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THE CREATION OF A COMMUNICATION SYSTEM: A STUDY OF DEAF CHILDREN OF HEARING PARENTS[1]

Susan Goldin-Meadow and Heidi Feldman[2]

Common knowledge has it that when you talk to a child in English the child learns to speak English, and when you talk to a child in Japanese the child learns Japanese. It is also now well known that when you sign to a child in American Sign Language, the child learns to sign American Sign Language. But what if you neither talk nor sign to a child? Will the child be able to communicate with others and, if he can, will his spontaneous communication have any or all of the properties of natural language?

In order to answer these questions about the role of linguistic input in the development of symbolic communication systems, we have observed a population which, in some sense, has been neither talked to nor signed to at all. Our subjects are deaf children whose severe hearing losses prevent them from acquiring oral language naturally. Furthermore, they are deaf children whose hearing parents have consciously decided not to teach their children a standard manual sign language and to instead concentrate on oral education. At this point in their development, our subjects have benefitted very little from their oral training. Our study was designed to observe the symbolic systems our subjects spontaneously might create in order to communicate, despite the lack of an obvious linguistic model to guide their communicative development.

Method. Our sample included four children ranging in age from one and one-half to four years. We visited each child in his home at intervals of approximately six weeks (see Table 1). At each visit we gave the child a variety of toys to play with and videotaped his activity with these toys in the presence of other hearing participants (e.g. the investigators, the child's parents). Although we recorded both the verbal and manual behaviors of our subjects and their parents, we became primarily interested in the gestural output of the deaf children; we concentrated on manual behavior simply because these children seemed to make very little systematic and spontaneous use of vocalizations, undoubtedly as a result of their hearing losses.

We used our videotapes to develop a coding system of the form and meanings of the gestures employed in communication. Our first task was to pull the gestures out of the stream of ongoing motor activity. To accomplish this task, we set up two criteria for a gesture: 1) The gesture must be directed to another individual; this criterion is met if the child makes some attempt to establish eye contact with his partner. 2) The gesture must affect the partner through its symbolic meaning and not as a direct motor act. For example, if a child physically restrains his partner, we do not consider this act a gesture; if, however, he holds up his open palm in a stop-like gesture, he is indirectly restraining his partner through the symbolic meaning of his gesture.

After discriminating gestures from motor acts, we then characterize the form of each gesture along the dimensions classically used to describe the gestures of the American Sign Language (see Stokoe 1960). We also coded the number of gestures contained within each gestural phrase. The assignment of gestural phrase boundaries was done with reference to the time interval between gestures, the continuity of movement, and the return to neutral position (hands in a relaxed position in front of the body), as is done in marking boundaries in American Sign Language. Spot reliability checks between two independent observers yielded 86% agreement on the isolation of gestures from the behavioral stream and on the assignment of gestural form and gestural phrase boundaries.

In addition, we coded the children's gestures according to the meanings they conveyed. Following Bloom (1970; 1973) we relied on context both to determine the meanings of the single gestures and to determine the semantic relations represented by gesture combinations. Each gesture in a combination was assigned to a semantic role or case (cf Fillmore 1968) according to its referent's relationship to the referents of the other gestures in the combination. For example, if the child produced the gestural combination signifying "mommy doll" when mother dressed the doll, then the gesture for mother was considered an *agent* and the gesture for doll was an *object* (or patient). The same combination could be produced after mother had received the doll. In this case, the gesture for mother would be classified as a *person* (or dative) and the gesture for doll would again be an *object*. An independent observer using our context code agreed with our meaning assignments on 94% of the gestural phrases.

Results. We find that the deaf child does indeed develop a gestural system for the purpose of symbolic communication. The developmental course of this gestural system is remarkably similar to the early stages reported for the hearing child learning to speak. At this point in our study, we have isolated three phases of development from cross-sectional data. We have data on two children in the first phase and on two different children in the second phase; one child in this second phase has progressed during our observation period to give us data on the third phase.

In the first phase of development, the deaf child uses very few different gestures and is limited to single-unit phrases. He produced these single gestures in the same contexts in which we find the hearing child's early single words (see Bloom, 1970; 1973). For example, the hearing child might say "more" when he wants an additional cookie; the deaf child will extend his hand, palm up, toward the potential agent and the desired object. When the hearing child sees a rabbit hopping across the room, he might say "see," or "dat"; in this situation the deaf child will point at the object. At this moment in development, both the deaf and the hearing children's symbols are ambiguous; we cannot determine from the child's word or gesture which aspect of the situation he is referring to. In the above example, we cannot determine whether he is referring to the rabbitness, the hoppingness, or the tailness of the situation. The child lacks specificity in his communication, a lack which both the deaf and hearing child remedy in the second phase of their respective developments.

In this next phase, there are two developments in the communication system, which are data suggest are simultaneous: 1) the deaf child creates lexical items to specify individual objects and actions; 2) the child specifies the relations between objects and actions by combining gestures into two-unit phrases according to his own gesture-order rule.

In his lexicon, the deaf child symbolizes an *action* through an action gesture. For example, if the child wants someone to open a jar for him, he will move his hand in a twist-like motion in the air; in this case, this gesture specifies the action he would like done. However, the deaf child also uses these action gestures to symbolize *objects*; in other words, in a different situation when no action has been, can be, or will be performed, the child uses the same twist-like motion to identify the jar itself. This motor iconic representation system allows the deaf child to be fairly precise in his symbols. For example, he can distinguish the symbol for banana (a fist at the mouth accompanied by opening and closing of the mouth) from the symbol for ice-cream cone (a fist at the mouth accompanied by tongue licks). These motor iconic gestures continue to be used by older deaf children (Tervoort 1967).

Table 2 presents a summary of the specific lexical items produced alone and in combination for the two children we have observed in the second phase of development. The data in this table provide us with three interesting facts about the deaf child's lexical development. First, both children produce a number of *different* specific lexical items, that is, a number of types (column 1). Second, these different lexical items often occur more than once in the sample; in other words, the number of tokens (column 2) is larger than the number of types. Third, the specific lexical items do occur in gesture combinations, that is, as part of the entire symbolic system (column 3).

In addition to these lexical advances, at this time the deaf child also begins to combine gestures to symbolize semantic relations. For example, he points at the hat he desires (object) and then, without breaking the continuity of his movement, points at the top of his head (location). He has explicityly coded two arguments or cases of the relation and from the context we infer the implicit relation "put." In Figure 1 we see a summary of the pairs of cases coded in each child's two-gesture combinations. The children expressed three predominant relations in their two-gesture combinations: action, location, and possession relations. Furthermore, they expressed these most frequent relations by using the same simple ordering rule: semantic object first, followed by the action, location, or possessor (see Figure 2 which presents only those combinations occurring more than five times during the observation period).

In this second phase of development the deaf child has created a means of specifying objects, actions, and the relations between them. The hearing child at a comparable point in his language development also begins to produce specific lexical items and to combine words (Nelson 1973; Goldin-Meadow, Seligman & Gelman 1974); he thus uses linguistic structures much like those the deaf child uses to attain the same level of communicative specificity.

There is a third phase of development in which the deaf child combines more than two gestures in one phrase in order to symbolize more than one semantic relation. For example, the child points at the picture of a bird beak on a puzzle piece, then points at his own mouth to denote the similarity between the two, and then points at the spot in the puzzle where the bird-beak piece is to go. Thus, the child has specified two aspects pertaining to the bird beak, similarity and location. In another example, the child symbolizes in one phrase that the shovel is used to dig outside when it snows, is associated with boots, and is kept downstairs. The data at the moment suggest that the child may be conjoining semantic relations in one phrase in a rule-governed, as opposed to a random, fashion. An increased data base is necessary to determine the reliability and the nature of these potential rules.

In summary, we have isolated three phases of development that the deaf child initially goes through in creating a gestural communication system. It is possible that the deaf child bases this communication system on some input model. One hypothesis is that the child's parents spontaneously generate the gestural system which the child then imitates. In order to eliminate this hypothesis, we have observed and videotaped the mother's spontaneous gestures and subjected these gestures to the same analysis we used on the child's manual output. We found that although the mothers generated as many names for objects and actions as the children generated during the sessions (see Table 3, columns 1 and 2), they did not develop the same lexical items that the children developed. Furthermore, the mothers very rarely produced their specific lexical items in combinations coding semantic relations, while the deaf children frequently did (see Table 3, column 3). Even when the mothers did combine gestures, their combinations were not rule-governed as the children's combinations were (see Figures 3 and 4). In general, we found that the mothers developed the combinatorial skill several sessions after the children already exhibited this skill in their symbolic behavior. Thus, the deaf children have not even been exposed to a spontaneous gestural system which might well have served as a model for symbolic development.

Discussion. Our deaf subjects differ from hearing children of language acquisition age in two important ways: first, the deaf child uses the visual-manual modality as the natural channel of symbol reception and production; and second, the deaf child does not receive an obvious linguistic model to guide his communicative behavior. Despite these differences, the deaf child develops his gestural communicative skills in the same sequence that the hearing child develops comparable verbal skills. In particular, the deaf child invents names for actions and for objects, and syntactically codes semantic relations between actions and objects. Thus, our data indicate that these linguistic skills can be expressed in a manual, as well as a vocal, mode. Studies of adult sign language confirm this finding (cf Bellugi & Fischer 1972). In addition, our data show that the ontogenesis of these skills does not depend on an obvious linguistic model. We know that the child can create a simple system of communication with no input model; however, it is not clear from our present data exactly how far the child can progress without the benefit of such a model.

Of course, if the child is supplied with a model in either the manual or the verbal mode, he by and large will conform his particular names and syntactic orders to that model. But where does the deaf child who has no obvious linguistic model get his particular names and syntactic orders? We hypothesize that the deaf child generalizes and abstracts from actions in the world in order to create names for both objects and actions. For example, the twisting motion of the wrist used in actually opening a jar becomes stylized into the deaf child's gesture for both "jar" and "open." Abstracting from actions is a process particularly compatible with the motoric mode the deaf child uses. Young hearing children, who sometimes create names in the verbal mode even though they are exposed to a linguistic model, create names which are often onomatopoetic (e.g. "num-num" for "food"). We suggest that the hearing child is abstracting from sound just as the deaf child is abstracting from action. Presumably, sound is as natural to the auditory mode as action is natural to the motoric mode. Thus, we have an example of how the modality through which symbols are expressed alters the form that the symbols take.

Similarly, we hypothesize that the deaf child's object-first ordering rule may also be induced from his motoric acts on the world. For example, if a child wants to relocate an object, he must first situate that object and then move it to its new location; in other words, the object occurs before the location in the child's motor action schema. We suggest that the child uses this ordered motor action schema as a basis for his symbolic representation of the same event (McNeill 1974).

In summary, we have shown that symbolic communicative behavior is a resilient skill that develops in children of normal intelligence who interact with humans and with objects. Symbolic communication can begin to develop despite severe auditory impairment and in the absence of an obvious linguistic model.

Our study, in conjunction with current work in sign linguistics, allows us to consider how certain variables affect the particular form a language will take. The modality through which a language is produced and received (e.g. the vocal apparatus and the ear) is one variable which, in part, shapes the form of the language. Since contemporary sign languages differ from verbal languages in modality, a comparison of the two different systems points to the effects of modality on linguistic structure (cf Bellugi & Fischer 1972; Stokoe 1974; Battison 1973; Siple 1973). Language change over generations comprises a second variable which shapes the form of a language (Bever & Langendoen 1971). American Sign Language, like all spoken languages, has undergone historical change (Frishberg 1973). Our deaf subjects, however, do not have an historically-based linguistic model available to them. The communication system they have created illustrates the influence of modality on linguistic structure *without* the influence of historical change. Thus, our data suggest how two factors, modality and lack of historical model, contribute to the design features of a language.

NOTES

[1] This paper was originally presented at the Society for Research in Child Development Meeting, Denver, Colorado, April 10-13, 1975. The data for the paper are preliminary and are extended in doctoral dissertations submitted to the University of Pennsylvania: "The Development of a Lexicon in Deaf Children of Hearing Parents" by Heidi Feldman, and "Symbolic Representation of Semantic Relations: A Study of a Spontaneous Gestural Language" by Susan Goldin-Meadow.

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NAME	SESSION	AGE (years; months)
David	I	2 ; 10
	II	2 ; 11
	III	3
	IV	3 ; 3
	.	
	.	
	.	
	VIII	3 ; 10
Dennis	I	2 ; 2
	II	2 ; 3
	III	2 ; 4
	IV	2 ; 6

Table 1. Subjects, Taping Sessions, Ages.

Subjects	TYPES[a]	TOKENS[b]	
		Alone	In Combination
David	56	107	62
Dennis	25	50	19

[a]Types = Number of different lexical items.

[b]Tokens = Number of lexical occurrences across types.

Table 2. Lexical Items Produced by David and Dennis during Sessions I-IV.

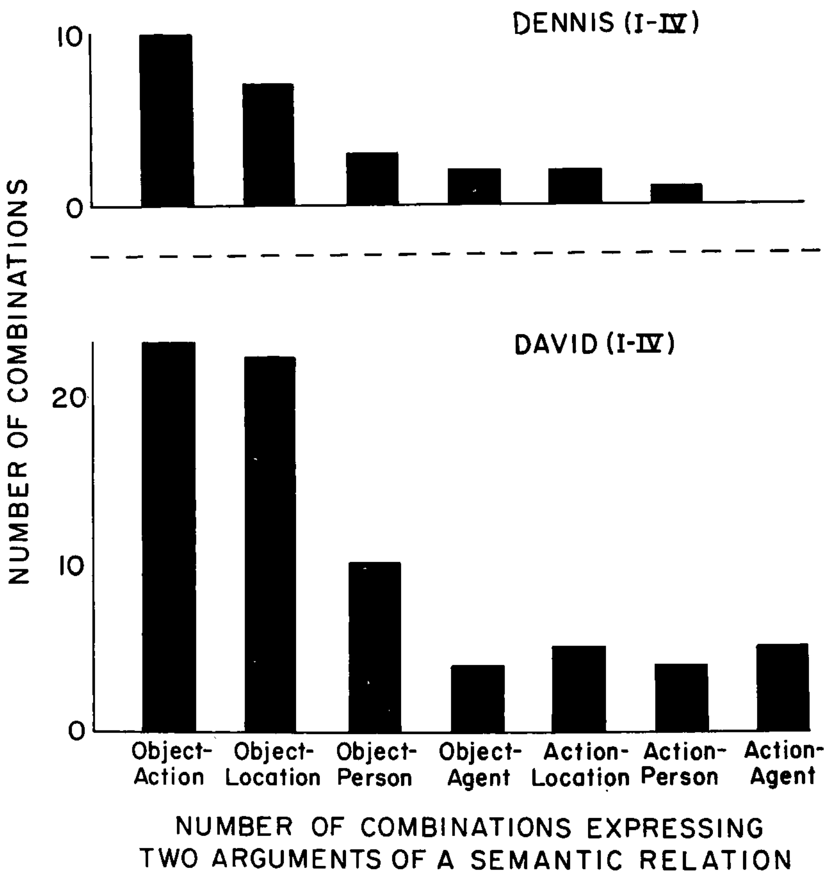

DENNIS (I-IV)
DAVID (I-IV)
NUMBER OF COMBINATIONS
10
0
20
10
0
Object-Action
Object-Location
Object-Person
Object-Agent
Action-Location
Action-Person
Action-Agent
NUMBER OF COMBINATIONS EXPRESSING
TWO ARGUMENTS OF A SEMANTIC RELATION

FIGURE 1

Sciences, University of Chicago, in 1976. Her research plans include further study (the third stage) of the deaf child's language creation and a study of the development of gesturing in hearing children.

Heidi Feldman with B.A., M.A., and nearly completed Ph.D. degrees from the University of Pennsylvania is now a student in the School of Medicine, University of California, San Diego.

Subjects	TYPES[a]		TOKENS[b]			
			Alone		In Semantic Relation Combinations	
	Child	Mother	Child	Mother	Child	Mother
David	56	54	107	90	47	9
Dennis	25	23	50	58	18	3

[a]Types = Number of different lexical items.

[b]Tokens = Number of lexical occurrences across types.

Table 3. Mother-Child Comparison of Number of Specific Lexical Items Produced during Sessions I-IV.

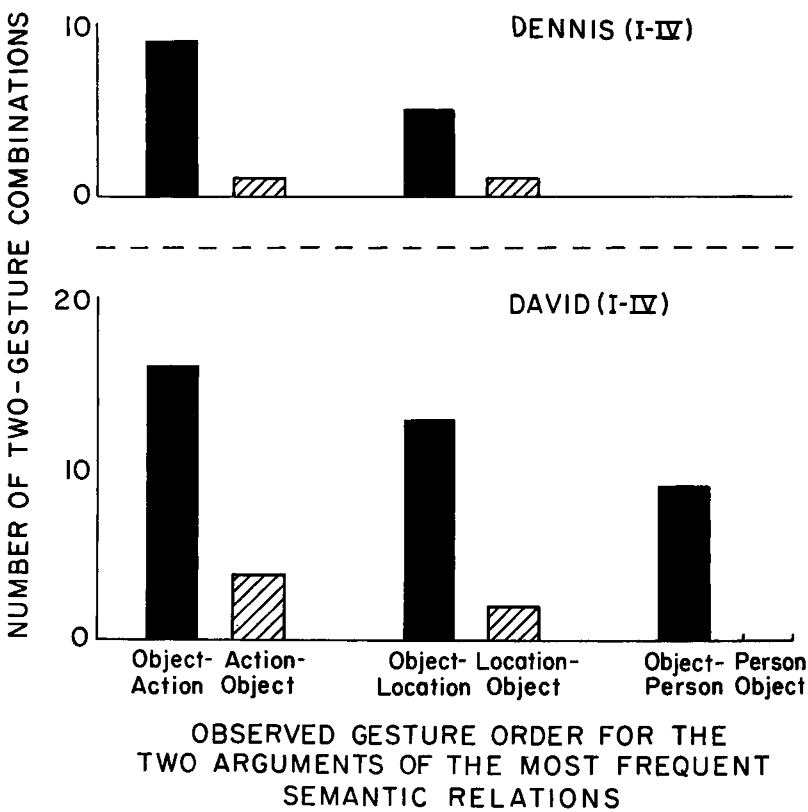

NUMBER OF TWO-GESTURE COMBINATIONS
10
0
DENNIS (I-IV)
20
10
0
DAVID (I-IV)
Object- Action
Action- Object
Object- Location
Location- Object
Object- Person
Person- Object
OBSERVED GESTURE ORDER FOR THE TWO ARGUMENTS OF THE MOST FREQUENT SEMANTIC RELATIONS

FIGURE 2

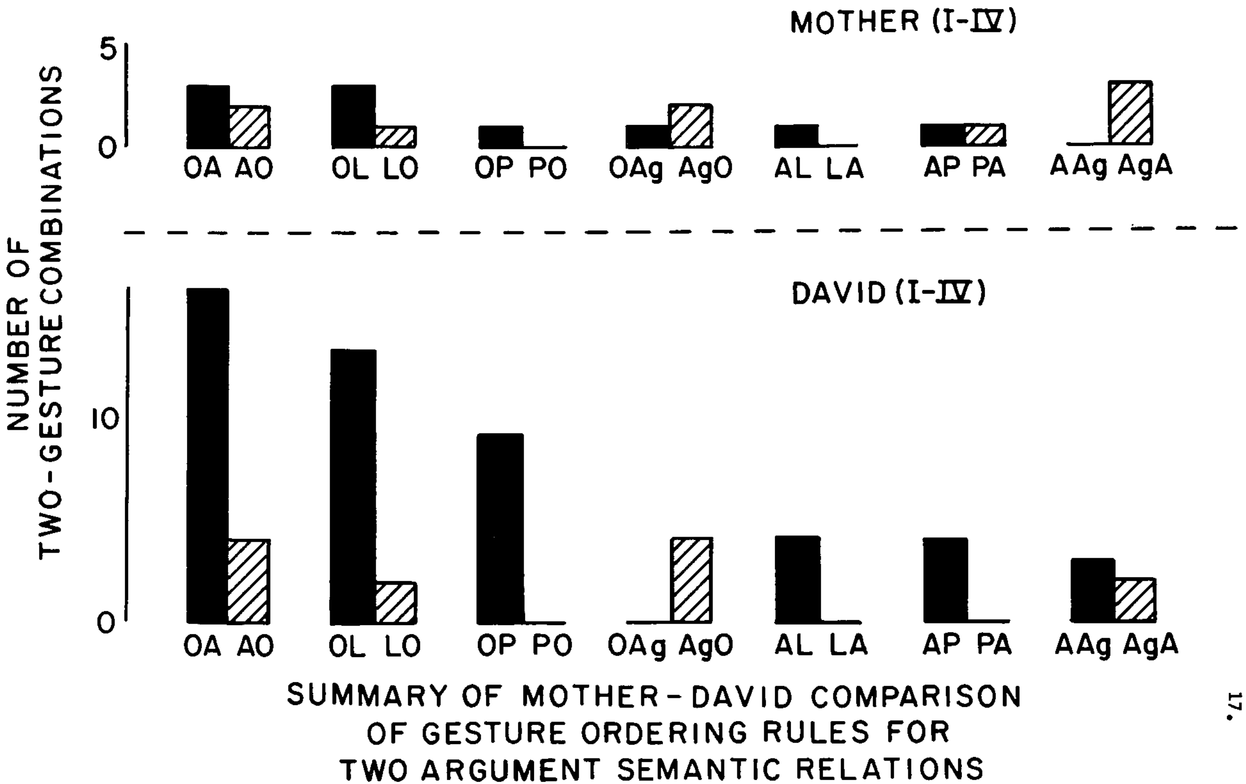
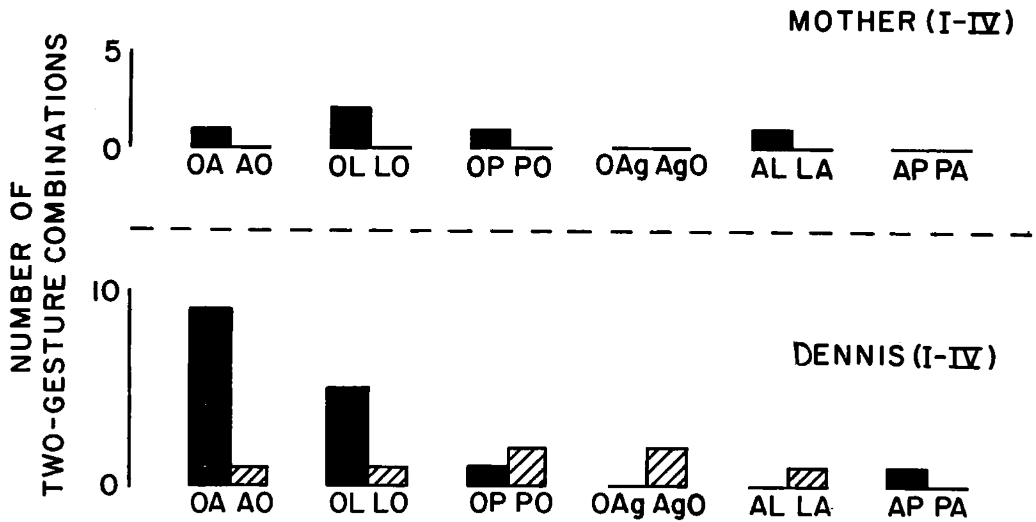

MOTHER (I-IV)
5
0
OA AO
OL LO
OP PO
OAg AgO
AL LA
AP PA
AAg AgA
DAVID (I-IV)
10
0
OA AO
OL LO
OP PO
OAg AgO
AL LA
AP PA
AAg AgA
NUMBER OF TWO-GESTURE COMBINATIONS
SUMMARY OF MOTHER-DAVID COMPARISON
OF GESTURE ORDERING RULES FOR
TWO ARGUMENT SEMANTIC RELATIONS

FIGURE 3



SUMMARY OF MOTHER - DENNIS COMPARISON
OF GESTURE ORDERING RULES FOR
TWO ARGUMENT SEMANTIC RELATIONS

FIGURE 4