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Gesture in Early Child Language: Studies of Deaf and Hearing Children

Susan Goldin-Meadow and Marolyn Morford
University of Chicago

The gesture systems developed by 10 deaf children, each incapable of acquiring a conventional spoken language naturally and not exposed to a conventional manual language by their hearing parents, were compared and contrasted to both the speech and the gesture systems developed by three hearing children learning English. Each of the deaf children was found to generate a gesture system comparable in content and form to the early spoken language system developed by each of the hearing children. In addition, each of the hearing children also developed spontaneous gesture systems that appeared to serve as a transitional form of communication en route to speech. Over developmental time, however, gesture in the hearing children declined in complexity and rate of production while gesture in the communications of the deaf children increased steadily.

When communication is blocked from the oral modality, the manual modality frequently assumes the functional burdens of speech (Kendon, 1980a). Elaborate signed systems resembling spoken language in many crucial aspects have been observed to arise in a number of situations where speech has been made impossible, whether by sensory incapacity (cf., Klima & Bellugi, 1979; Newport, 1983; Supalla, 1982; Wilbur, 1979), by environmental circumstances (as in sawmill factories, Meissner & Philpott, 1975), or by speech taboos (as in Australian aborigines, Kendon, 1980b; or Trappist monks,

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Wundt, 1900/1973). It thus appears that communication in humans is a resilient phenomenon; when prevented from coming out the mouth, it emanates almost irrepressibly from the fingers.

One of the most striking examples of the resilience of communication in humans is found in deaf children who are not able to process the oral language which surrounds them and who have not yet been exposed to a conventional manual language by their hearing parents. These children, unable to learn a spoken language naturally, have been observed to exploit spontaneously the manual modality for communication and to invent their own gestural systems (Fant, 1972; Lenneberg, 1964; Moores, 1974; Tervoort, 1961). Moreover, the gestural systems these deaf children develop have been found to be organized in language-like ways (Feldman, Goldin-Meadow, & Gleitman, 1978; Goldin-Meadow, 1979, 1982, 1985, in press; Goldin-Meadow & Feldman, 1975, 1977; Goldin-Meadow & Mylander, 1984) and have been found to be structurally more complex than the gestures their hearing parents produce (Goldin-Meadow & Mylander, 1983, in press). Thus, even a young child appears able, without tutoring, to make effective use of the manual modality when communication is blocked in the oral modality.

Two questions may be asked at this juncture. First, do the gestural systems which deaf children develop on their own without conventional language models resemble spoken child languages in content and/or form? It is already recognized that young deaf children who are taught a conventional manual language (e.g., American Sign Language [ASL] or Signed English) indeed develop child languages in sign which are comparable in both content and in form to the child languages that young hearing children develop in speech (Caselli, 1983; Hoffmeister, 1978; Hoffmeister & Wilbur, 1980; Kantor, 1982; Newport & Ashbrook, 1977; Schlesinger & Meadow, 1972). In the present study we compare the gestures developed by 10 deaf children who have not yet been exposed to sign with the speech of 3 hearing children at the earliest stages of language acquisition. Our goal is to determine which of the properties of early child language can be taken over by spontaneous (untutored) gesture when the manual modality is the only modality available to a young child.

A second question addressed in this report is the role of gesture in child language when both manual and oral channels are available to the child. Gestures have often been observed in the spontaneous speech of hearing adults, and several descriptive systems have been proposed to capture the relationship between those gestures and the speech they accompany (Efron, 1941/1972; Ekman & Friesen, 1969; Kendon, 1980a; McNeil & Levy, 1982). These gestures have been

found for the most part to complement the concurrent spoken utterance; for example, by indicating the particular entities referred to in speech, both in hearing adults (Marslen-Wilson, Levy, & Tyler, 1982) and hearing children (Bates, 1976; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; DeLaguna, 1927). Moreover, gestures have also been found to supplement the spoken utterance by conveying elements that might otherwise have been spoken. In hearing adults, for example, a film director indicates a location to his electrician verbally ("Five balcony") while requesting the action he desires at that location gesturally by moving a light switch in pantomime (Slama-Cazacu, 1976). Gestures also supplement in hearing children. For example, a child of 21 months verbally produces the word *touch* while gesturally pointing at a tape recorder (Greenfield & Smith, 1976). In the present study, we describe the spontaneous gestures produced by three hearing children and compare those hearing children's gestures to the children's own speech, as well as to the gestures of 10 deaf children. In this way, we attempt to determine the role of spontaneous gesture in a young child's communications when the child can make use of both the manual and oral channels.

METHODS AND PROCEDURE

Subjects

Deaf subjects. The data reported here were gathered from 10 deaf subjects during two separate studies. Six deaf children in the Philadelphia area were observed initially, and four deaf children in the Chicago area were subjects in a second (replication) study. The 10 children, 6 boys and 4 girls, ranged in age from 1 yr, 4 mo (hereafter given, for example, as 1–4) to 4–1 at the time of the initial interview and from 2–6 to 4–6 at the time of the final interview (see Table 1; for further details on the Philadelphia children, see Goldin-Meadow, 1979, and on the Chicago children, see Goldin-Meadow, 1985). Eight of the children came from white, middle-class families, and two from black lower-class families. At the time of these observations, three of the children had no siblings; seven had at least one sibling. Eight had two parents living in the home, with the mother as primary caretaker; two had only one parent (mother) in the home for all or part of the study.

Each child was congenitally deaf, with no other known cognitive or physical disabilities. Each had a severe to profound hearing loss (greater than 90 dB hearing loss) and, even when wearing hearing aids (which the children wore continuously at school and often at home), was unable to acquire speech naturally.

Table 1. Summary of Gesture Samples for Deaf Children and Speech Samples for Hearing Children

Subject	*No. of Sessions*	*Age Range (years-months)*	*Mean Length Range*[a]	*Upper Bound Range*[b]	*Rate per Hour Range*[c]
Chicago Deaf Subjects:					
Mildred	12	1-4 to 3-8	1.00-1.31	1-5	40.6-102.4
Abe	9	2-3 to 3-9	1.00-1.30	1-8	24.6-120.0
Marvin	6	2-11 to 4-2	1.22-1.41	3-8	85.5-187.5
Karen	6	3-1 to 4-2	1.08-1.39	3-6	67.5-140.6
Philadelphia Deaf Subjects:					
Kathy	9	1-5 to 2-8	1.00-1.27	1-6	40.0- 93.0
Dennis	4	2-2 to 2-6	1.04-1.21	2-3	50.9-102.0
Donald	11	2-5 to 4-6	1.04-1.25	2-4	6.6-198.0
David	8	2-10 to 3-10	1.14-1.80	2-9	36.0-384.0
Chris	3	3-2 to 3-6	1.15-1.20	4	92.2-120.9
Tracy	2	4-1 to 4-3	1.22-1.30	4-6	119.1-142.1
Hearing Subjects:					
Carl	5	1-5 to 1-11	1.00-1.23	1-3	25.5-303.0
Ann	12	0-10 to 2-6	1.00-1.95	1-11	30.0-420.4
Beth	9	1-2 to 2-5	1.00-2.85	1-10	3.6-260.3

[a] The lowest and the highest mean utterance length (the average number of words or gestures produced per utterance, calculated by session) achieved throughout the observations.

[b] The lowest and the highest upper-bounds (the number of words or gestures in the longest utterance produced in a session) achieved throughout the observations.

[c] The lowest and the highest production rates (the number of utterances produced per hour, calculated by session) achieved throughout the observations.

The children were being educated by an oral method of deaf education, a method which advocates early and intense sound training for the deaf child and which discourages the use of conventional sign language with the child. At the time of these interviews, the children had made little progress in acquiring spoken English. In addition, none of the children were exposed to conventional sign language. Consistent with the oral education philosophy, sign was not used in any of the oral schools these children attended. Moreover, neither the children's parents nor siblings knew sign. Thus, these children, who at the time of the study had made little use of oral linguistic input, were also not exposed to conventional manual linguistic input.

It is possible, of course, that, in an effort to communicate, the hearing caretakers of these deaf children spontaneously generated a structured gesture system which their children then learned, or that the caretakers unconsciously shaped the structure of their children's gestures by patterning their responses to those gestures. Both of these hypotheses have been shown to be false in an analysis of the communications of six hearing mother-deaf child pairs (the four Chicago subjects and 2 Philadelphia subjects; see Goldin-Meadow & Mylander, 1983, in press).

Hearing subjects. Our goal was to compare the deaf children's gestures to the earliest stages of language acquisition in hearing children, in particular, to the hearing child's one- and two-word stages. Thus, we began observing the hearing children between 10 and 17 months of age and stopped observing them at approximately 30 months (one of the three hearing children, Carl, moved from Chicago at 22 months, forcing us to conclude our observations on him prematurely).

All three hearing children were from white middle-class two-parent families, with mother as primary caretaker. None of the three had any apparent hearing difficulties, nor had they any other known cognitive or physical disabilities.

Experimental Procedure

Each child was videotaped periodically at home during informal play sessions. The primary caretaker, the mother in every instance, was asked to interact with her child for at least ½ hour of each session. Either the mother then continued to play with the child, or an experimenter (or, for the deaf subjects, one of the child's siblings) played with the child for the remainder of the session. A large bag of toys, books, and puzzles (described in Goldin-Meadow, 1979) served to facilitate interaction. Each session lasted from 1 to 2 hours, depending upon the child's attention span.

Each child's videotapes were coded for both speech and gesture. We briefly describe our coding procedures, first for the deaf children, and then for the hearing children. (See Goldin-Meadow & Mylander, in press, for detailed information on criteria and justification for each of the coding categories.)

Coding the deaf child's videotapes. We reviewed the deaf children's videotapes to extract those motor acts which appeared to be used symbolically for communicative purposes. We then described those acts, borrowing from the system developed by Stokoe (1960) to describe ASL, and subsequently segmented these gestures into word units and sentence units. The deaf subjects produced two types of word-like gestures: (a) *Deictic* pointing gestures were used to single out objects, people, places and the like in the surroundings; and (b) *characterizing* gestures were stylized pantomimes whose iconic forms varied with the intended meaning of each gesture (e.g., a fist pounded in the air, used to represent hammering). The children produced a third type of gesture, the *marker* (e.g., nods, headshakes) which they used to modulate (e.g., affirm, negate) meanings but which were not analyzed in this study.

Finally, we assigned semantic meanings to each of the gestured words and sentences, using as guides Bloom's (1970) method of rich interpretation and Fillmore's (1968) case descriptions. We assigned gestured words to one of three categories: (a) *Indicators,* deictics used to point out the existence of objects, persons, places; (b) *Cases,* deictics used to indicate objects which, in context, appeared to play a role in a semantic relation, e.g., an actor or a patient role; or (c) *Predicates,* characterizing gestures used to represent either action or attribute relations. Gestured sentences were classified as *Simple* (one proposition) or *Complex* (two or more propositions), and simple sentences were further classified according to the type of semantic relation conveyed: *Transitive Actions,* actions which affect objects; *Intransitive Actions,* actions which have no effect on objects; and *Attributes,* static characteristics of objects. Reliability for coding the deaf children's gestures ranged from 83% to 100% agreement between two coders, depending on the coding category.

The deaf children's vocalizations were also analyzed and coded initially as either *meaningful* or *meaningless.* Meaningful vocalizations were spontaneously produced words that were used appropriately in context. A vocalization which was a relatively close approximation of an adult English word and which was used consistently to refer to a particular object or action (e.g., *ba* used consistently to refer to a bottle) was considered meaningful. Meaningless vocalizations were either unrecognizable sounds spontaneously produced by the child,

or sounds elicited by the child's caretaker who, in an attempt to encourage lip reading and vocalization, would often hold an object near her mouth, point to her lips, and mouth in exaggerated fashion the word for that object. Reliability in coding vocalizations for the deaf children ranged from 88% to 99% agreement between two coders. (Vocalizations were not coded for the Philadelphia subjects.)

Coding the hearing child's videotapes. On the first of two passes through the tapes, we coded the children's spoken utterances, using the same semantic categories we used to code the deaf children's gestures. In particular, the children's spoken nouns and pronouns were classified as either Indicators or Cases, and their spoken verbs and adjectives were classified as Predicates. The children's spoken sentences were classified as Simple or Complex, and their simple sentences were further classified as conveying Transitive Action, Intransitive Action, or Attribute relations. Reliability for coding the hearing children's speech ranged from 95% to 100% agreement between two coders depending on the coding category.

We then reviewed the hearing children's videotapes a second time, coding gestures according to the same criteria we used to define a gesture for the deaf children, Deictic or Characterizing, and noted whether each gesture occurred alone, with another gesture, or with accompanying speech. Finally, we assigned semantic categories to the single gestures, to the gesture + gesture combinations, and to the gesture + speech combinations produced by the hearing children during the videotaping sessions. This procedure meant that the hearing children's spoken utterances which occurred with gestures were classified semantically twice: once taking only speech into account, and a second time taking both gesture and speech into account. Reliability on coding the hearing children's gestured communications ranged between 88% and 100% agreement between two coders, depending on the coding category.

STUDY 1

In Study 1 the gesture language systems developed by the deaf subjects were compared with the spoken language systems of the hearing subjects. Gesture was found to serve as the primary means of communication for all 10 of the deaf subjects. Even though all of the deaf children vocalized frequently, only a small percentage of each deaf child's vocalizations were found to be meaningful. Of all of Marvin's vocalizations, 1% (1/100) were meaningful, while 3% (36/1200) of Abe's, 6% (33/550) of Mildred's, and 10% (12/120) of Karen's vocalizations were meaningful. (Vocalizations were not coded for the

Philadelphia deaf subjects.) In addition, all of the meaningful vocalizations that the deaf children produced were single words, and almost half (43%, 35/82) of those words were modulators, e.g., *no, uh-oh.* The remaining 57% of the deaf children's meaningful words (47 in toto) were single nouns, verbs, or adjectives. As a result of the small percentage of meaningful vocalizations, we focused our analyses entirely on the deaf children's gestures, comparing those gestures to the spoken words the hearing children used as their primary means of communication.

Single Lexical Items

All four of the Chicago deaf subjects were found to produce single gestures at the start of the study (ages 1–4 to 3–1). (Single gestures were not coded for the Philadelphia deaf subjects, who therefore are not discussed in this section.) The deaf children used their single deictic pointing gestures to denote a relatively wide range of objects; in particular, toys, food, vehicles, animals, people, body parts, clothing, and places. Moreover, the deaf children used their single characterizing gestures to denote both action and attribute predicates. By comparison, in terms of onset, two of the three hearing children, Ann and Beth, each produced single words on the videotapes for the first time at 1–4, while the third child, Carl, was already producing single words during his initial observation session at 1–5. In terms of lexical use, all three hearing children used their single spoken nominals (nouns and pronouns) to denote the same range of objects denoted by the deaf children with their single deictic gestures. Moreover, the hearing children used their single spoken verbs and adjectives to denote action and to attribute relations much like the deaf children's use of their characterizing gestures.

As shown in Table 2, all four deaf children used their single deictic gestures as indicators (e.g., a point to the drum, used to indicate to the listener the existence of the drum) and cases (e.g., a point to the drum, used to request the listener to act on the drum, the patient of the beating relation). Similarly, all three hearing children used their single nominal words to indicate the existence of objects, as well as to represent the case roles of objects.

Two of the deaf children, Mildred and Abe, used their single deictic gestures as indicators during their initial observation sessions (at ages 1–4 and 2–3, respectively), but did not begin to use their single deictic gestures to represent case roles until ages 1–6 for Mildred and 2–5 for Abe. (The other two deaf children, Marvin and Karen, used the single deictic gesture for the case function as well as the indicator function at the start of the study, ages 2–11 and 3–11, respec-

Table 2. Proportions of Types of Single Gestures and Single Words

Subject	*Indicators*	*Cases*	*Predicates*	*Total Single Lexical Items*[a]
Chicago Deaf Subjects:				
Gestures				
Mildred	.79	.07	.15	211
Abe	.69	.21	.09	174
Marvin	.45	.33	.22	249
Karen	.71	.17	.12	173
Hearing Subjects:				
Words				
Carl	.86[b]	.05	.08	485
Ann	.81	.08	.11	809
Beth	.57	.08	.35	413

[a]The number of tokens of single lexical items produced by each child.

[b]"What's that?" utterances are included in the category of spoken indicators for the hearing children primarily because utterances of this type served to point out objects (in addition to requesting labels) and because these utterances were not frequent enough to warrant a separate category (Ann produced 36, Beth 5, Carl 0).

tively.) This same developmental pattern was found in all three hearing children: Carl used his single nominal words as indicators at least at 1–5 and as cases at 1–8; Ann used her nominals as indictors at 1–4 and as cases at 1–8; and Beth used her nominals as indicators at 1–4 and as cases at 1–7. Greenfield and Smith (1976) have reported a similar pattern in two hearing children learning English: Single words were used initially to indicate the existence of objects and only later were used to represent the case functions of objects.

In addition to these similarities in the developmental patterns of single words and gestures, we also found similarities in the frequency with which the deaf and hearing children used their different types of single lexical items. In Table 2 are the proportions of indicator, case and predicate single lexical items that were used by the deaf and hearing children. The deaf children and hearing children both can be seen to use single lexical items most often as indicators of the existence of objects, and much less frequently to describe predicate relations or the case roles of objects. Apparently, the deaf children developed single gestures which were utilized in a manner quite comparable to the hearing children's use of single spoken words.

Simple Sentences

Age of onset. Seven of the 10 deaf children were found to be producing two-gesture sentences at their initial observation sessions

(ages 2–2 to 4–1). The remaining three deaf children (Mildred, Kathy, and Abe, ages 1–4, 1–5, and 2–3 at their respective initial sessions) were observed to be in the "one-gesture" stage for the initial part of the study, producing only single deictic gestures (e.g., point at a drum) and single characterizing gestures (e.g., two fists moving up and down in the air to represent beating a drum). Mildred and Kathy produced their first two-gesture sentences (e.g., point at drum, followed by the characterizing gesture BEAT) by 1–6, but Abe did not produce his first two-gesture sentence until age 2–5. By comparison, the 3 hearing children were all observed initially in either the preverbal or the one-word stage, and were noted to produce their first two-word sentences at 1–9 for Beth, at 1–10 for Ann, and at 1–11 for Carl. These ages fall well within the reported normal limits in English-learning hearing children (Bloom, 1973; Brown, 1973; Greenfield & Smith, 1976) but, interestingly, appear somewhat later than the onset of two-gesture sentences in two of the three deaf children who began sentence production during this study.

Semantic content. All of the deaf children and all of the hearing children used simple one-proposition sentences to describe actions which affected objects (transitive actions), actions which had no effect on objects (intransitive actions), and static characteristics of objects (attributes). As indicated in Table 3, all of the children, both hearing, with spoken sentences, and deaf, with gestured sentences, conveyed a relatively small proportion of intransitive action relations (range for the deaf children, .03 to .14; range for the hearing children, .05 to .14) compared to both transitive actions and attributes. Eight of the 10 deaf children conveyed more transitive action than attribute relations; one (Tracy) conveyed more attributes than transitive actions, and one (David) conveyed an equal proportion of each. A similar variable pattern was found in the hearing children's spoken sentences: Beth conveyed more transitive actions than attributes, Carl conveyed more attributes than transitive actions, and Ann conveyed an equal proportion of each. Thus, not only did the deaf children begin to produce two-gesture sentences at a time in development within the normal range of onsets of two-word sentences in the hearing children, but the deaf children also used their two-gesture sentences to convey the same range of semantic relations in the same proportions as the hearing children conveyed in their two-word sentences.

Structural regularities. In all natural languages, including child languages, words are strung together in a structured and rule-governed fashion to create sentences. Two types of structural regularities have commonly been observed in the early two-word sentences of

Table 3. Proportions of Semantic Relations Conveyed in Simple Sentences

Subject	*Transitive Actions*	*Intransitive Actions*	*Attributes*	*Total Number of Simple Sentences*
Chicago Deaf Subjects: Gestured Sentences				
Mildred	.56	.10	.34	79
Abe	.49	.16	.35	136
Marvin	.64	.08	.28	125
Karen	.60	.11	.29	110
Philadelphia Deaf Subjects: Gestured Sentences				
Kathy	.73	.14	.14	42
Dennis	.83	.03	.13	31
Donald	.52	.10	.37	138
David	.45	.13	.42	437
Chris	.56	.14	.27	43
Tracy	.24	.14	.62	65
Hearing Subjects: Spoken Sentences				
Carl	.32	.14	.55	22
Ann	.43	.05	.52	299
Beth	.55	.06	.39	262

young hearing children: deletion devices and ordering devices. We determined whether there is evidence for these two devices in our hearing children's two-word sentences and in our deaf children's two-gesture sentences. Only transitive action relation sentences were used as a data base for this analysis simply because, as we reported, intransitive sentences were infrequent in all of the subjects.

First, deletion is considered. Bloom (1970) in her study of four young hearing children at the two-word stage of language acquisition noted their systematic tendency to omit words for particular case functions from two-word sentences. Specifically, the children tended to omit a word for the subject (most often the actor) in a sentence, while explicitly producing a word for the object (patient) in the sentence. In Table 4 we present the actor and patient production probabilities found in our deaf and hearing subjects' two-gesture or two-word transitive sentences. Included in the analysis in Table 4 are only transitive sentences with two-place predicates (i.e., sentences which permitted three semantic elements in underlying structure: an act predicate, and two case roles, the actor and the patient), simply be-

Table 4. Production Probability in Transitive Simple Sentences with Two-Place Predicates[a]

Subject	*Patient Production Probability*	*Actor Production Probability*
Chicago Deaf Subjects:		
Gestured Sentences		
Mildred	.91	.18
Abe	.76	.31
Marvin	.93	.13
Karen	.74	.35
Philadelphia Deaf Subjects:		
Gestured Sentences		
Kathy	.77	.44
Dennis	1.00	.10
Donald	.90	.10
David	.83	.28
Chris	1.00	.00
Tracy	.85	.30
Hearing Subjects:		
Spoken Sentences		
Carl	.78	.22
Ann	.71	.30
Beth	.87	.13

[a] Patient and actor production probabilities were calculated on the basis of the following numbers of transitive sentences with two explicit semantic elements in surface structure and three semantic elements in underlying structure (actor, patient, act): Mildred, 22; Abe, 29; Marvin, 30; Karen, 23; Kathy, 9; Dennis, 10; Donald, 29; David, 88; Chris, 7; Tracy, 13; Carl, 9; Ann, 79; and Beth, 67.

cause we have previously found that the number of semantic elements which can be explicitly produced in a sentence affects the probability with which a given element is produced (Goldin-Meadow, 1979; 1985). Because production probability is also affected by the number of semantic elements in the surface structure of a sentence, the data base in Table 4 is further limited to sentences with two semantic elements explicitly produced.

The data in Table 4 suggest that both deaf and hearing subjects utilized deletion as Bloom (1970) described: All deaf children tended to produce a gesture for the patient case role in their two-gesture transitive sentences but tended to omit a gesture for the actor case role in the sentences, and all hearing children tended to produce a word for the patient case role in a transitive sentence but to omit a word for the actor case role. It is important to note that the distinction

between patients and actors in terms of production probability is not an artifact of our production probability measure. The children could have produced words or gestures for actors as often as words or gestures for patients, either by producing only one type of transitive sentence, sentences containing words or gestures for both the patient and the actor (e.g., "mommy grape"), or by producing sentences containing words or gestures for the patient and the act (e.g., "eat grape") as often as sentences containing words or gestures for the actor and the act (e.g., "mommy eat").

Neither we nor Bloom are claiming that the child necessarily deletes semantic elements by design. It is quite possible that the child is a victim of output constraints (the most likely candidate being memorial limits), constraints which would lead naturally to the deletion of semantic elements in surface structure. It is of interest, however, that not only were deletion regularities found in both the deaf and hearing children's sentences, but that the same elements were found to be favored (the patient) and suppressed (the actor), independent of communication modality.

In sum, the deaf subjects appeared to use the same systematic deletion device in their two-gesture sentences as the hearing children used in their two-word sentences.

Ordering is considered now. Hearing children acquiring spoken languages have been shown to produce two-word sentences which are characterized by systematic word orders, usually the particular orders found in the adult languages spoken around them (Bowerman, 1973; Braine, 1976; Brown, 1973). We examine the existence of ordering rules in our deaf children's language, developed without an external model, and compare their ordering strategies to those of our hearing children who were learning English. In Table 5 are the data from the deaf children's two-gesture sentences and the hearing children's two-word sentences which contained gestures or words for the patient case and the act predicate and those which contained gestures or words for the actor case and the act predicate, classified according to the order of the case and predicate elements. The deaf subjects' two-gesture and the hearing subjects' two-word transitive sentences could indeed be characterized by systematic construction orders, although the deaf children and, to some extent, the hearing children did not use rigid construction orders in their sentences; rather, the children exhibited reliable tendencies to produce signs (or words) for a given semantic element before signs (or words) for other semantic elements.

As can be seen in Table 5, 6 of the 10 deaf children produced sentences characterized by systematic gesture orders, 4 showing sta-

Table 5. Order in Transitive Two-Gesture and Two-Word Simple Sentences

Subject	*P-A*	*A-P*	*Ar-A*	*A-Ar*
Chicago Deaf Subjects:				
Gestured Sentences				
Mildred	19	8*	1	2
Abe	11	12	4	0
Marvin	21	12	0	2
Karen	17	8†	1	1
Philadelphia Deaf Subjects:				
Gestured Sentences				
Kathy	8	4	1	1
Dennis	10	1**	0	0
Donald	26	15*	1	0
David	44	18***	3	8
Chris	6	4	0	0
Tracy	7	1†	2	0
Hearing Subjects:				
Spoken Sentences				
Carl	0	5†	0	0
Ann	7	48***	25	0***
Beth	3	56***	9	0**

Note: P = patient, A = act, Ar = actor. Each entry represents the number of two-gesture or two-word sentences following a particular order (e.g., P-A, patient precedes act) produced by each child.

†$p < .10$, trend; *$p < .05$; **$p < .01$; *** $p < .001$; binomial or chi-square test, two-tailed.

tistically significant patterns and 2 showing trends. Each of these children tended to produce two-gesture sentences in which the patient case preceded the act predicate (e.g., point at drum, BEAT). Note that this pattern differs from the canonical ordering of patients and acts in English, e.g., "beat the drum." Of the remaining four deaf children, Kathy and Marvin showed ordering tendencies in the same direction (i.e., patients before acts), Abe had no patient/act ordering preference whatsoever, and Chris showed the following unusual (and systematic) ordering pattern: He produced gestures for the patients of transferring relations like "give" or "put" *before* gestures for the act (e.g., point at apple, GIVE, 6 P-A vs. 0 A-P), but produced gestures for the patients of transforming relations like "eat" *after* gestures for the act (EAT, point at apple, 0 P-A vs. 4 A-P) ($p < .005$, Fisher Exact Text, one-tailed).

Overall, the deaf children produced very few two-gesture sentences with gestures for actors and acts. David, who produced 11

such sentences, showed a slight tendency to produce gestures for the actor *after* gestures for the act (e.g., BEAT, point at soldier), a pattern different from the canonical English word order pattern (e.g., "the soldier beats"). Abe, however, showed a tendency to follow the English pattern and produced gestures for the actor *before* gestures for the act (e.g., point at soldier, BEAT). Note that Abe was the one deaf child who showed no tendency whatsoever to order his gestures for patients and acts.

In contrast, all three of the hearing subjects used two-word sentences with ordering regularities which followed canonical English word order. The hearing children tended to produce the word for the patient *after* the word for the act (e.g., "eating cookie"); for two of the children, this pattern was statistically significant and for the third, a trend was evident. The two hearing children who produced sentences with words for the actor and the act (Ann and Beth) produced the word for the actor *before* the word for the act ("he's eating"); this pattern was statistically significant for both children.

In sum, we found that both the deaf and the hearing children tended to utilize the syntactic strategy of construction orders in their respective two-gesture and two-word sentences. However, the particular construction orders the deaf children used in their gesture sentences differed from those found in the spoken sentences of the English-learning hearing subjects. These findings stand in contrast to the data for production probability, where not only did both the deaf and hearing children employ the same general syntactic strategy (deletion) but their specific production probability rules (i.e., produce patients and omit actors) were also identical.

Complex Sentences

All 10 of the deaf subjects produced complex gesture sentences, sentences which conveyed more than one proposition, either concatenations of action propositions, attribute propositions, or action plus attribute propositions (e.g., point at tower, HIT—FALL, a comment on the fact that the child had hit [Act_1] the tower and that the tower had fallen [Act_2]; or point at lobster, UGLY—DIVE, a comment on a picture of an ugly [attribute] lobster who was diving [act] into the water). Similarly, all three of the hearing subjects produced complex spoken sentences (e.g., "I make [Act_1] it work [Act_2]"; or "put on [act] a baby's [attribute] head"). As Table 6 shows, six of the deaf children were already producing complex gesture sentences during their initial observation sessions (ages 2–2 to 4–1). The four deaf children who began complex sentence production during the study produced their

Table 6. Complex Sentences

Subject	*Age First Observed (years-months)*	*Proportion of Sentences*[a]
Chicago Deaf Subjects:		
Gestured Sentences		
Mildred	2-2	.12 (11/90)
Abe	2-5	.25 (45/181)
Marvin	(2-11)[b]	.23 (38/163)
Karen	(3-1)	.22 (31/141)
Philadelphia Deaf Subjects:		
Gestured Sentences		
Kathy	2-2	.17 (11/65)
Dennis	(2-2)	.11 (4/37)
Donald	3-11[c]	.07 (12/171)
David	(2-10)	.31 (240/774)
Chris	(3-2)	.14 (8/57)
Tracy	(4-1)	.12 (10/83)
Hearing Subjects:		
Spoken Sentences		
Carl	1-11	.08 (2/24)
Ann	2-3	.13 (45/344)
Beth	1-9	.13 (38/300)

[a]The numerator is the total number of complex sentences and the denominator the total number of all (simple and complex) sentences each child produced.

[b]Parentheses indicate that the child was producing complex sentences during the first session he or she was observed.

[c]Donald was not observed during the period from 3-1 to 3-11 and therefore might have begun producing complex sentences as early as 3-2.

first complex gesture sentence at 2–2 for Mildred and Kathy, at 2–5 for Abe, and at 3–11 for Donald (since we did not observe Donald during the period from 3–1 to 3–11, Donald might have begun producing complex gesture sentences as early as 3–2). We were able to observe the onset of complex spoken sentences in all of the hearing subjects: at 1–9 for Beth, 1–11 for Carl, and 2–3 for Ann, ages somewhat earlier than the deaf subjects' onset ages for complex gesture sentences.

Table 6 also shows that both the deaf and the hearing children were equally likely (or unlikely) to produce complex sentences when they produced sentences at all (range for the deaf children, .07 to .31; range for the hearing children, .08 to .13).

Deaf Children's Gestures and Hearing Children's Speech

Having considered similarities in the deaf and hearing children's gesture and word productions, we turn now to a discussion of the dif-

ferences between the deaf children's gesture corpus and the hearing children's speech.

Lexical differences. We note at the outset that the lexical properties of the deaf children's gestures and the hearing child's words differed fundamentally in terms of the referential information each conveyed. As an example, a deictic pointing gesture, unlike a spoken word, served to direct a communication partner's attention to the existence of a particular person, place, or thing, and (of necessity) to its location as well. A pointing gesture always explicitly specifies the location of its referent in a way a word (even a pro-form) never can. Conversely, a pointing gesture does not (indeed cannot) ever specify precisely *what* the object is (or what about the object is being referenced); deictic points merely indicate *where* an object is. Put another way, pointing gestures are "location-specific" but not "identity-specific" with respect to their referents, whereas single words can be "identity-specific" (e.g., *lion* and *ball* serve to classify their respective referents into different sets) but are not "location-specific," unless the word is itself accompanied by a pointing gesture.

Another important difference between single gestures and single words relates to *iconicity.* Characterizing gestures, the lexical items the deaf children used to denote actions and attributes, were almost always iconic (i.e., the form of the gesture was transparently related to its referent). This feature of characterizing gestures stands in sharp contrast to the far less transparent spoken verbs and adjectives, the lexical items the hearing children used to denote actions and attributes. Note, however, that in contrast to their "location-specific" pointing gestures, the deaf children's characterizing gestures resembled the hearing child's words in that both were "identity-specific." Through its iconicity, the characterizing gesture can specify the identity of its referent, but, like words and unlike pointing, the gesture cannot specify its referent's location.

Mean utterance length. The deaf children's systems differed from the hearing children's along a second dimension: that of *mean utterance length.* The lowest and the highest MLU (mean length of utterance, calculated by session) for each of the deaf and hearing subjects are given in Table 1. At the high end, the hearing subjects' MLU's ranged from 1.23 to 2.83, while the deaf subjects' MLU's ranged from 1.21 to 1.80. Note that the deaf subjects were quite clearly at the low end of the hearing children's mean length range, even though at the final observation sessions the deaf subjects were older (2–6 to 4–6) than were the hearing subjects (1–11 to 2–6). The second measure of length commonly cited in the child language literature, the *upper-bound* (the number of words or gestures in the child's longest utterance), revealed length differences between the deaf subjects and the hearing subjects, although the differences are

not as striking. In Table 1 are the lowest and the highest upper-bound, calculated by session, for each of the deaf and hearing subjects. At the high end, the hearing subjects' upper-bounds ranged between 3 and 11, whereas the deaf subjects' ranged only between 3 and 9.

It is worth noting that MLU may be lower in general for signed languages than it is for spoken languages. Bellugi and Fischer (1972) found that subjects bilingual in both English and ASL produced underlying sentences in an English rendition of a story at a rate comparable to their production of underlying sentences in an ASL rendition of the same story. However, the subjects were found to use nearly twice as many words in their English renditions as signs in their ASL renditions to fill in those underlying sentences.

Rate of production. As a final point of comparison, the deaf children's gesture systems also differed from the hearing children's spoken systems in terms of rate of production. Given in Table 1 are the lowest and the highest production rates (the number of utterances produced per hour, calculated by session) for each of the deaf and the hearing subjects. At the high end, the hearing children's production rates ranged from 260.3 to 420.4 utterances per hour versus the deaf children's which ranged only from 93.0 to 384.0.

In sum, in addition to the obvious difference of production modality, other differences have been demonstrated, most notably in lexicon, mean length of utterance, and rate of production, between the deaf children's gesture systems and the hearing children's spoken systems.

By way of summary of Study 1, we have shown that a child who is unable to make use of the oral modality to learn speech (and who is not receiving any formal instruction in a conventional manual language) can nevertheless exploit the manual modality for the purposes of communication. Each of the 10 deaf subjects developed a gesture system which resembled the spoken systems of the hearing subjects, both in the kinds of notions conveyed, and also in the structural regularities used to convey those notions.

It is important to note, however, that the deaf subjects were in almost all cases much older than the hearing subjects. (At their final observation sessions, the deaf ranged in age from 2–6 to 4–6; the hearing, from 1–11 to 2–6.) Recall also that while two of the deaf children (Mildred and Kathy) began production of two-gesture sentences at approximately the same age as the hearing children began production of two-word sentences, one deaf child (Abe) was delayed by several months. Similarly, three of the deaf children (Mildred, Kathy, and Abe) began production of complex gesture sentences at approxi-

mately the same age as the hearing children began production of complex spoken sentences, but again one deaf child (Donald) was delayed by at least 1 year. These age comparisons suggest that, although the deaf child appears able to develop a gesture system comparable in content and structure to the earliest spoken systems hearing children use, the deaf child's gesture development may not, in all cases, keep pace with the hearing child's speech development. Moreover, whether the deaf children will ever be able to advance their gesture use beyond the earliest functions of language is an open, and as yet unexplored, question. Nevertheless, on the basis of the data presented here, it seems reasonable to conclude that a young child who (for physiological reasons) is unable to acquire a conventional spoken language and who (for social reasons) is unable to acquire a conventional manual language, is able to make use of gesture to fulfill the major functions of early child language.

STUDY 2

We have seen that gesture flourishes as a means of communication in a deaf child who has not been exposed to a conventional system of manual communication. Thus, gesture can serve apparently as the dominant means of communication in a child who does not have the oral modality available. But what is the role of gesture in a child who has *both* oral and manual channels available, as is the usual case for hearing children?

The Distribution of Gesture and Speech

Prelinguistic hearing children have been reported to use deictic pointing gestures several months before they begin to speak (Bates, 1976). Moreover, observations by Bates et al. (1979), Carter (1974), and Greenfield and Smith (1976) suggest that, even after a hearing child has begun to speak, he or she continues to use gesture to support verbal communications. Our goal in this study was to describe the gestures that three hearing children produced in relation to their speech. The first question was whether hearing subjects would use their hands to gesture at all; the second, whether their gestures would form a communication system separate from speech or, alternatively, would serve as an adjunct system well-integrated with speech. To address these issues, we began by classifying the hearing children's gestures according to whether they occurred alone or in combination with spoken words.

In Table 7 are the proportions of the hearing subjects' communications which contained gestures alone, speech alone, or gesture and

Table 7. Proportions of Communicative Gesture and Speech in Hearing Children

Subject	*Gesture Alone*[a]	*Gesture + Speech*	*Speech Alone*	*Total Number of Communications*
Carl	.34	.25	.41	746
Ann	.24	.32	.43	1599
Beth	.17	.13	.71	1005

[a]Hearing children tended to vocalize even when they produced gestures without speech: 82% of Ann's, 35% of Beth's, and 80% of Carl's gestures which were not accompanied by meaningful speech (i.e., gestures alone) were accompanied by meaningless vocalizations (e.g., point at bubbles + "uh").

speech combined. All the children tended to use gesture alone approximately as often as they used gesture in combination with speech (Beth, .17 gesture alone vs. .13 gesture + speech; Ann, .24 vs. .32; Carl, .34 vs. .25). However, Beth used proportionally less gesture overall (.30) than did either Ann (.56) or Carl (.59), and Beth used gesture less often than did either Ann or Carl. Beth's highest rate of gesture production (i.e., the number of gestures alone and gesture + speech combinations produced per hour) was 25.5 gestured communications per hour (at age 1–4), while Ann's was 145.6 (age 1–7), and Carl's was 120.1 (age 1–11). Note that Ann's and Carl's highest gesture production rates were within the range of our deaf subjects' highest gesture production rates (range 93.0 to 384.0). Thus, even though the hearing subjects used speech as their primary means of communication, two of the hearing children tended to produce gestures approximately as often as did the deaf subjects.

There were, however, additional differences between the deaf and hearing subjects in the developmental course of gesture production. All of the deaf subjects tended to increase their rates of gesture production over the course of our observations. In contrast, two of the three hearing children appeared to reach a production peak for gesture alone sometime in the middle of the study, after which their production rates for gesture alone declined steadily. Ann's peak production for gesture alone occurred at 1–8 (99.2 gestures alone per hour), and Beth's at 1–4 (23.7 gestures alone per hour). In addition, Beth also reached a production peak for gesture + speech during the study at 1–10 (16.4 gesture + speech combinations per hour). Note that Beth's production peak for gesture alone occurred 6 months earlier than her production peak for gesture + speech combined. At the end of the observations, Ann's production rate for gesture + speech was still increasing at 2–6 (118.3 gesture + speech combinations per

hour), and Carl's production rates for both gesture alone and gesture + speech combined were still increasing at 1–11 (21.8 gestures alone per hour; 90.1 gesture + speech combinations per hour). Moreover, the three children were continuing to increase their production rates for speech at the end of the study (124.7 spoken utterances per hour for Beth at 2–5, 148.3 for Ann at 2–6, and 162.9 for Carl at 1–11).

In summary, the three hearing children were found to gesture. In fact, 17% to 34% of each child's communications contained gestures alone, accompanied by no speech. In addition, the children produced gestures along with speech in another 13% to 32% of their communications. Thus, even children learning spoken languages appear to make use of gesture to communicate. The crucial question, however, is whether the gestures the hearing children produced were as linguistically complex as were those produced by the deaf subjects. This question is addressed next in detail.

Linguistic Complexity of Gestures

Single gestures. We found that the hearing children began producing single gestures several months before they began producing single words. Both Beth and Ann produced their first deictic gestures at 1–2, but did not produce their first spoken nouns until 1–4 and their first spoken pronouns until 1–7. (Carl was producing deictic gestures and spoken nouns during his initial observation session at 1–5, but, like the other two hearing children, did not begin producing spoken pronouns until several months later at 1–11.) Thus, the hearing subjects used single gestures approximately 2 months before they used single words.

The hearing subjects tended to use their single gestures in the same way they used their single words, and in the same way the deaf subjects used their single gestures. The proportions of the hearing children's single gestures used as indicators, cases, and predicates, as shown in Table 8, should be compared to Table 2. As was the case for the deaf children's single gestures and the hearing children's single words, the hearing children's single gestures were most often used to

Table 8. Proportions of Single Gesture Types in Hearing Children

Subject	*Indicators*	*Cases*	*Predicates*	*Total Single Gestures*
Carl	.78	.19	.03	183
Ann	.83	.04	.13	362
Beth	.75	.01	.24	169

indicate the existence of objects, and relatively few were used to represent cases and predicates.

Further, we found that the hearing children used their single deictic pointing gestures to refer to the same range of objects that they referred to with their spoken nouns and pronouns, and that the deaf subjects referred to with their single deictic gestures (i.e., toys, vehicles, food, animals, body parts, people, places, and clothing), with a few exceptions: Beth did not use points to indicate food, places, or clothing, and Carl did not use points to indicate clothing—objects that the children did indicate with their single words.

All of the hearing children were also found to produce characterizing gestures to represent predicates. However, the range of predicates they conveyed with their characterizing gestures was quite restricted, far more restricted than the range of predicates they themselves conveyed with their spoken verbs and adjectives, and far more restricted than the range of predicates the deaf children conveyed with their characterizing gestures. The three hearing children produced the action characterizing gesture GIVE (open palm extended to request an object). Beth produced no further types of characterizing gestures; Ann produced no other types of action characterizing gestures without accompanying speech but 14 other types (18 tokens) with accompanying speech (i.e., complementary gesture + speech combinations, e.g., "brush teeth" + BRUSH, fist moving up and down near teeth, to comment on a picture of a toothbrush); and Carl produced one attribute characterizing gesture (2 tokens) without accompanying speech (LONG, index finger moved from nose away from body in an arc to comment on the shape and length of an elephant's trunk).

Gesture + gesture combinations. Each of the hearing children was found to produce a small number (less than 1% to 2% of each child's gestures without speech) of gesture-alone communications which contained two distinct gestures, each denoting a different semantic element (e.g., GIVE + point at dog, or point at puzzle-piece + point at puzzle-board). In addition, the hearing children produced their gesture + gesture strings for only a relatively short period of time (see Figure 1). However, the timing of these infrequent two-gesture sentences relative to the onset of two-word speech was of interest: All three children produced their two-gesture sentences *prior* to the onset of their two-word sentences, beginning production 5 to 9 months and stopping production 2 to 5 months before two-word speech began.

Gesture + speech. Finally, we found that the hearing children not only produced gestures in combination with other gestures but

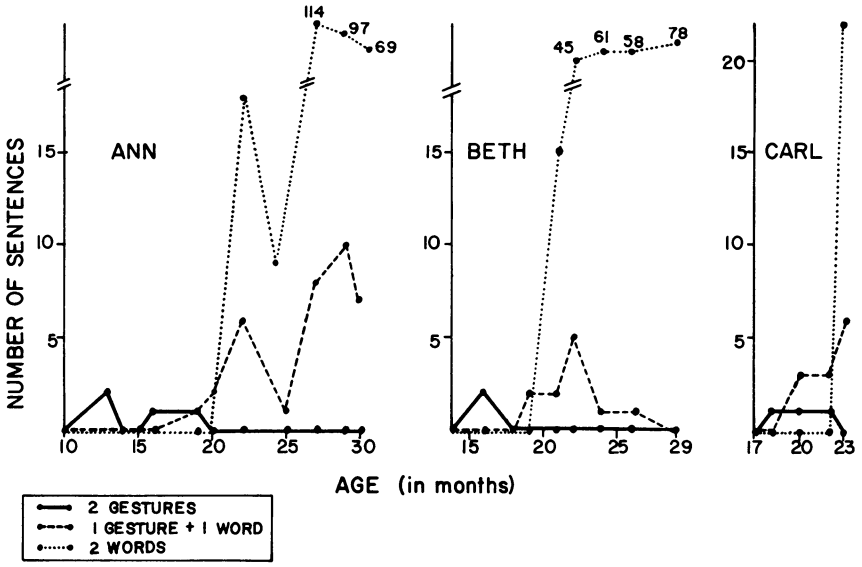

Figure 1. Number of two-unit sentences conveying two different semantic elements produced by the three hearing children at each observation session. The sentences are classified according to the modality used to convey the two semantic elements: gesture + gesture sentences (e.g., point at bubbles + point at table), gesture + word sentences (point at bubbles + "table"), and word + word sentences ("bubble table").

also produced a number of gestures in combination with speech. Our analysis revealed that gesture could play two distinct roles in these gesture + speech combinations: complementary and supplementary roles. In certain combinations, gesture served to complement a word in the spoken utterance, denoting the same semantic element as the word, e.g., point at glasses + "glasses" or GIVE + "give." In other gesture + speech combinations, gesture served to supplement the spoken utterance, denoting a different semantic element from that

Table 9. Proportions of Types of Gesture + Speech Combinations in Hearing Children

Subject	*Complementary Combinations*	*Supplementary Combinations*	*Total Combinations*
Carl	.88	.12	184
Ann	.89	.11	516
Beth	.71	.29	117

denoted in speech, e.g., point at glasses + "out" or GIVE + "puzzle." The proportions of the hearing children's complementary and supplementary gesture + speech combinations are given in Table 9. All three children produced many more complementary gesture + speech combinations (.71 to .89) than supplementary gesture + speech combinations (.11 to .29).

In Table 10 are the hearing children's complementary gesture + speech combinations, categorized according to the particular semantic category assumed by the gesture. As shown there, Ann and Carl used their complementary gestures in gesture + speech combinations primarily as indicators (e.g., point at bottle + "bottle") and even Beth used her complementary gesture + speech combinations as indicators half of the time. Interestingly, the majority of the complementary gesture + speech indicators that the children produced were point + noun combinations (e.g., point at dog + "dog"): 83% (253/333) of Ann's, 98% (45/46) of Beth's, and 87% (123/142) of Carl's gesture + speech indicators were point + noun combinations. Much smaller percentages of the children's gesture + speech indicators were either point + request-for-name combinations (e.g., point at dog + "what's that?" 11%, 0%, and 7%, for Ann, Beth, and Carl, respectively) or point + pronoun combinations (e.g., point at dog + "that," 13%, 2%, and 13%, respectively).

In addition, all the children produced some complementary gesture + speech combinations in which the gesture assumed a case role, either concatenated with a single spoken word (e.g., point at bubbles + "bubble," used to request the listener to open the bubbles, the patient) or concatenated with a spoken sentence (e.g., point at bubbles + "open bubble"). In contrast to the complementary gesture + speech *indicators* (which were primarily point + noun combinations), complementary gesture + speech *cases* were frequently point + pronoun combinations: 49% (56/115) of Ann's, 64% (23/36) of Beth's, and 40% (8/20) of Carl's complementary gesture + speech cases were point + pronoun combinations. Finally, Ann produced a small number (13) of complementary gesture + speech combinations in which her gesture assumed a predicate role, e.g., "and cut salami" + CUT (fist moving down abruptly in air).

An analysis of the semantic category assumed by the gesture in the hearing children's few supplementary gesture + speech combinations reveals that, for two of the children, the supplemental gesture was used primarily to represent a case (e.g., "blow" + point at bubbles; 92% [67/73] of Ann's and 100% [22/22] of Carl's supplementary gesture + speech combinations) and was less frequently used as a predicate (e.g., GIVE + "bubbles"; 8% of Ann's and none of Carl's

Table 10. Semantic Category Proportions of the Gesture in the Hearing Children's Complementary Gesture + Speech Combinations

Subject	*Indicators*	*Cases*	*Predicates*	*Total Complementary Combinations*
Carl	.88	.12	.00	162
Ann	.72	.25	.03	461
Beth	.55	.45	.00	83

supplementary gesture + speech combinations). In contrast, the third child, Beth, tended to use her supplemental gesture as a predicate (62%, 21/34) more frequently than as a case (38%). A supplementary gesture + speech combination could not be classified as an indicator (i.e., as a combination whose only function was to indicate the existence of an object) simply because, by definition, a combination of this type contained at least two different semantic elements, one represented by a word and a second represented by the supplemental gesture.

Developmental onsets of gesture + speech combinations. The hearing children produced their first complementary gesture + speech combinations (point at bubbles + "bubble") at 1-4 for Ann, 1-6 for Beth, and 1-5 for Carl, 1 to 4 months before they produced their first supplementary gesture + speech combinations (GIVE + "bubble" or point at bubble + "open") at 1-6, 1-7, and 1-8, respectively. Thus, the gesture + speech combination appears to be used first to denote the same semantic element (complementary information) and only later to denote two different semantic elements (supplementary information).

Moreover, the supplementary gesture + speech combination seemed to serve as a transitional form between the children's two-gesture sentences and their two-word sentences. All three children produced supplementary gesture + word sentences 2 to 4 months after they began producing two-gesture sentences but 2 to 3 months before they began producing any two-word sentences (gesture + gesture sentences at 1-1, supplementary gesture + word sentences at 1-6, and word + word sentences at 1-8 for Ann; 1-4, 1-7, and 1-9 for Beth; and 1-6, 1-8, and 1-11 for Carl; see Figure 1). These data suggest that a gestural transition period may precede the child's entry to the two-word stage, just as a gestural transition period seems to precede entry to the one-word stage. The child appears to have the ability to convey two semantic elements in one combination prior to the first two-word sentence, and exhibits this ability initially in the (presumably easier) gesture + gesture and gesture + word forms.

To summarize this second study: We found that all three of these hearing subjects used gesture to communicate. In fact, gesture seemed to be a relatively easy way for the hearing children to express themselves. The children produced single deictic gestures to indicate objects months before they produced single words to indicate those same objects. Moreover, all the children conveyed two concatenated semantic elements first in a gesture + gesture sentence form (point at bubbles + point at table, a request to put the bubbles on the table), next in a gesture + word sentence form (point at bubbles + "table"), and only months later in a word + word sentence form ("bubble table"). Gesture thus seemed to serve as a transitional form en route to speech. All the hearing children stopped producing the two-gesture sentence prior to their first two-word productions. Moreover, for Ann and Beth, the production rate for gesture alone, and for Beth, the production rate for gesture combined with speech, reached a peak sometime during the middle of the study and declined steadily thereafter. Thus, for all of the hearing children, as they grew older speech appeared to assume the communicative functions which were once filled, however briefly, by gesture.

Even though all of the hearing subjects gestured, the gestures produced were not as linguistically complex as the deaf subjects' gestures: The characterizing gestures were quite restricted in the range of predicates denoted, representing almost exclusively the predicate *give*. Very few two-gesture sentences were produced and a complex gesture sentence (i.e., a gesture sentence which conveyed two propositions) was never produced. Moreover, most of the gestures alone seemed to serve only to indicate the existence of objects.

When the hearing children combined their gestures with speech, the gestures tended to play a complementary role vis-à-vis the spoken utterance; that is, the gesture referred to precisely the same semantic element as did the word. Only rarely did the gesture add supplemental information not conveyed in a word to the spoken utterance. In addition, the children tended to use these complementary gesture + speech combinations as they used their single gestures, primarily to indicate the existence of objects and only occasionally to represent either predicate relations or the case roles of objects. Not surprisingly, given that the hearing subjects were acquiring a conventional spoken language, gesture did not come to take over all, or even many, of the functions of communication in these young children.

DISCUSSION

We have shown that young children who are incapable of using the oral modality for speech can nevertheless exploit the manual mo-

dality for the purposes of communication. The 10 deaf children observed in this study had in common two characteristics: (a) Each child was congenitally deaf and unable to acquire spoken language naturally even with a hearing aid, and (b) each child had not yet been exposed to a conventional sign language. Thus, all of the deaf children in the study experienced the same lack of oral and manual linguistic input. Yet none was prevented by this lack of input from developing a structured communication system in the manual modality.

In addition, it was shown that the gesture systems the deaf subjects developed were organized in many of the ways that the young hearing child's spoken communication system is organized. Despite differences in lexicon, mean length of sentences, and rate of production, the deaf children's gesture systems were found to be comparable to the early systems of three hearing children learning English in single lexical items and in the semantic content and structural properties of sentences. In particular, each of the deaf children developed gestural lexical items and each of the hearing children developed spoken lexical items which they used singly to denote the existence of objects, the case roles of objects, and action and attribute predicate relations. In addition, each deaf child was able to concatenate her/his gestures and each hearing child her/his words into both simple (one-proposition) and complex (multi-proposition) sentences. Both the deaf and the hearing children's simple sentences were found to be characterized by two types of surface regularities: (a) *Deletion* regularities described which semantic elements were likely to be represented by gestures or words (patients) and which were likely to be omitted (actors) in a transitive sentence; and (b) *Ordering* regularities described where in a transitive sentence gestures or words for particular cases and predicates were likely to be produced.

Thus, the manual language systems developed by the deaf children were found to be structured as were the spoken language systems of the hearing children. However, unlike the hearing children who were developing their spoken language systems under the guidance of a conventional language model, the deaf subjects were developing their manual language systems without the benefit of a conventional language model. These results suggest not only that the manual modality is capable of fulfilling some of the functions of human language (a fact illustrated by conventional adult sign languages which have been found to be organized much like adult spoken languages), but also that a young child, even one who is lacking exposure to a conventional manual language model, can sui generis make use of the manual modality to communicate.

The ease with which a child can exploit the manual modality for language when communication is blocked from oral channels should

not be surprising, given that, at least at the earliest stages of language learning, children seem to acquire language in the manual modality more easily than language in the oral modality. For example, Orlansky and Bonvillian (in this issue of the *Merrill-Palmer Quarterly*) have shown that deaf children learning ASL from their deaf parents acquire their first signs and achieve a 10-sign vocabulary several months in advance of the norms for the acquisition of words in hearing children. Moreover, when exposed to usable conventional language models in both the oral and manual modalities, even hearing children seem to make more progress initially in the manual language than in the spoken language. For example, Prinz and Prinz (1979) studied a hearing child exposed to ASL by her deaf mother and exposed to English by her hearing father, and found that the child began to acquire signs several months before she began to acquire spoken words. The data of our hearing subjects provide another example of the ease with which the manual modality can be used for language. Hearing subjects were found to produce single gestures before single words, and two-gesture sentences before two-word sentences. Thus, from all these lines of evidence, it may be tentatively concluded that the manual modality seems to provide a child with easier access to language than does the oral modality, at least at the earliest stages of language acquisition (but see Abrahamsen, Cavello, and McCluer in this issue of the *Quarterly* for evidence that the manual modality may fail to provide easier access to language than the oral modality for certain subsets of handicapped hearing children).

Our results further suggest that, even though gesture can be elaborated by a child into a system sufficiently complex to take over the major functions of spoken child language, such elaboration does not take place if speech is the child's primary means of communication. The hearing children were found to use gesture prior to speech in the very first stages of language acquisition, but they did not continue to elaborate their gestures over time, as did the deaf children. The hearing subjects did not develop as extensive a gestural lexicon as did the deaf subjects, nor did they develop gesture sentences which were as complex in either content or form as were the deaf subjects' gesture sentences. In fact, especially over the later course of development studied here, gesture in the hearing children appeared to show a decline rather than an increase in both complexity and rate of production. The hearing subjects' most complex gesture (the two-gesture sentence) was produced only for a very brief period, and all prior to the onset of two-word speech. In sum, though gesture tends to be used early in development by hearing children, under normal circumstances the frequency of its use appears to decline, although not disappear, as the child begins to talk.

Our data suggest that the role of gesture in hearing children's communications is as an adjunct to speech. The three hearing subjects used their gestures in combination with speech primarily to indicate the objects labeled by their spoken nouns, a function which gestures serve in adult spoken discourse as well (Marslen-Wilson et al., 1982). Note that, as discussed earlier, since a noun cannot on its own locate the particular object to which it is referring, the deictic point (which does locate objects) is serving an important referent-locating function in discourse, a function which even very young hearing children seem to know about.

In conclusion, it has been shown that a young child, deaf or hearing, can exploit the manual modality and develop single gesture and two-gesture forms to convey information to others. If the child is hearing and is exposed to a spoken language model, that child will, as speech develops, come to gesture less often and less elaborately, relegating gesture to the object-indicating role it tends to serve in adult spoken discourse. In contrast, if the child is deaf and is not exposed to a conventional manual language model, that child is likely to develop gestures into a full-fledged child language system. Prevented from following the conventional route to language learning, a child appears able to generate, through gesture, his or her own unconventional solution to the language acquisition problem.

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