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When does gesture become language? A study of gesture used as a primary communication system by deaf children of hearing parents

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Perhaps the clearest example of the resilience of language comes from the fact that language is not tied to the mouth and ear but can also be processed by the hand and eye. Sign languages of the deaf have been found to take over all of the functions and to assume the structural properties characteristic of spoken languages (Klima & Bellugi, 1979). Moreover, when exposed to a conventional sign language such as American Sign Language, deaf children acquire the language as effortlessly as hearing children acquiring spoken language (Newport & Meier, 1985). Thus, the manual modality can serve as a medium for language, suggesting that the capacity for creating and learning a linguistic system is modality independent.

The manual modality is exploited even by those who use spoken language. Hearing adults and children frequently use gesture along with their speech. However, unlike conventional sign languages, the spontaneous gestures of hearing individuals do not stand on their own and must be interpreted in the context of the speech they accompany (McNeill, 1987). Moreover, although spontaneous gestures may reflect the ideas of the speaker (cf., Church & Goldin-Meadow, 1986; Perry, Church & Goldin-Meadow, 1988), they do so in a form that is distinct from the form assumed by speech and sign (McNeill, 1987). Thus, while the manual modality can assume all of the formal and functional properties of language in the conventional sign languages of the deaf, it does not appear to do so in the spontaneous gestures of hearing speakers.

The purpose of this chapter is to explore one condition under which gesture appears to take on both the form and the function of language. The children who are the focus of my work are deaf with hearing losses so severe that they cannot naturally acquire spoken language. In addition, these children are born to hearing parents who have not yet exposed them to a conventional sign language. Despite their lack of usable linguistic input, either signed or spoken,

these deaf children develop gestures which they use to communicate. My colleagues and I have found that these gestures, which comprise the children's sole means of communication, take on many of the formal and functional properties found in the early communication systems of children learning conventional languages. Moreover, the deaf children's gestures are structured in ways that the spontaneous gestures of their hearing parents are not. These observations suggest that gesture will assume language-like properties when used as a primary communication system (but not when used as an adjunct to speech), and that language-like properties can develop in the absence of a conventional language model. I will consider these findings in terms of the light they may shed on the effects (or non-effects) of the environment on language development in an individual child, and on the circumstances compatible with the creation of language-like structure.

1. Background on deafness and language-learning

The sign languages of the deaf are autonomous languages which are not based on the spoken languages of hearing cultures (Klima & Bellugi, 1979). A sign language such as American Sign Language (ASL) is a primary linguistic system passed down from one generation of deaf people to the next and, like spoken language, is structured at syntactic, morphological, and "phonological" levels of analysis.

Deaf children born to deaf parents and exposed from birth to a conventional sign language such as ASL have been found to 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). Thus, in an appropriate linguistic environment, in this case, a signing environment, deaf children are not handicapped with respect to language learning.

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 of hearing parents, or to the acquisition of sign by deaf children of deaf parents. By age 5 or 6, and despite intensive early training programs, the average profoundly deaf child has only a very reduced oral linguistic capacity (Conrad, 1979).

In addition, unless hearing parents send their deaf children to a school in which sign language is used, these deaf children are not likely to receive conventional sign language input. 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.

Previous studies of deaf children of hearing parents have shown that these children spontaneously use gestures (referred to as "home signs") to communicate even if they are not exposed to a conventional sign language model (Lenneberg, 1964; Moores, 1974). 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 his accessible modality (the manual modality) for the purposes of communication. However, given that no language model is present in the child's accessible modality, one might not expect that the child's communication would be structured in language-like ways.

My work has focused on the structural aspects of deaf children's gestures and, in particular, has attempted to determine whether any of the linguistic properties found in natural child language can also be found in those gestures. My colleagues and I have analyzed the gestures of ten deaf children of hearing parents, and found that these gestures consistently served many of the functions typical of child language and, in addition, were structured on several levels, as is child language. I will focus here on both the functions of the deaf children's gestures and on three aspects of their structure: lexicon, syntax, and morphology.

The ten children in my sample ranged in age from 1;4 (years;months) to 4;1 at the time of the first interview and from 2;6 to 5;9 at the time of the final interview. The children were videotaped in their homes during play sessions with their hearing parents or an experimenter every 2 to 4 months for as long as each child was available (the number of observation sessions per child ranged from two to 16). Six of the children lived in the Philadelphia area and four in the Chicago area. The children were all born deaf to hearing parents and sustained severe (70–90 dB) to profound (> 90 dB) hearing losses. Even when wearing a hearing aid in each ear, none of the children were able to acquire speech naturally. In addition, none of the children in the sample had been exposed to conventional sign language.

2. Functional uses of gesture in deaf children of hearing parents

All of the children used their gestures as "tools" for communication – to convey information about current, past, and future events, and to manipulate the world around them. Like children learning conventional languages, the deaf

children requested objects and actions from others and did so using their gestures; e.g., a pointing gesture at a book, a "give" gesture, and a pointing gesture at the child's own chest, to request mother to give the child a book; or a "hit" gesture followed by a pointing gesture at mother, to request mother to hit a tower of blocks. Moreover, like children learning conventional languages, the deaf children commented on the actions of objects, people, and themselves, both in the past (e.g., a "high" gesture followed by a "fall" gesture to indicate that the block tower was high and then fell to the ground) and in the future (e.g., a pointing gesture at Lisa with a head-shake, an "eat" gesture, a pointing gesture at the child himself, and an "eat" gesture with a nod, to indicate that Lisa would not eat lunch but that the child would). Gestures were also used to recount events which happened some time ago; e.g., one child produced an "away" gesture, a "drive" gesture, a "beard" gesture, a "moustache" gesture, and a "sleep" gesture to comment on the fact that the family had driven away to the airport to bring his uncle (who wears a beard and a moustache) home so that he could sleep over.

Moreover, in addition to the major function of communicating with others, some of the deaf children used their gestures for other functions typically served by language. For example, the children used their gestures when they thought no one was paying attention, as though "talking" to themselves. In addition, one of the children used gesture to refer to his own gestures. For example, to request a Donald Duck toy that the experimenter held behind her back, the child pursed his lips to imitate Donald Duck's bill, then pointed at his own pursed lips and pointed toward the Donald Duck toy. When offered a Mickey Mouse toy, the child shook his head, pursed his lips and pointed at his own pursed lips. The point at the lips is roughly comparable to the words "I say," as in "I say 'Donald Duck bill'." It therefore represents a communicative act in which gesture is used to refer to a particular act of gesturing and, in this sense, is reminiscent of a young hearing child's quoted speech (cf., Miller & Hoogstra, 1989). The deaf child appeared able to distance himself from his own gestures and treat them as objects to be reflected on and referred to, thus exhibiting in his self-styled gesture system the very beginnings of the reflexive capacity that is found in all languages and that underlies much of the power of language (cf., Lucy, 1992).

In sum, the deaf children were able to use their gestures for many of the major functions filled by hearing children's words and deaf children's signs. The next three sections explore the form of the deaf children's gestures, and show that those gestures were structured at different levels as are the words and signs of children learning conventional languages.

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3. Lexical structure in the gestures of deaf children of hearing parents

The deaf children produced three types of gestures that differed in form. *Pointing* gestures maintain a constant kinesic form in all contexts and were used predominantly to single out objects, people, places, and the like in the surroundings. In contrast, *characterizing* gestures were stylized pantomimes whose forms varied with the intended meaning of each gesture (e.g., a fist pounded in the air as someone was hammering; two hands flapping in the presence of a pet bird). Finally, *marker* gestures were typically head or hand gestures (e.g., nods and headshakes, one finger held in the air signifying "wait") which are conventionalized in our culture and which the children used as modulators (e.g., to negate, affirm, doubt). Markers are not included in the analyses presented here).

3.1. Pointing gestures

At the outset, it is important to note that pointing gestures and words differ fundamentally in terms of the referential information each conveys. The pointing gesture, unlike a word, serves to direct a communication partner's gaze toward a particular person, place, or thing; thus, the gesture explicitly specifies the location of its referent in a way that a word (even a pro-form such as "this" or "that") never can. The pointing gesture does not, however, specify what the object is, it merely indicates where the object is. That is, the pointing gesture is "location-specific" but not "identity-specific" with respect to its referent. Single words, on the other hand, can be identity-specific (e.g., "lion" and "ball" serve to classify their respective referents into different sets) but not location-specific, unless the word is accompanied by a pointing gesture or other contextual support.

Despite this fundamental difference between pointing gestures and words, the deaf children's pointing gestures were found to function like the object-referring words of hearing children in two respects. First, the referents of the points in the deaf children's gestured sentences encompassed the same range of object categories (in approximately the same distribution) as the referents of nouns in hearing children's spoken sentences (Feldman, Goldin-Meadow & Gleitman, 1978). Secondly, the deaf children combined their pointing gestures with other points and with characterizing gestures; if these points are considered to function like nouns and pronouns, the deaf children's gesture combinations turn out to be structured like the early sentences of children learning conventional languages (see below). Thus, the deaf children's pointing gestures appear to function as part of a linguistic system.

In addition, the deaf children used their pointing gestures in ways that went beyond merely directing gaze toward a particular object. The children primarily used their pointing gestures to refer to real-world objects in the immediate environment (e.g., the child pointed at a jar of bubbles, followed by a "blow" characterizing gesture, to request that the bubbles be blown). However, the children also used their pointing gestures to refer to objects that were not present in the here-and-now, and did so by pointing at a real-world object that was similar to the (absent) object they intended to refer to (e.g., the child pointed at an empty jar of bubbles, followed by a "blow" gesture, to request that the absent, full jar of bubbles be blown). We have examined pointing gestures in detail in one of our deaf subjects, and found that this child could extend his use of points even further beyond the here-and-now by pointing at an arbitrary location in space set up as a place-holder for an absent, intended referent (e.g., the child pointed at a spot on his own gesture – a "round" gesture representing the shape of a Christmas tree ball – to refer to the hook typically found at that spot on Christmas tree ornaments). This child was found to use points to indicate objects in the immediate context when he was first observed at age 2;10; he first used his points to indicate objects that were not present in the here-and-now at age 3;3, and began using points to indicate arbitrary locations set up as place-holders for objects at age 4;10 (Butcher, Mylander & Goldin-Meadow, 1991). Hoffmeister (1978) reports a similar developmental pattern from points at real-world objects, to "semi-real-world" objects, to arbitrary loci, in deaf children who have been exposed to a conventional sign language (ASL) from birth.

3.2. Characterizing gestures

The characterizing gesture is the lexical item the deaf children used to denote actions and attributes. It differs somewhat from the words or signs typically used by young language learners exposed to conventional language models. The form of the deaf children's iconic characterizing gesture captures an aspect of its referent and, in this respect, is distinct from the far less transparent verb and adjective word forms hearing children use to denote actions and attributes. It also differs from the early sign forms of deaf children acquiring ASL, most of which are not iconic (Bonvillian, Orlansky & Novack, 1983) or, if iconic from an adult's point of view, are not recognized as iconic by the child (Schlesinger, 1978). Note, however, that in contrast to their location-specific pointing gestures, the deaf children's characterizing gestures resemble hearing children's words in that the characterizing gesture (via its iconicity) can specify the identity of its referent.

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We used the form of the children's gestures as the basis for assigning a lexical meaning to each characterizing gesture. As an example of an action form, one child held a fist near his mouth and made chewing movements to comment on his sister eating snacks; this gesture was assigned the meaning "eat". Another child moved his hand forward in the air to describe the path of a moving toy, and this gesture was assigned the meaning "go". Similarly for attribute forms, one child formed a round shape with his hand to describe a Christmas tree ornament; basing the meaning of the gesture on its form, we assigned the meaning "round" to this gesture.

The characterizing gestures that the deaf children produced showed considerable stability of form throughout our observations; that is, the children tended to use the same form to convey the same meaning over time. For example, 91% of the 170 different forms one child produced over a two-year period were used to convey a consistent meaning throughout that period; conversely, 99% of the 188 different meanings the child conveyed were conveyed by a consistent form. Thus, the child's system appeared to be characterized by standards of form, although those standards were idiosyncratic to him or her and not shared by a community of language users.

4. Syntactic structure in the gestures of deaf children of hearing parents

4.1. Predicate structure

The deaf children in our studies combined their gestures into strings that functioned in a number of respects like the sentences of early child language. First, the children's gesture sentences expressed the semantic relations typically found in early child language (in particular, action and attribute relations), with characterizing gestures representing the predicates and pointing gestures representing the arguments playing different thematic roles in those semantic relations (Goldin-Meadow & Mylander, 1984). For example, one 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. Another child produced a pointing gesture at a train (representing the argument playing the actor role) followed by the characterizing gesture "circle" (representing the act predicate) to comment on the fact that a toy train was circling on the track.

In addition, the predicates in the deaf children's sentences were comparable to the predicates of early child language in having underlying frames or

structures composed of one, two, or three arguments. For example, all of the children produced "transfer" or "give" gestures with an inferred predicate structure containing three arguments – the actor, patient, and recipient (e.g., you/sister give duck to her/Susan). The children also produced two types of two-argument predicates: transitive gestures such as "eat" with a predicate structure containing the actor and patient (e.g., you/Susan eat apple), and intransitive gestures such as "go" with a predicate structure containing the actor and recipient (e.g., you/mother go upstairs). Finally, the children produced gestures such as "sleep" or "dance" with a one-argument predicate structure containing only the actor (e.g., you/father sleep).

We attributed these one-, two- and three-argument predicate structures to the deaf children's gestures on the basis of the following evidence (see Goldin-Meadow, 1979, 1985, for further types of evidence for these constructions). We found that each child, at some time during our observations, produced gestures for all of the arguments associated with a particular predicate structure. For example, one child produced the following different two-gesture sentences, all conveying the notion of transfer of an object: "cookie–give" (patient–act), "sister–David" (actor–recipient), "give–David" (act–recipient), "duck–Susan" (patient–recipient). By overtly expressing the actor, patient, and recipient in this predicate context, the child exhibited knowledge that these three arguments are associated with the transfer predicate (although few children ever explicitly gestured all of the semantic elements required for three-argument predicates within a single sentence).

4.2. *Ordering and production probability rules*

The deaf children's gesture sentences were structured on the surface as are the sentences of early child language (Goldin-Meadow & Feldman, 1977; Goldin-Meadow & Mylander, 1984). The sentences the children produced were found to conform to regularities of two types: ordering regularities and production probability regularities. Moreover, the particular structural regularities found in the children's sentences showed considerable consistency across the ten children in the sample.

Ordering regularities were based on the position a gesture for a particular thematic role tended to occupy in a sentence. The children tended to order gestures for patients, acts, and recipients in a consistent way in their two-gesture sentences. The following three ordering patterns were found in many, but not all, of the children's two-gesture sentences: *patient–act* (e.g., the gesture for the patient, cheese, preceded the gesture for the act, eat), *patient–recipient* (e.g., the gesture for the patient, hat, preceded the gesture for the recipient,

cowboy's head), and *act–recipient* (e.g., the gesture for the act, move-to, preceded the gesture for the recipient, table).

Production probability regularities were based on the likelihood that a particular thematic role would be gestured in a sentence. If the children were randomly producing gestures for the thematic roles associated with a given predicate, they would, for example, be equally likely to produce a gesture for the patient as for the actor in a sentence about eating. We found, however, that the children were not random in their production of gestures for thematic roles – in fact, they used likelihood of production in such a way as to distinguish among thematic roles. We found, in particular, that all ten of the children were more likely to produce a gesture for the patient, e.g., cheese in a sentence about eating, than to produce a gesture for the actor, mouse. Note that this particular production probability pattern tends to result in two-gesture sentences that preserve the unity of the predicate: i.e., patient + act sentences (akin to object–verb in conventional systems) were more frequent in our deaf children's gestures than (transitive) actor + act sentences (akin to subject–verb in conventional systems).

In addition, nine of the ten children produced gestures for the intransitive actor (e.g., the mouse in a sentence describing a mouse running to his 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 is analogous to the structural case-marking patterns of ergative languages in that the intransitive actor is treated like the patient rather than like the transitive actor (note, however, that in conventional ergative systems it is the transitive actor which is marked, whereas in the deaf children's gesture systems the transitive actor tends to be omitted and, in this sense, could be considered unmarked; cf., Silverstein, 1976). In addition to an ergative-like pattern in production probability, the one child who produced a sufficient number of sentences with transitive actors to allow us to determine a pattern also showed an ergative pattern in the way he ordered his gestures. He tended to produce gestures for the patient and the intransitive actor *before* gestures for the act in his two-gesture sentences, but gestures for the transitive actor *after* gestures for the act. This one child thus treated patients and intransitive actors alike, and distinct from transitive actors, not only with respect to production probability but also with respect to gesture order.

The ergative pattern found in the deaf children's gestures could reflect a bias on the part of the child toward the affected object of an action. In an intransitive sentence such as "you go to the corner", the intransitive actor "you", in some

sense, has a double meaning. On the one hand, "you" refers to the goer, the actor, the effector of the going action. On the other hand, the "you" refers to the gone, the patient, the affectee of the going action. At the end of the action, "you" both "have gone" and "are gone", and the decision to emphasize one aspect of the actor's condition over the other is arbitrary. By treating the intransitive actor like the patient, the deaf children appear to be highlighting the affectee properties of the intransitive actor over the effector properties.

4.3. Complex sentences

We determined the boundaries for a string of gestures on the basis of gesture form (using relaxation of the hand as the criterion) and then determined the number of propositions conveyed within that gesture string. We found that all ten of the deaf children in our sample generated complex sentences containing at least two propositions (Goldin-Meadow, 1982). The propositions conjoined in the children's complex sentences often had a temporal relationship to one another; these sentences either described a sequence of events or requested that a sequence of events take place. For example, one child pointed at a tower, produced a "hit" gesture and then a "fall" gesture to comment on the fact that he had hit [act_1] the tower and that the tower had fallen [act_2]. The children also produced complex sentences conveying propositions which were not ordered in time. For example, one child pointed at Mickey Mouse, produced a "swing" gesture and then a "walk" gesture to comment on the fact that Mickey Mouse both swings [act_1] on the trapeze and walks [act_2].

5. Morphological structure in the gestures of deaf children of hearing parents

5.1. Derivational morphology

At this point in our studies, we have completed our investigation of morphological structure in the gestures of only one deaf child in our sample (we do, however, have extensive preliminary evidence from two other children suggesting that the gesture systems of these children are also characterized by morphological structure; data from the remaining seven children in our sample have not yet been coded for morphological structure). We found that the corpus of characterizing gestures the child produced over a two-year period (from age 2;10 to 4;10) could be regarded as a system of handshape and motion morphemes (Goldin-Meadow & Mylander, 1991). The gestures were composed of a limited and discrete set of five handshape and nine motion forms,

Table 2.1. *Examples of hand gestures*

Motions	Fist-han (handle long ob
Short Arc motion (reposition)	Reposit small, l by hand scoop u
Arc To and Fro motion (move to and fro)	Move a long ob fro by wave b string forth)
Circular motion (move in a circle)	Move long o circle (e.g., pole i

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Table 2.1. *Examples of hand and motion morphemes in the deaf child's gestures*

Motions	Handshapes		
	Fist-hand (handle a small, long object)	O-hand (handle a small object of any length)	C-hand (handle a large object of any length)
Short Arc motion (reposition)	Reposition a small, long object by hand (e.g., scoop utensil)	Reposition a small object of any length by hand (e.g., take out bubble wand)	Reposition a large object of any length by hand (e.g., pick up bubble jar)
Arc To and Fro motion (move to and fro)	Move a small, long object to and fro by hand (e.g., wave balloon string back and forth)	Move a small object of any length to and fro by hand (e.g., move crayon back and forth)	Move a large object of any length to and fro by hand (e.g., shake salt shaker up and down)
Circular motion (move in a circle)	Move a small, long object in a circle by hand (e.g., wave flag pole in circle)	Move a small object of any length in a circle by hand (e.g., turn crank)	Move a large object of any length in a circle by hand (e.g., twist jar lid)

each of which was consistently associated with a distinct meaning and recurred across different gestures. For example, the Fist handshape (meaning "handle a small, long object") combined with a Short Arc motion (meaning "reposition" in place) formed a gesture which meant "reposition a small, long object by hand" (e.g., scoop a spoon at mouth). Table 2.1 presents examples of this same Fist handshape combined with the Short Arc motion and other motions – the Arc To and Fro motion (meaning "move to and fro") and the Circular motion (meaning "move in a circle") – as well as examples of other handshapes – the O-hand (meaning "handle a small object of any length") and the C-hand (meaning "handle a large object of any length") – combined with these three motions. As the table illustrates, the meaning of each gesture is predictable from the meaning of its handshape component and its motion component. Note that the motions in the gestures presented in Table 2.1 all represent transitive actions, with the handshapes of these gestures representing the hand of the actor as it is shaped around the patient. These handshape morphemes are comparable to Handle classifiers in ASL which combine with motions to convey transitive actions (McDonald, 1982).

As in ASL, various handshapes were used not only to represent the handgrip around objects of varying sizes and shapes, but also to represent objects themselves; for example, our deaf child also used the C-hand to mean "a curved object". These object handshape components similarly combined with motion components to create paradigms of meanings; for example, the C-hand, when combined with a Linear motion (meaning "change location"), formed a gesture which meant "a curved object changes location" (e.g., a toy turtle moves forward) and, when combined with an Open and Close motion (meaning "open and/or close"), formed a gesture which meant "a curved object opens and/or closes" (e.g., a bubble expands). As these examples suggest, the object handshapes were typically combined with motions representing intransitive actions, with the handshape representing the size, shape, or semantic class of the actor. These object handshapes are comparable to Semantic-Class and Size-and-Shape classifiers in ASL which combine with motions to create intransitive verbs of motion (Supalla, 1982).

The deaf child in our study, at times, also produced his object handshapes with motions representing transitive predicates; in these gestures, the handshape represented the size, shape, or semantic class of the patient – omitting any representation of the actor entirely. For example, to represent placing a toy cowboy on a horse, the child produced a C-hand with his fingers pointed downward (meaning "a curved object") combined with a Short Arc motion (meaning "reposition"), thereby focusing attention on the curved legs of the cowboy as they are placed around the horse. Gestures of this sort are comparable to Size-and-Shape classifiers in ASL which combine with motions typically to represent instruments of transitive actions (Schick, 1987).

The morphemes in the deaf child's gestures were thus organized into a framework or system of contrasts. When the child generated a gesture to refer to a particular object or action, the form of that gesture was determined not only by the properties of the referent object or action, but also by how that gesture fitted with the other gestures in the lexicon. Thus, the child's gestures appeared to reflect a morphological system, albeit a simple one, akin to the system that characterizes the productive lexicon in ASL.

5.2. *Inflectional morphology*

Analyses of the deaf child's gestures suggest that the system also has inflectional morphology. 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). The deaf child in our study

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could vary the placement of his characterizing gestures, producing gestures either in neutral space (e.g., a "twist" gesture performed at chest level) or oriented toward particular objects in the room (e.g., a "twist" gesture produced near a jar). In the latter case, the placement of the gesture served to identify an entity playing a particular thematic role in the predicate represented by the gesture and, as such, served to modify the predicate to agree with one of its arguments. As an example, for transitive predicates, the characterizing gesture was typically displaced toward the object playing the patient role – the jar in the above example – thereby marking the jar as the patient of the predicate. In contrast, for intransitive predicates, the characterizing gesture was typically displaced toward the object playing the recipient role; for example, the child moved his "go" gesture 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. Gestures were very rarely displaced toward the actor of either transitive or intransitive predicates.

As in ASL (cf., Hoffmeister, 1978), it was not necessary that an object be in the room for the deaf child in our study to mark that object morphologically via displacement. The child could produce his gestures near an object that was similar to the object he wished to refer to (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 twisted open). Or, if the object the child wanted to indicate were animate, the child could indicate the object by producing his gestures on his own body (e.g., a "twist" gesture produced on the side of the child's body to indicate that he wanted the experimenter to twist a key on the side of a Mickey Mouse toy). Note that, in this example, the child is representing one individual with his hand (the experimenter) and a different individual with his body (Mickey Mouse); thus, as is frequently the case in ASL, the child appears to be using his body as a stage for his own gestures.

In a developmental analysis, we found that the child first began to displace his gestures toward objects that were similar to his intended-but-absent referents between the ages of 3;3 and 3;5 – the age at which this same child began producing points at objects in the room to refer to objects that were not in the room (Butcher *et al.*, 1991). Thus, this child's morphological marking system began to be freed from the here-and-now situation at about the same moment in development as was the child's system of pointing gestures.

6. The role of parental gestures in guiding the deaf child's system

The deaf children in our studies were found to elaborate gestural communication systems characterized by a lexicon, a simple syntax, and a simple morphology without the benefit of a conventional language model. It is

possible, however, that the children's hearing parents spontaneously generated their own structured gesture systems which their children saw and learned. The parents – not the children – would then be responsible for the emergence of structure in the children's gestures.

The hearing mothers of the deaf children in our studies all produced gestures as they spoke to their children. Indeed, five of the six mothers whose gestures we analyzed in detail produced single gestures (as opposed to gesture strings) more often than their children. Moreover, the mothers produced both pointing and characterizing gestures, and produced them in approximately the same proportions as their children. However, the mothers produced fewer different types of characterizing gestures than their children, and their lexicons of characterizing gestures were different from their children's, overlapping no more than 33% and as little as 9%. Thus, the deaf children and their mothers both produced lexicons containing characterizing and pointing gestures, although the lexical items themselves did differ.

Despite the fact that the mothers were prolific producers of single gestures, they were not prolific producers of gesture strings: Five of the six mothers produced gesture strings less often than did their children. In addition, the mothers' gesture strings did not show the same structural regularities as their children's. The mothers showed no reliable gesture order patterns in their strings. Moreover, the production probability patterns in the mothers' gesture strings were different from the production probability patterns in the children's strings. Finally, the mothers began conveying two propositions in their gesture strings later in the study than their children, and produced proportionately fewer sentences with conjoined propositions than their children (Goldin-Meadow & Mylander, 1983, 1984).

With respect to morphology, the mother of the deaf child whose gestures were shown to be characterized by a morphological system was found to produce the same five handshape and nine motion forms as her child. In terms of meanings, however, only 50% of the mother's handshapes and 51% of her motions conformed to the child's system; in contrast, 95% of the child's handshapes and 90% of his motions conformed to the system. Moreover, the fit between mother's and child's meaning systems did not improve over the two-year period during which the pair was observed. In addition, the child appeared to have generalized beyond his mother's gestures in two respects: 1. The child produced almost all of the different types of handshape/motion combinations that his mother produced (20 of his mother's 25) but, in addition, produced another 34 combinations that were not found in his mother's repertoire. In order to go beyond his mother's gestures as he did, the child must have isolated the handshape and motion dimensions and used them as a basis for generating

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7. Gesture as a pri
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his novel combinations. 2. The mother used her gestures to refer to individual events (e.g., she used the C-hand combined with a circular motion only to refer to opening a jar and to no other types of actions or objects), while the child used his to refer to classes of related events (Goldin-Meadow & Mylander, 1990).

Thus, if a source for the handshape and motion components in the deaf child's gestures could be found in his mother's gestures, the child would have had to search through considerable noise in order to arrive at those components. Moreover, the child appeared to treat whatever structure he might have found in his mother's gestures as a starting point, using it to generalize to novel combinations and to novel referential uses.

With regard to the input issue in general, it is important to note that we are not claiming that the deaf child develops his gesture system in a vacuum. It is clear that the child receives input from his surroundings which he undoubtedly puts to good use. The crucial question, however, is: How close is the mapping between this input and the child's output? We have looked for isomorphic patterns between mother's gestures and child's gestures on the assumption that the child might have been inclined to copy a model that was easily accessible to him. We found that the gesture systems developed by the deaf children in our studies had some obvious similarities to the gestures produced by their hearing mothers: Both the children and their mothers produced pointing and characterizing gestures which they used to express the action and attribute relations typical of early mother–child conversations. However, the children consistently surpassed their mothers by organizing these gestural elements into productive systems with consistent patterns on at least two linguistic levels – the level of the sentence and the level of the word. All of the deaf children regularly combined the gestural elements into linear strings characterized by an, albeit simple, syntactic structure. The one child studied thus far analyzed the gestural elements into component parts characterized by a productive morphologic structure. Thus, our deaf children had, indeed, gone beyond the input, contributing linearization and componentialization to the gestures they received as input from their hearing mothers.

7. Gesture as a primary communication system versus gesture as an adjunct to speech

7.1. Comparison to conventional sign languages

The deaf children's gestures exhibited formal structuring at many of the same levels as a conventional sign language such as ASL, and exhibited similar kinds of organizational principles, in particular, constrained systems of components,

rules based on underlying forms, and recursive processes (cf., Bellugi *et al.*, 1988). However, the deaf children's gestures formed a linguistic system that was far less complex than the linguistic system of ASL, a conventional language with a long history and shared by a wide community of signers. For example, ASL makes use of many more handshape and motion forms than the limited set described for the deaf children's gestures (cf., Wilbur, 1987); moreover, deaf children acquiring ASL from their deaf parents have already begun to acquire many of these handshape and motion forms at ages comparable to those at which we have observed our deaf children (cf., Supalla, 1982).

The simplicity of the deaf children's system relative to ASL highlights the importance of a community in generating and maintaining complexity in a linguistic system. Our present study of deaf children is a study of the kind of language system an individual (more specifically, an individual child) can create without the participation of a second language-user. We suggest that at least two language-users are likely to be required in order to introduce arbitrariness into a language system. Moreover, it may well be necessary for language to be passed on from one generation of users to the next (that is, for a group of fresh minds to learn the language as a whole) in order for language to undergo the sort of reorganization necessary for complex linguistic structures to develop (cf., Singleton, 1989).

7.2. Comparison to gestures in hearing children and adults

It is important to note that despite the simplicity of the deaf children's gestures, their gestures did exhibit structural regularities and, in this sense, went beyond the gestures typically produced by hearing children learning spoken language at the same age. Hearing children in the early stages of spoken language development do indeed gesture, and certain communicative functions may even appear in gesture before they appear in speech (Volterra & Caselli, 1986; Goldin-Meadow & Morford, 1985). Not surprisingly, however, speech comes to dominate over gesture in the hearing child and this domination typically occurs before the child's gestures become complex. For example, hearing children rarely produce their pointing gestures in combination with other gestures, even other points (Masur, 1983), and tend not to produce strings of characterizing gestures (Petitto, 1988).

In fact, young hearing children produce very few motor acts that would even meet our criteria for characterizing gestures (i.e., motor acts that do not involve direct manipulation of objects and that are used for communication rather than symbolic play). Even when hearing children produce the same character-

produced – because they formed an integrated system with speech – were not "free" to take on the language-like structure that characterized the deaf child's gestures.

7.3. *When does gesture become language?*

The study of gesture provides a unique window into the conditions that foster language-like structure. The fact that the gestures of hearing individuals do not exhibit inter-gesture and intra-gesture structure suggests that communication in the manual modality does not inevitably result in structure at the sentence and word levels. Thus, language-like structure is not forced by the manual modality.

A priori, one might have thought that language-like structure would arise whenever information is conveyed. The gestures that hearing individuals produce along with their speech *do* convey information – information that is interpretable not only to experimenters (cf., McNeill, 1992; Church & Goldin-Meadow, 1986; Perry *et al.*, 1988) but also to individuals who have not been trained in coding gesture (Goldin-Meadow, Wein & Chang, 1992, e.g., adults, both trained and untrained, are able to observe a child who demarcates the width of a container with her hands in a Piagetian conservation task and infer that the child is, at some level, aware of this dimension of the task object). Nevertheless, these gestures do not exhibit language-like structure.

What then is the difference between the gestures produced by hearing individuals, which do not exhibit language-like structure, and the gestures produced by the deaf children in our studies, which do? I suggest that the function gesture serves in these two situations differs, and that this difference may contribute to the observed variations in structure (see Kendon, this volume, for a similar view). 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 which accompany those words are rarely combined (each spoken clause being accompanied by a single gesture, McNeill, 1987) and are not themselves decomposeable (each gesture serving as a holistic depiction, like a picture or an enactment, presented in a single moment of time, Kendon, this volume). This holistic representation is adequate simply 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 children in our studies assume the burden of a primary

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communication system and thus, in a sense, must frame themselves. To understand this distinction better, 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. It appears as if gesture must be both decomposeable and combinatorial (i.e., it must be composed of "constructed units" in Kendon's terms) in order to function as a primary "linguistic" communication system. We have shown that the deaf children's gestures do indeed serve as elements in gesture strings (forming a simple syntax) and are themselves composed of recombineable elements (forming a simple morphology). It is precisely this combinatorial system which appears to be necessary for language to fulfill the range of functions it typically serves and which gives the deaf children's gesture its language-like quality.

In sum, the diversity of communicative uses to which the deaf children put their gestures have, in a sense, forced the children to go beyond holistic representation, requiring them to break their gestures into parts and to use those gestures as parts of larger wholes. Nevertheless, it is important to realize that, in order for those parts to form a combinatorial *system*, the deaf children must have been capable of, and inclined toward, creating that system.

8. The resilience of language

In general, the phenomenon of gesture creation in deaf children is a testament to the robustness of language in humans. However, children can be raised in circumstances which are not compatible with the development of language. For example, children raised under conditions of extreme deprivation, lacking not only linguistic input but also the social supports of typical human existence, do not develop language during their periods of deprivation (cf., Skuse, 1988). Thus, language-learning is not infinitely robust and, although it may not be necessary to have a language model to develop the rudiments of a linguistic system, it does appear to be essential to have another human to communicate with.

I 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 indispensible 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 both hearing children and hearing adults underscores (and continues to clarify by contrast) the language-like nature of the deaf children's gestures.

In sum, we have shown that a child who is not exposed to a usable conventional language model can create a communication system that is indeed language-like. This situation of language creation is quite clearly not a simulation of the situation in which language was created for the first time, simply because the deaf children are developing their communication systems in a world in which language and its consequences are pervasive. Thus, although 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, it may 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 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 which evolved along with language and which 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.

Thus, the techniques necessary to communicate in language-like ways appear to be fundamental to human interaction – so fundamental that they can be reinvented by a child who has access to the artifacts of the modern world but not to a culturally-shared linguistic system.

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