, he continued to maintain a distinction between categories by abbreviating nouns but not verbs (akin to derivational morphology), by producing verbs but not nouns in marked locations (akin to inflectional morphology), and by producing verbs and nouns in distinct positions in gesture sentences (akin to syntax). Thus, at 3;3, David began to use grammatical devices to maintain inter-category boundaries.

There are other changes that coincided with what appears to be the onset of a grammatical system in David's gestures. Prior to age 3;3, David produced all of his iconic gestures in contexts consistent with their grammatical function. During the first three observation sessions, he produced verbs *only* in contexts in which the relevant action and object were both present, and nouns *only* in contexts in which the object and the action were both absent — prototypical contexts for identifying actions and objects (cf. Huttenlocher and Smiley 1987, 1989). Thus, just as children learning English initially distinguish between nouns and verbs on the basis of a semantic rather than a grammatical distinction (Macnamara 1982), David may be basing his first categories on a semantic (object-action) rather than a grammatical (noun-verb) distinction. However, at age 3;3, David began using noun and verb gestures in intermediate contexts where the action was absent and the object was present — precisely the moment when he introduced grammatical devices to keep noun and verb categories distinct. Thus, David began to use gestures in what amounts to ambiguous action and object contexts at just the moment that he secured his grammatical system for distinguishing nouns from verbs.

At this same point in development, David's gestures 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 David's gesture system, but no evidence that David had broken his gestures into component parts. At age 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 and Mylander 1990; Goldin-Meadow *et al.* 1995). Handshape and motion components combined to form word-stems. These stems were then fed to the next level of the system — they were abbreviated when used as nouns or inflected when used as verbs, and placed into distinctive positions in sentences. Thus, we see sets of units corresponding to the different levels found in conventional languages (word-stem morphology, derivational and inflectional morphology, syntax) which come together at the same moment in development and constitute the building blocks of David's gesture system.

The transformation of David's lexicon from an unorganized collection of gestures into a system of contrasting morphemes that work within a grammatical system co-occurred with yet one other change. At age 3;3, David began to refer, either via pointing gestures or the placement of iconic gestures, to objects that were not in the here-and-now (Butcher, Mylander and Goldin-Meadow 1991). For example, David pointed at the head chair at the dining room table, followed by a "sleep" gesture. No one was sleeping in the chair at the time, but David's father was sleeping in his bedroom down the hall. David used the dining room chair, which is where his father typically sat, as a "stand-in" for dad — the sentence thus meant "dad sleeps." David had pointed at an object in the room to refer to an object that was not in the room. At the same age, David also began inflecting his verb gestures toward objects in the room to indicate objects that were not in the room (Butcher *et al.* 1991). For example, David displaced a "twist" gesture toward an open jar in order to request his mother to twist the lid off a closed jar in the kitchen. Thus, David began to systematize his lexicon in the context of a grammatical system at the same time as he began to use his gestures in an increasingly symbolic fashion.

The impetus for a massive reorganization of the sort David experienced at age 3;3 might have been the child's maturational state — that is, the fact that he had reached a certain age. Or perhaps the impetus came from the state of the gesture system itself — that is, the fact that the system had become sufficiently cumbersome to require reorganization. One approach to pulling apart these possibilities is to conduct developmental analyses on the gesture systems of the remaining deaf children in our study. Whatever the outcome of such analyses, however, it is clear that the reorganization that occurred resulted in a *system* that looks very much like natural language. Moreover, the development of this system did *not* depend on guidance from a conventional language model.

4. Properties of the homesign gesture system that do not change over time

It seems to require time for the deaf children to construct morphological structure and a set of grammatical categories within their gesture systems. In contrast, as

soon as the children began producing gestures together within a single sentence, they developed devices for marking semantic roles in those sentences. All ten of the children we have studied used two different sentence-level devices to indicate "who does what to whom."

4.1 Marking roles by producing them at a particular rate in a sentence

As described above, the deaf children went through a stage during which they produced no more than two gestures in a sentence. As a result, children at this stage cannot produce gestures for all of the roles they might like to express in a single sentence. One solution to this problem is for the children to produce gestures for the different roles haphazardly. However, this is not the solution the children chose — they systematically produced gestures for some roles and omitted gestures for others, thereby distinguishing one role from another.

Production probability is the likelihood that a particular thematic role will be gestured in a sentence of a given length. All ten of the deaf children we have observed were more likely to produce a gesture for the patient (e.g., the eaten cheese) in a sentence about eating than to produce a gesture for the actor (e.g., the eating mouse). In other words, production probability was significantly lower for transitive actors than for patients for each of the ten children (Goldin-Meadow and Mylander 1984). Two points are worth noting.

First, the children's production probability patterns convey information about who is the doer and the done-to in a two-gesture sentence. If, for example, a deaf child produces the gesture sentence "boy hit," we would guess from this utterance that the boy is the hittee (patient) in the scene rather than the hitter (actor) simply because the deaf children tend to produce gestures for patients at the expense of transitive actors.

Second, note that the deaf children's particular production probability pattern tends to result in two-gesture sentences that preserve the unity of the predicate — that is, patient + act transitive sentences (akin to OV in conventional systems) are more frequent in the deaf children's gestures than actor + act transitive sentences (akin to SV in conventional systems).

We also calculated production probability for intranstive sentences. Nine of the ten children produced gestures for the intransitive actor (e.g., the mouse in a sentence describing a mouse going to a hole) as often as they produced gestures for the patient (e.g., the cheese in a sentence describing a mouse eating cheese), and far more often than they produced gestures for the transitive actor (e.g., the mouse in a sentence describing a mouse eating cheese). This production probability pattern (see Figure 1, top graph) is reminiscent of case-marking patterns found in ergative languages — gesture production is high and equal for intransitive actors and patients, and low for transitive actors (cf., Dixon 1979; Silverstein 1976).

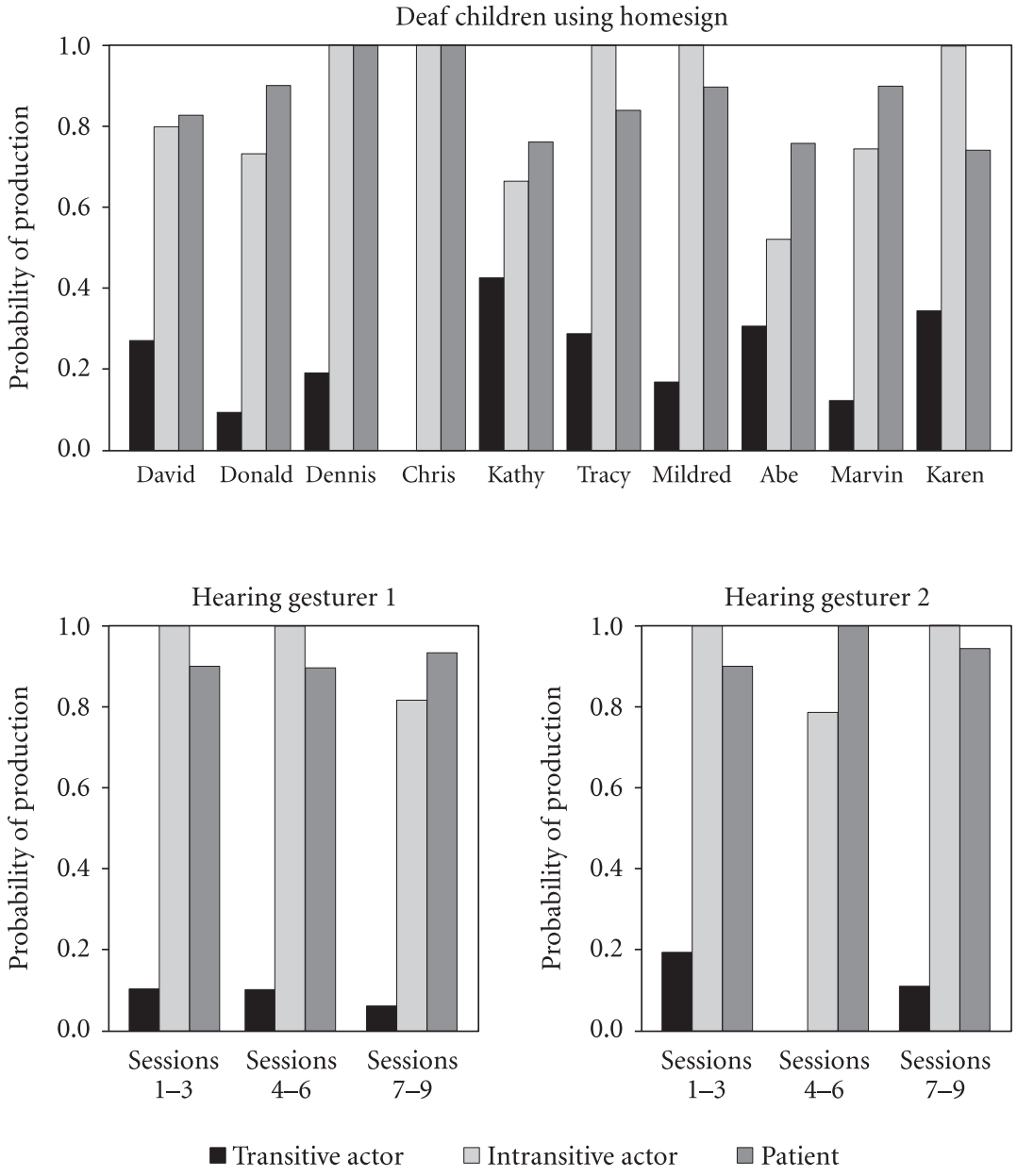

Figure 1. The likelihood that a gesture will be produced for a transitive actor (black bars), an intransitive actor (light grey bars), or a patient (dark grey bars) in a two-gesture sentence that permits all of these elements. The top graph displays the production probability patterns in the homesigns of ten deaf children of hearing parents. The bottom graphs display the production probability patterns in the gestures invented by two adult English-speakers who were asked to gesture without speaking. The data for the adults are divided into three parts: the first 3 sessions in which the two gesturers participated, the second 3, and the last 3. In both the deaf children and the hearing adults, the gesturer was more likely to produce gestures for intransitive actors and patients than for transitive actors (an ergative pattern)

It is important to note that the deaf children really were marking thematic role, and not just producing gestures for the most salient or most informative element in the context. One very sensible (albeit, in this case, wrong) possibility is that the deaf children produced gestures for intransitive actors and patients more often than for transitive actors because intransitive actors and patients tend to be new to the discourse more often than transitive actors (cf. DuBois 1987). In other words, the deaf children's production probability patterns could be an outgrowth of a semantic element's status as "new" or "old" in the discourse. If the novelty of a semantic element is responsible for how often that element is gestured, we would expect production probability to be high for all "new" elements (regardless of role) and low for all "old" elements (again, regardless of role). We found no evidence to support this hypothesis (Schulman, Mylander and Goldin-Meadow 2001; see also Goldin-Meadow and Mylander 1984:49). Rather, we found an ergative production probablity pattern for "new" elements when analyzed on their own, as well as for "old" elements when analyzed on their own, as we would expect if thematic role, rather than novelty, determined how often an element was gestured.

4.2 Marking roles by placing them in a particular position in a sentence

In addition to reliably producing gestures for some thematic roles at the expense of others, the children were also consistent in where the gestures they did produce were positioned in their two-gesture sentences. Many, but not all, of the children ordered gestures for patients, acts, and recipients in a consistent way in their two-gesture sentences (Goldin-Meadow and Mylander 1984:35–6): (1) gestures for *patients* (e.g., cheese) preceded gestures for *acts* (e.g., eat), (2) gestures for *patients* (e.g., hat) preceded gestures for *recipients* (e.g., cowboy's head), and (3) gestures for *acts* (e.g., move-to) preceded gestures for *recipients* (e.g., table). Importantly, these ordering patterns were not reducible to the discourse status of the semantic elements — if we reanalyze the sentences in terms of whether an element is "new" or "old" to the discourse, we find that most of the children's gesture sentences were "old-old" or "new-new," and that the "old-new" sentences were approximately as frequent "new-old" sentences. In other words, "new" elements did not consistently occupy the initial position in the deaf children's gestures sentences, nor did "old" elements (Goldin-Meadow and Mylander 1984:51).

Nine of the 10 children produced gestures for patients before gestures for acts. Moreover, 7 children also produced gestures for intransitive actors before gestures for acts (Goldin-Meadow 2002b). Thus, many of the children treated intransitive actors like patients with respect to gesture order as well as production probability. David was the only child who produced a sufficient number of sentences with transitive actors to allow us to discern an ordering pattern for this thematic role. David not only treated patients and intransitive actors alike with respect to gesture

order, but he ordered them differently from transitive actors — he produced gestures for patients and intransitive actors *before* gestures for acts, but gestures for transitive actors *after* gestures for acts (Goldin-Meadow and Mylander 1984: 39). For example, David pointed first at the snack he was offering me, then produced an "eat" gesture, and finally pointed at me, roughly translated as "snacks eat Susan" with the patient preceding the act and the transitive actor following it. In contrast, when David asked me to move to a particular spot — that is, when I played the role of intransitive actor rather than transitive actor — David pointed first at me and then produced a "move-over" gesture. David thus treated patients and intransitive actors alike and distinct from transitive actors — he displayed an ergative pattern — not only with respect to production probability, but also with respect to gesture order.

5. Language creation in adults

The deaf children we study are not exposed to a conventional sign language and thus cannot be fashioning their gestures after such a system. They are, however, exposed to the gestures that their hearing parents use when they speak — and these gestures could serve as a model for the deaf children's system. To explore this hypothesis, we examined the gestures that the hearing mothers of six of the deaf children spontaneously produced as they talked to their children. We found that the mothers' gestures displayed little systematicity either within or across individuals, and that the consistent patterns that the mothers did display did not match their children's patterns (Goldin-Meadow and Mylander 1983, 1984, 1998). Thus, the mothers' gestures could not have served as a straightforward model for the gesture systems their children created.

The hearing mothers and their deaf children interacted with one another on a daily basis. We might therefore have expected mother and child to develop a shared gesture system. But they didn't. The question is — what leads gesture to assume language-like structure in the deaf children, but not their hearing parents? I suggest that it is only when gesture is called upon to carry the full burden of communication that it assumes a language-like form. When produced along with speech, gestures do not and, I would argue, because of the constraints imposed by speech, *cannot* assume the segmented form of the words they accompany. One might suspect that if the deaf children's hearing mothers had merely refrained from speaking as they gestured, their gestures would have become more language-like in structure. In other words, the mothers might have been more likely to use gestures that mirrored their children's if they kept their mouths shut.

To test this hypothesis, we conducted a series of experiments in which hearing adults were asked to describe scenes with and without speech. We predicted that

the gestures the adults would produce without speech would be distinct from the gestures these same adults produced when they described the scenes verbally. We thus attempted to simulate the deaf child's language-creating situation but with hearing adults as creators. There are two, very obvious differences between hearing adults and the deaf children in our studies. First, the adults already know a conventional language (English) and thus their created gestures could be heavily influenced by the particular language that they know. Second, the adults are not children and thus are well beyond whatever critical period there is for language-learning (and perhaps language-creating). To the extent that we find differences between the gestures that the adults and the deaf children create, age and language-knowledge become likely candidates for causing those differences. But to the extent that the gestures created by the adults and deaf children resemble one another, we have evidence that the created structures do *not* reflect a child-like way of organizing the world. Adults, even those who already have a language, may organize their communications in precisely the same ways as the deaf children, raising the possibility that the language-like properties found in the deaf children's systems result from trying to get information from one human mind to another in real time.

5.1 Gestures with and without speech

We asked English-speakers who had no knowledge of sign language to participate in the study (Goldin-Meadow, McNeill and Singleton 1996). We showed the adults videotaped vignettes of objects and people moving in space from the test battery designed by Supalla, Newport and their colleagues (2002) to assess knowledge of ASL. Half the scenes contained only one moving object (e.g., a porcupine wandering across the screen) while the other half contained one moving object and one stationary object (e.g., a girl jumping into a hoop). The adults were asked to describe each event depicted on the videotape twice, first using speech and a second time using only their hands. We examined whatever gestures the adults produced in their first pass through the events (the Gesture+Speech condition) and compared them to the gestures they produced in their second pass (the Gesture condition). As predicted, we found that the adults' gestures resembled the deaf children's in the Gesture condition but not the Gesture+Speech condition.

Specifically, in the Gesture condition, the adults frequently combined their gestures into strings and those strings were reliably ordered, with gestures for certain semantic elements occurring in particular positions in the string. Interestingly, the gesture order that the adults used did *not* follow canonical English word order. For example, to describe a girl jumping into a hoop, the adults gestured "hoop girl jump," rather than the more typical English order "girl jump hoop". In

contrast, although the adults did produce gestures that stood for actions and objects in the Gesture+Speech condition, they rarely combined those gestures into strings. In this condition, the adults used their gestures as representations for global wholes rather than as building blocks for larger units.

5.2 Ergative structure emerges again

All of the vignettes in our initial study involved objects and people moving about in space, events that elicit intransitive sentences. With only these stimuli, we were unable to determine whether the adults used ergative constructions in their gestures, as did the deaf children. We therefore conducted a second study with vignettes involving some events that elicit intransitive sentences and others that elicit transitive sentences (Goldin-Meadow, Yalabik and Gershkoff-Stowe 2000). We included only the Gesture condition in this study — the adults were asked to describe each scene using their hands and not their mouths. Because we were interested in whether there would be changes in the gestures over time, we arranged for the two adults to meet twice a week for several weeks.

We used the same system of analysis for the adults as we did for the deaf children. We looked at gesture strings that could have contained three semantic elements but, in fact, only contained two (e.g., transitive sentences with an underlying structure of actor-act-patient, and intransitive sentences with an underlying structure of actor-act-recipient). Both adults produced gestures for intransitive actors as often as they produced gestures for patients, and far more often than they produced gestures for transitive actors. In other words, they displayed the same ergative pattern seen in the deaf children's gestures. And they did so immediately — the ergative pattern was evident in the adults' initial sessions and did not change over time (see Figure 1, bottom graphs; Goldin-Meadow 2002b).

In terms of gesture order, both adults produced gestures for intransitive actors in first position of their two-gestures sentences (e.g., 'mouse runs'). This result is hardly surprising as the pattern parallels typical word order for intransitive actors in English. Neither adult produced many gestures for transitive actors, which made it impossible to determine an order preference for this semantic element. More interestingly, both gesturers also produced gestures for patients in first position of their two-gesture sentences ('cheese eat'). Not only is this pattern identical to the deaf children's gesture order for patients, but it is also different from the pattern typically found in English (i.e., "eat cheese").

The patient-first pattern is particularly interesting in the adults. The deaf children often (although not always) used pointing gestures to convey patients. The adults were unable to take advantage of this strategy simply because there were no objects in the room to point at. The adults were forced to invent an iconic gesture for their patients — for example, a smoking movement at the

mouth to refer to an ashtray, which was then followed by a gesture representing the action that was done on that ashtray (e.g., a throwing action). Despite the fact that they used iconic rather than pointing gestures to refer to patients, the adults followed the same (non-English) ordering patterns as the deaf children.

Thus, when asked to describe a series of action vignettes using their hands rather than words, English-speaking adults invent an ergative structure identical to the one developed by the deaf children, rather than the accusative pattern found in their own spoken language. Ergative structure is *not* unique to child language-creators and therefore cannot reflect a child-like way of organizing information for communication. Rather, the ergative pattern may reflect a robust solution to the problem of communicating information from one mind to another, be it an adult or child mind.

5.3 Morphological structure does not emerge

The emergence of production probability and gesture ordering patterns immediately in the experimental paradigms that we used with adults underscores the resilience of these grammatical properties in symbolic human communication. With no time for reflection, the adults in our studies constructed a set of gesture sentences in which thematic roles were marked by gesture production probability and gesture ordering. Interestingly, however, our simple experimental paradigm was not sufficient to support the emergence of all of the grammatical properties found in the deaf children's gesture systems. The adults' gestures were not systematically organized into a system of internal contrasts, that is, into a morphology (Goldin-Meadow *et al.* 1996).

When the hearing adults generated a gesture, their goal was to produce a handshape that adequately represented the object, and their choice of handshapes appeared to be constrained only by their imaginations and the physical limitations imposed by their hands (gesture-to-world relations). For example, a hearing adult might produce a different handshape for each of the five airplanes on the test, with each handshape capturing an idiosyncratic property of the airplane pictured in that event. In contrast, when the deaf children in our studies generate a gesture, their choice of handshapes is guided not only by how well the handshape captures the features of the object, but also by how well that handshape fits into the set of handshapes allowed in their individual gesture systems (gesture-to-gesture relations). Thus, they use the same handshape for all airplanes (indeed, for all vehicles), regardless of their individual idiosyncracies, and this handshape contrasts with the handshape used to represent, say, curved objects. The fact that adults instantly invent a gesture system with devices for marking thematic roles but without a system of internal contrasts suggests that some properties of language may be more resilient than others.

6. Language-creation without a willing partner

The deaf children are creating their gesture systems without the benefit of a language model and, in this sense, are like the original creators of language. However, their language-creation situation is clearly not a simulation of the situation in which language was created for the first time. The deaf children are developing their communication systems in a world in which language and its consequences are pervasive. It may not be necessary for a child to be exposed to a language model in order to create a communication system with language-like structure. However, it may well be necessary for that child to experience the human cultural world. It is very likely that, as language evolved, the cultural artifacts that characterize our world evolved along with it. Indeed, Hockett (1977: 149) argues that the ability to carry artifacts (in particular, tools) and the ability to refer to objects that are not visible (communication beyond the here-and-now) developed side-by-side, each developing in small increments furthered by the already-achieved increments of itself and of the other. The deaf children in our studies, while lacking conventional language, nevertheless had access to the artifacts that evolved along with language and that could have served as supports for the child's invention of a language-like system for communicating both within and beyond the here-and-now.

Although not lacking modern-day artifacts, the children did lack a communication partner who was willing to create a system with them. The families in our study chose to educate their deaf children through an oral method and their focus was on their children's verbal abilities. The families did not treat the children's gesture as though it were a language and, in this sense, they were not partners in their children's gestural communication. As a result, the children were forced to keep their gestures iconic — if they had invented relatively arbitrary symbols, no one would have been able to understand them. This aspect of the deaf children's gesture-creation situation may, in fact, be comparable to the original language-creation scene. The first language-creator is very likely to have been communicating with others who (like the deaf children's hearing parents) were willing, even eager, to interact with the creator, but did not share the creator's emerging language.[3]

As another symptom of their unusual communication situation, the deaf children were producers, but not receivers, of their gestures. The gestures that the deaf children saw were the gestures that their hearing parents produced as they talked, gestures that were qualitatively different in both form and function from the gestures that the children themselves produced (cf. Goldin-Meadow *et al.* 1996). The give-and-take between parent and child thus never became seamless and automatic. The interesting point is how far these deaf children could go in constructing a grammatical system despite the fact that they experienced no pressure to automatize their gestures.

If grammar is truly "an instrument of speeded-up, more automated language processing" (Givón 1998:92), we might expect that the deaf children would have no need for it. The fact that the deaf children did invent gesture systems with both morphological and syntactic structure suggests that at least a rudimentary grammatical system can evolve without the pressure to speed up processing. There must be other forces propelling the deaf children (and perhaps all language-creators and -learners) toward grammatical structure.

In fact, I suggest that there may be two types of forces at work. Some forces lead to grammatical structure *immediately* whenever two individuals (children or adults) attempt to communicate with one another, whether those individuals know a conventional language or not. Freyd (1983) has suggested that certain knowledge structures emerge because of their social utility at the group level rather than at the individual level. For example, scenes are perceived seamlessly along continuous dimensions, yet are made accessible to the minds of others by fitting individual experiences into discrete, conventional categories. Perhaps the production and ordering regularities that we observed in the deaf children's and adults' gestural communications emerged because the task required imparting information to another person. An alternative and equally likely possibility, however, is that the regularities grew out of the way the children and adults conceptualized and parsed the scenes (Gershkoff-Stowe and Goldin-Meadow 2002). Whatever the cause, the effect is that sentence-level structure is introduced immediately into communication that is created *de novo*.

Another set of forces seem to work *over time* and lead to the evolution of a system. These forces transform the initial communication into a system characterized by word-level structure and grammatical categories, as well as sentence-level structure. The push to systematize may come from the state of the communication itself — that is, the communication may become sufficiently cumbersome that reorganization becomes a necessity. Children may begin to have trouble recalling their gestures and, in response, may find it necessary to organize their gestures in relation to one another (and not just in relation to the world); that is, they may find it necessary to introduce morphological structure into their gestures. Similarly, children may begin to have trouble creating different gestures for nouns and verbs and, in response, may introduce grammatical devices that mark nouns differently from verbs and thus allow the same gesture form to be used for both functions. Finally, the fact that, in David, the changes in morphological structure and grammatical categories occurred at the same moment in development raises the intriguing possibility that these changes are synergistic and must both occur in order for either to occur.

Our challenge is to discover the forces that shape gesture creation in deaf children — for these are the forces that are likely to play a role in language creation every time it takes place, perhaps even the very first time.

Notes

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1. The newly developing Nicaraguan Sign Language is a creole-like situation which is taking place right now. Opening the first school for the deaf in Managua in the late 1970s created an opportunity for deaf children to interact with one another for the very first time. The result was a sign language. This language, which resembles pidgin languages in many respects, is now being learned by a second generation of young signers who are introducing new grammatical structure into the language (Kegl, Senghas and Coppola 1999; Senghas 1995, 2000; Senghas and Coppola 2001; Senghas, Coppola, Newport and Supalla 1997).

2. We follow sign language researchers in using the term "inflection" for the displacement of gestures away from neutral space (the chest-level area). The directionality of an inflecting verb reflects agreement of the verb with its subject or object, just as a verb in English agrees with its subject in number. Verbs in ASL agree with the person (I, you, he/she/it) of its subject or object. The 1st person affix places the sign near the signer's body; the 2nd person affix places the sign in the direction of the addressee; and the 3rd person affix places the sign at the locus assigned to that entity (Padden 1983).

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