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ABSTRACT

The study examined whether deaf children's gesture systems are structured at the morpheme level of analysis. A 3-year-old deaf child from the authors' previous study was selected and all of his characterizing signs produced during a 2-hour naturalistic play session in his home were videotaped. Each sign was coded in terms of its handshape, motion, and place of articulation. Analysis revealed that his signs could be described in terms of handshape form/measuring categories and motion form/meaning categories. His signs were composed of a limited and discrete set of 10 hand and 9 motion forms each of which was consistently associated with a distinct meaning and recurred across lexical items. Further analysis suggested that he used discrete forms to represent objects, actions, and traits in his world despite the fact that one can manually represent movements and shapes in a continuous fashion. His signs also appeared to be organized in relation to one another, as opposed to being organized only in relation to the objects they represent. (CL)

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# The Development of Morphology without a Conventional Language Model*

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## INTRODUCTION

The language-learning child in all cultures is exposed to a model of a particular language and, not surprisingly, acquires that language. Thus, linguistic input clearly has an effect on the child's acquisition of language. Nevertheless, it is possible that linguistic input does not affect all aspects of language development uniformly, and that variations in linguistic input will alter the course of development of some properties of language but not of others. In our own work, we have focused on isolating the properties of language whose development can withstand wide variations in learning conditions -- the "resilient" properties of language. We have observed children who have not been exposed to conventional linguistic input in order to determine which properties of language can be developed by a child under one set of degraded input conditions. The children we study are deaf with hearing losses so severe that they cannot naturally acquire oral language, and born to hearing parents who have not yet exposed them to a manual language. Despite their impoverished language learning conditions, these deaf children develop a gestural communication system which is structured in many ways like the communication systems of young children learning language in traditional linguistic environments (Feldman, Goldin-Meadow & Gleitman 1978; Goldin-Meadow 1979, 1982; Goldin-Meadow & Mylander 1983, in press).

In our previous work we have shown that the gesture systems our deaf subjects develop are structured at the sentence level of analysis, i.e., there are patterns identifiable across gestures in a string. However, natural languages, both signed and spoken, are known to be structured at many different levels of analysis. If a hierarchy of structured levels is common to natural languages, it becomes important to ask whether the deaf children in our studies display such hierarchical structure as well (i.e., is hierarchical structure a "resilient" property of language?). Consequently, the primary objective of this study is to determine whether the deaf children's gesture systems are also structured at a second level of analysis, the level of the morpheme. Thus, we ask whether structure exists within gestures as well as across them, and consequently whether aspects of morphological structure can be developed by a child without the benefit of a conventional language model.

Background. Sign languages of the deaf are autonomous languages which are not derivative from 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 is a language in the full linguistic sense of the word -- it has structural properties (as does a spoken language) at syntactic (Fischer 1975; Liddell 1980), morphological (Fischer 1973; Klima & Bellugi 1979; McDonald, 1982; Newport 1981; Supalla 1982) and "phonological" (Battison 1974; Lane, Boyes-Braem & Bellugi 1976) levels of analysis.

Deaf children born to deaf parents and exposed from birth to a conventional sign language (e.g., ASL) have been found to acquire language naturally; i.e., these children progress through stages in acquiring a conventional sign language similar to those of hearing children acquiring a conventional spoken language (Hoffmeister & Wilbur 1980). Thus, in the appropriate linguistic environment (a signing environment), deaf children are not at all handicapped with respect to language learning.

However, 90% of deaf children are not born to deaf parents who could provide early exposure to a sign language. Rather, they are born to hearing parents who quite naturally expose their children to speech (Hoffmeister & Wilbur 1980). 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 instruction. Even with instruction, the children's acquisition of speech is markedly delayed when compared either to the signs of deaf children of deaf parents or the speech of hearing children of hearing parents. By the age of 5 or 6, and despite intensive early training programs, the average profoundly deaf child has only a very reduced oral linguistic capacity at his disposal (Conrad 1979).

In addition, unless hearing parents send their deaf children to a school in which sign language is taught, these deaf children will not be exposed to conventional sign input. Under such non-propitious 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 symbols (gestures) to communicate even if they are not exposed to a conventional manual language model (e.g., Tervoort 1961). These gestures are referred to as "home signs."

Early studies, however, did not ask whether home sign systems are structured as human languages are. As a result, we have focused particularly on the structural aspects of deaf children's home signs and have attempted to determine which linguistic properties found in natural child language can also be found in home signs.

The Spontaneous Sign Systems of Deaf Children: Syntactic Properties.[1] We observed the home signs of 6 deaf children of hearing parents in Philadelphia and 4 in Chicago. We found that all 10 children developed systems with a number of lexical and syntactic-semantic properties comparable to early child language (Feldman et al. 1978; Goldin-Meadow 1979, 1982). In addition, we investigated the possibility that the deaf children might have learned their home sign systems from their hearing parents. In particular, we asked whether the parents, in an effort to communicate with their children, might not have generated a structured gesture system which their children then imitated, or whether the parents might not have shaped the structure of their children's gestures by patterning their responses to those gestures. We found no evidence for either of these hypotheses (Goldin-Meadow & Mylander 1983, in press).

The children developed 2 major types of lexical signs: 1) deictic signs used to refer to people, places, and things (e.g., pointing gestures which rely on context for interpretation); and 2) characterizing signs used to refer to actions and attributes (e.g., a fist held at the mouth accompanied by chewing [EAT], or the index finger and thumb forming a circle in the air [ROUND]).

In addition, the children concatenated these lexical items into sign sentences expressing the semantic relations typically found in child language. We use linguistic terms such as "sentence" loosely and only to suggest that the deaf children's gesture strings share certain elemental properties with early sentences in child language. As an example of a sign sentence, one deaf child pointed at a block tower and then signed HIT (fist swat in air) to indicate that he had just hit the tower. In another example, the same child signed HIT, then pointed at his mother to request her to perform the hitting. These sign sentences were found to conform to regularities of 2 types: 1) Construction order regularities which describe where a particular case or predicate tends to appear in a sign sentence (e.g., the sign for the patient, apple, tends to precede the sign for the act, EAT); 2) Deletion regularities which describe the likelihood of a particular case or predicate to be omitted in a sign sentence (e.g., a sign for the patient, apple, would be less likely to be omitted in a sentence about eating than would a sign for the actor, boy).

Finally, the children were able to generate novel complex sentences (containing at least two propositions) from combinations of simple, one-proposition sentences. For example, one child pointed at a tower, produced the HIT sign and then the FALL sign (flat palm flops over in air) to comment on the fact that he had hit [act$_1$] the tower and that the tower had fallen [act$_2$].

MORPHOLOGICAL PROPERTIES OF THE DEAF CHILD'S SIGN SYSTEM

As described above, our previous work focused on the structural regularities across signs in our deaf subjects' gesture sentences. For the purposes of this "syntactic" analysis, we treated each sign as the minimal meaning-bearing unit. However, in examining the corpus of signs produced by each child, we began to notice certain sub-sign forms (e.g., handshape and motion) which seemed to be associated with consistent meanings, and which seemed to recur across different signs. For example, one child used the same motion form (moving the hand forward in a straight line) to mean "movement along a linear path" in at least 2 different signs, once with a fist handshape (resembling a person's hand moving a lawnmower in a straight line) and a second time with a flat palm handshape (resembling the lawnmower itself moving in a straight line). In addition to suggesting that the child can focus either on a person acting on an object or on the object itself in generating a sign, this example also suggests that handshape and motion might be separable sub-sign components within the child's gesture system.

A second type of example further reinforces the hypothesis that the deaf child's signs are divisible into components. Several children produced signs composed of 2 conflated motions, and at other times produced these same motions in 1-motion signs. For example, one child produced a conflated 2-motion sign to describe snow falling: a palm with the fingers spread handshape (representing particles of snow) was moved downward in a linear path [motion 1] while the fingers were wiggled [motion 2] ("snow-FALL+FLUTTER"). The same child at other times produced each of these motions in separate 1-motion signs: The finger wiggle motion was combined with the spread palm handshape to mean "snow-FLUTTER" and the linear path motion was combined with the spread palm handshape to mean "snow-FALL."

These examples suggest that at least some of the deaf children's signs are decomposable into smaller morpheme-like components. Nevertheless, these examples do not by themselves provide evidence of systematic hand

and motion morphemes, as these selected cases may not be representative of the child's entire lexicon. In order to argue that the deaf child's signs are consistently divisible into hand and motion morphemes, we must review the corpus of signs as a whole and show 1) that the child has a limited set of discrete hand and motion forms which comprise his lexical items, 2) that a particular hand or motion form is consistently associated with a particular meaning (or set of meanings) throughout the child's lexicon, and 3) that a particular hand or motion form recurs across different lexical items and thus is not limited to a single and (for the child) potentially unanalyzed lexical item.

Recent research on the signs of ASL that are highly mimetic in form has shown these signs to be composed of combinations of a limited set of discrete morphemes (McDonald 1982; Newport 1981; Supalla 1982). These signs appear to be constructed from handshape, movement and placement morphemes which combine with one another in a rule-governed fashion. To determine whether our deaf subjects' gestures can also be characterized by systematic combinations of meaningful forms, we selected one of our original subjects (David) and analyzed all of the characterizing signs the child produced during a 2-hour naturalistic play session videotaped in his home when he was 3;11, an age at which both deaf and hearing children learning conventional languages have typically already begun to acquire certain morphemic distinctions (e.g., MacWhinney 1976; Supalla 1982). Following the ASL literature on morphological structure in mimetic signs, we coded each sign produced during this session in terms of its handshape, motion, and place of articulation.[2] Reliability between two independent coders was 85-95% agreement for handshape, 83-93% for motion, and 88% for place of articulation.

<u>Handshape Morphemes</u>

<u>Handshape Forms</u>. Following Supalla (1982) and McDonald (1982), we coded each handshape according to 4 dimensions: the shape of the palm, the distance between the fingers and the thumb, the number of fingers extended, and the presence or absence of spread between the fingers. We began by coding handshapes without any pre-established categories along these dimensions. Thus, for example, we wrote down the distance (in inches) between the fingers and thumb of a particular handshape and did not try to force that handshape into a limited set of thumb-finger distances. We found, however, that David used only a restricted number of values on each of the 4 dimensions (see Table 1 which displays the handshapes David used on these tapes described in terms of the 4 dimensions).[3] In fact,

David used fewer values on certain of the dimensions than are used in ASL (e.g., David used 3 values for thumb-finger distance; Supalla lists 5 values for ASL) and he used them in a more restricted way than is typical of ASL (e.g., David used 2 fingers extended only with a straight palm and +Spread; in ASL Supalla finds that 2 fingers can be used with a straight or round palm and with or without spread).

TABLE 1

Description of Handshapes Used by David at Age 3;11a

| | Shape of Palm | Thumb-Finger Distance | Number of Fingers | Spread Between Fingers | Number of Times Used |
|---|---|---|---|---|---|
| Fist | Round | Fingers curled into palm | 4 | - | 55 (.27) |
| O | Round | Touch or <1/2" | 4 | - | 62 (.30) |
| C | Round | 3" | 4 | - | 11 (.05) |
| Palm | Straight | na | 4 +/- thumb | - | 36 (.18) |
| Spread Palm | Straight | na | 4 + thumb | + | 14 (.07) |
| Point | Straight | na | 1 | na | 14 (.07) |
| V | Straight | na | 2 | + | 7 (.03) |
| L | Straight | na | 1 + thumb | + | 1 (.01) |
| Thumb | Straight | na | thumb | na | 1 (.01) |
| F | Round | Touch | 1 | na | 3 (.01) |

a. Both 1-motion and 2-motion signs are included in this table; na = not applicable

The handshapes we found in David's signs turn out to be, for the most part, the unmarked handshapes of ASL (cf., Klima & Bellugi 1979), and the handshapes deaf children learning ASL from their deaf parents produce in their initial stages of acquisition (McIntire 1977). Moreover, the most frequent of David's handshapes, the Fist, O, C, Palm, Spread Palm, and Point, also turn out to be just those handshapes found in the spontaneous gestures accompanying the speech of hearing children asked to explain conservation during a Piagetian task (Church & Goldin-Meadow 1984). These handshapes thus appear to be common in the communications of both deaf and hearing individuals and it is therefore not surprising that they appear in David's lexicon.

Handshape Form-Meaning Mapping. We saw above that David used a limited set of discrete handshapes in his signs. We next determined whether those handshapes mapped in any systematic way onto categories of meanings. We found that David used his handshapes in 3 ways (cf. Table 2): to represent the way a hand is shaped as it HANDLES an object, to represent the shape of an OBJECT itself, or to function like a pencil TRACE of the extent of a static object or the path of a moving object. David's OBJECT and HANDLE handshapes are reminiscent of the classifier and instrumental handshapes, respectively, described for ASL (cf., Frishberg 1975; Kegl & Wilbur 1976; McDonald 1982; Supalla 1982) and his TRACE handshape resembles those handshapes Mandell (1977) cites in his descriptions of sketching in ASL. Within the TRACE category, note that the O hand is used to trace the extent of static objects and is thus distinguished from the Point hand, which is used to trace the path of moving objects.

Table 2 displays the handshapes David produced in 1-motion signs, classified according to form and type of representation. Listed in each category are all of the objects David chose to represent with that form (the number in parentheses next to each object represents the number of times the handshape was used for that object). For each group of objects, we were able to abstract a common attribute shared by all objects in that group. That common core we take to be the meaning of the handshape morpheme. All of David's 181 handshapes in 1-motion signs could be classified into categories defined by particular hand forms and object meanings. In addition, 22 (92%) of the 24 handshapes in David's 2-motion signs (not shown in Table 2) were found to conform to the form/meaning criteria established on the basis of the 1-motion signs. It is worth noting that only two handshape categories were represented in the set of 2-motion signs David produced -- the Fist form meaning "Grasp small & long object" and the Palm form meaning "Vehicle or animate object" -- suggesting that in David's system there may be additional constraints on the types of handshapes that can be used in 2-motion signs.

Although most of the handshapes in Table 2 were used to represent a set of (more than 1) objects, 4 were used for single exemplars only. The Thumb was used once to represent pushing a button. The other 3 handshapes, V, L, and F (all of which are marked handshapes in ASL), are conventional gestures within our hearing culture, representing scissors, a gun, and a coin, respectively.

TABLE 2
Handshapes in X-Motion Signs

| | Handle X-type of Object | X-type of Object | Trace Path or Trace Extent of Object |
|---|---|---|---|
| Fist | Grasp small (<2" diam) and long (>5" length) objects 10 (39)<br>balloon string (3), drumstick (15), handlebar (2), hat brim (2), reins (10), shirt (3), spoon (1), steering wheel (1), trapeze ring (1), umbrella handle (1) | | |
| O | Grasp small (<2" diam) object of any length: 8 (12)<br>banana (2), crank (1), drumstick (1), piece of lead (1), shoe laces (1), spoon (1), straw (1), trapeze ring (4) | Round compact objects: 2 (11)<br>round hat (4), round nose (7) | Trace extent of objects 4 (9)<br>beard (3), mustache (1), tie (1), straw (4) |
| C | Grasp large (>2" diam) object of any length: 5 (7)<br>cup (2), guitar neck (2), length of straw (1), wide tank (1), salt shaker (1) | Curved objects: 1 (4)<br>turtle (4) | |
| Palm | Contact large surfaces 6 (13)<br>top of push-down toy (1), stomach (4), mouth (1), sides of toybag (2), back of turtle (1), front of guitar (4) | Flat, wide objects: 7 (13)<br>fish (2), flag (1), bird wings (4), butterfly wings (3), wheel (1), beard (1), hat (1)<br><br>Vehicle or Animate objects 4 (6)<br>soldier in car (2), skate (2), Katie (1), Santa (1) | |
| Spread Palm | Contact many small surfaces: 1 (2)<br>piano keys (2) | Many small particles or object with individuated parts: 5 (7)<br>snow (2), toes (1), spokes of umbrella (1), veins of bird wings (2), veins of butterfly wings (1) | |
| Point | | Thin, straight objects: 2 (3)<br>straw (1), flat penny (2) | Trace path of objects: 5 (8)<br>bear (1), penny (1), Sesame (3), toy bag (2), wheel (1) |
| V | | Scissors (7) | |
| L | | Gun (1) | |
| F | | Coin (3) | |
| Thumb | Contact press-button (1) | | |

It is important to note that the handshape David used in his signs was not necessarily a literal representation of the way a hand grasps a particular object in the real world. For example, the same form (the Fist) was used to represent grasping a balloon string, drumstick and handlebars, objects which vary in diameter. Thus, David did not appear to distinguish objects with varying diameters within the Fist category. However, he did distinguish objects with small diameters as a set from objects with large diameters (e.g., a cup, a guitar neck, the length of a straw) which were represented by a C hand. Overall, David's handshapes appeared to be discrete categories rather than analog representations of "real world" actions.

Motion Morphemes

Motion Form. Friedman (1977) isolated manner of motion as a fundamental aspect of movement in ASL. In analyzing David's signs, we similarly focused on manner of motion, i.e., the way in which the arm and/or hand moved. We found 4 types of hand movements (open/close, bend, wiggle, finger revolve) and 4 types of arm movements (pivot, partial-revolve, full-revolve, rotate) in David's signs. We noted that arm movements, either alone or in combination, perforce create different trajectories traced by the hand. The shape of a trajectory is determined (1) by the type or types of arm movements used (e.g., a single wrist pivot results in a small arced trajectory; an elbow full-revolve combined with a shoulder pivot results in a circular trajectory) and (2) in instances of pivot-combinations, by how those movements are combined (e.g., if 2 pivots in a combination move in opposing directions, the resulting hand trajectory is linear).[4] We also found that movements (or combinations of movements) in David's signs varied in directionality -- some were unidirectional and others were bidirectional.

Table 3 displays the different motion forms plus a "no motion" category found in David's signs. Each motion form was defined in terms of types of movements (alone or in combination) and directionality. The resulting 9 motion forms are reminiscent of (but not identical to) the motion morphemes Newport (1981) and Supalla (1982) isolated in their descriptions of ASL.

Motion Form-Meaning Mapping. We next determined whether each of the 9 motion forms was associated with a particular class of meanings. We found that David used most of his motion forms to represent actions but also used some to represent descriptive traits. Table 4 displays the motions David produced in his 1-motion signs, classified according to form and type of representation. Listed in each category are all of the

TABLE 3

Description of Motions Used by David at Age 3;11[a]

| | Type of Motion | Directionality | Number of Times Used |
|---|---|---|---|
| Linear | Combination of Pivots, + Opposition | Uni | 26 (.12) |
| Long Arc | 1) Combination of Pivots, - Opposition | Uni | 21 (.11) |
| | 2) Combination of Pivots and Partial Revolves | Uni | |
| Short Arc | One Pivot | Uni | 16 (.08) |
| Arc To & Fro | 1) Combination of Pivots, - Opposition | Bi | 58 (.31) |
| | 2) One Pivot | Bi | |
| Circular | 1) Combination of Full Revolves | Uni | 15 (.08) |
| | 2) Combination of Full Revolves and Pivots | Uni or Bi | |
| | 3) Wrist Rotates | Bi | |
| | 4) Fingers Revolve | Uni | |
| Open/Close | Hand or Fingers Open or Close | Uni | 10 (.05) |
| Bend | Hand or Fingers Bend | Uni or Bi | 5 (.03) |
| Wiggle | Fingers Wiggle | Bi | 3 (.02) |
| No Motion | Hand held in place | na | 36 (.19) |

a. Both 1-motion and 2-motion signs are included in this table; Uni = unidirectional; Bi = bidirectional.

actions or traits David chose to represent with that motion form. As we did for the handshape analysis, we were able to abstract a common action or description meaning for each category. 92% of David's 171 motions in 1-motion signs could be classified into these categories (the 13 exceptions are not included in Table 4). In addition, 16 (84%) of the 19 motions in David's 2-motion signs (not shown in Table 4) were found to conform to the form/meaning criteria established on the basis of the 1-motion signs.

## Handshape and Motion Combinations

We have shown that David's signs can be described in terms of handshape form/meaning categories and motion

TABLE 4

Motions in 1-Motion Signs

| | Action | Description |
|---|---|---|
| Linear | Change of Location along a straight path: 4 (7) snow fall (1), skate glide (1), turtle go (4), penny go (1) | Extent or Outline of objects: 7 (14) tall hat (2), long nose (1), wide hat (1), long beard (4), long tie (1), long straw (4), outline moustache (1) |
| Long Arc | Change of Location to or from a particular endpoint: 6 (11) penny go to (1), scoop spoon to (2), wheel tip to (1), Susan move to (3), move surface to (1), remove shirt from (3) | |
| Short Arc | Reorientation at the beginning or endpoint of a change of location: 7 (7) don hat (1), Katie sit (1), jab food (1), lift bag (1), put straw (1), put bear (1), remove hat (1) | |
| Arc To & Fro | Change Orientation by moving back and forth: 10 (34) hit turtle (1), tap mouth (1), bird wings flap (2), butterfly wings flap (2), strum guitar (5), move shoelaces in and out (1), move guitar up and down (2), beat drum (11), move reins up and down (8), flag wave (1) | |
| Circular | Move in circular path or rotate around axis: 7 (11) turn bag around (3), turn straw around (1), rotate steering wheel (1), wave balloon string in circle (3), turn crank (1), twist knob (1), wheel rotate (1) | Orientation of object: 1 (4) upturned nose (4) |
| Open/Close | Open or Close: 3 (7) umbrella open (1), Santa straighten up (1), scissors cut (5) | |
| Bend | Bend: 5 (5) fish swim (1), bird wing flap (1), toes curl (1), press gun hammer (1), press button (1) | |
| Wiggle | Wiggle: 2 (3) snow flutter (1), play p[illegible]o (2) | |
| No Motion | Hold Object: 7 (24) hold umbrella (1), handlebars (2), reins (2), banana (2), straw (11), cup (2), stomach (4) | Object Exists: 5 (11) hat (2), nose (1), straw (3), scissors (2), coin (3) |

form/meaning categories. However, we have not yet shown that a sign in David's system was a composite of hand and motion morphemes rather than one unanalyzed whole, i.e., that handshape and motion are separable units. Since signs are composed of hands moving in space, it is not possible to find handshapes which are actually separated from their motions. Nevertheless, if we find that a handshape is not uniquely associated with one sign but is combined with several different motions in different signs, then we have evidence that the handshape can function as an independent unit in David's system. Similarly, if a motion is combined with different handshapes in different signs, there is evidence for the separability of that motion.

Table 5 presents the number of types (and tokens) of signs produced by David, classified according to handshape and motion. Note that 6 of the handshapes (Fist, O, C, Point, Palm, and Spread Palm) were found in combination with at least 4 and as many as 8 different motions. Moreover, all of the motions except Wiggle were found in combination with at least 2 and as many as 5 of these handshapes. These 6 handshapes and all of the motions except Wiggle thus satisfy our criterion as independent units in David's signs. In contrast, of the remaining 4 handshapes, Thumb, L and F were each found combined with only 1 motion and V occurred with 2 motions, one of which was "no motion." Recall that in Table 2 each of these 4 handshapes was used to represent only one object rather than a class of objects. Thus, the signs in David's system which contain these 4 handshapes may in fact be unanalyzed wholes in which handshape and motion are <u>not</u> isolable units.

## DISCUSSION

We have found that the corpus of signs David produced can be characterized as a system of hand and motion morphemes; in particular, David's signs were composed of a limited and discrete set of 10 hand and 9 motion forms each of which was consistently associated with a distinct meaning and recurred across different lexical items. Thus, David's signs appeared to be decomposable into smaller morpheme-like components, suggesting that his gesture system was indeed structured at the sign level.

Two important points are worth noting about the signs in David's gesture system. First, David used discrete forms to represent the objects, actions and traits in his world despite the fact that in the manual modality one can represent movements and shapes in a continuous fashion. Although mimetic signs in conventional sign languages such as ASL were originally

TABLE 5

Handshape and Motion Combinations in David's 1-Motion Signs[a]

| | Linear | Long Arc | Short Arc | Arc To & Fro | Circular | Open/ Close | Bend | Wiggle | No Motion |
|---|---|---|---|---|---|---|---|---|---|
| Fist | | 2 (4) | 2 (2) | 2 (20) | 2 (4) | | | | 3 (5) |
| O | 6 (12) | 1 (1) | 1 (1) | 2 (18) | 2 (5) | | | | 4 (16) |
| C | 1 (4) | | | 1 (2) | 2 (2) | | | | 1 (2) |
| Point | 1 (1) | 2 (4) | 2 (2) | | 1 (1) | | | | 1 (3) |
| Palm | 3 (3) | 2 (2) | 2 (2) | 6 (11) | 1 (1) | 1 (1) | 2 (3) | | 1 (4) |
| Palm Spread | 1 (1) | | | 2 (3) | | 1 (1) | 1 (1) | 2(3) | |
| Thumb | | | | | | | 1 (1) | | |
| V | | | | | | 1 (5) | | | 1 (2) |
| L | | | | | | | 1 (1) | | |
| F | | | | | | | | | 1 (3) |

a. The first number represents the total number of different types of signs David produced in that category; the number in parentheses represents the total number of tokens.

thought to be built on just such an analog use of movement and space (DeMatteo 1977), current research has shown the signs of ASL to be composed of combinations of a limited set of discrete morphemes in the sign systems of deaf adults (McDonald 1982; Newport 1981; Supalla 1982). Moreover, during the acquisition process, young deaf children acquiring ASL from their deaf parents do not learn the signs of ASL that can be seen as analog representations of movement and space any more easily than they learn the signs that cannot be seen as analog representations (Meier 1981). Thus, sign systems, be they conventional or individualistic, appear to be characterized by a system of categorical rather than analogic representation.

Second, David's signs appear to be organized in relation to one another, as opposed to being organized only in relation to the objects they represent. One indication of organization across lexical items is the fact that David's signs, at times, adhered to sign-sign constraints (i.e., the fit between a sign and the rest of the signs in the lexicon) at the expense of sign-object constraints (i.e., the fit between a sign and the object it represents). The 2 hand exceptions in David's 2-motion signs illustrate this point. Recall that only two handshapes seemed to be allowable in David's 2-motion signs and that this set included only one HANDLE handshape -- the Fist. In exception 1, the Fist hand was inappropriately used to represent contacting the back of a turtle, a referent that fits David's meaning category "Contact large surface" and (on the basis of the properties of the object) should have been represented by a HANDLE Palm. David appeared to use the formally appropriate Fist rather than the semantically appropriate Palm, suggesting that formal considerations may override semantic considerations in David's system. Similarly, in exception 2, the Fist hand was inappropriately used to represent grasping a small short knob, a referent that fits David's meaning category "Grasp small object of any length" and (based on the properties of the object) should have been represented by a HANDLE O. Again David substituted a Fist (the handshape for small <u>long</u> objects), adhering to the formal constraints on handshapes in 2-motion signs at the expense of sign-object constraints.

We have described the gestures developed by a deaf child with hearing losses so severe he cannot naturally acquire oral language, and born to hearing parents who have not yet exposed him to a conventional manual language. Despite his impoverished language-learning conditions, this child developed a gestural communication system with structure at the sign level, i.e., a gestural system whose lexical items were organized with respect to one another, with component pieces of form and component pieces of meaning inter-relating the items. These results suggest that a child can develop the rudiments of a structured communication system -- including structure at a morphological level -- even without a conventional language model to guide his development.

## FOOTNOTES

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1. "Spontaneous" here is not meant as a developmental statement: Undoubtedly, the development of the deaf child's sign system is influenced by both internal and external factors. We use "spontaneous" only to distinguish our subjects' individualistic sign systems from conventional sign language systems (e.g., ASL,

Signed English).
2. Place of articulation will not be discussed in this report.
3. Numbers reported for handshape (Tables 1 and 2) reflect signs in which handshape was codable regardless of whether the corresponding motion could be seen and coded. Similarly, numbers reported for motions (Tables 3 and 4) reflect signs in which motion was codable, again independent of whether the corresponding handshape could be coded. Numbers reported for hand and motion combinations (Table 5) reflect signs in which both handshape and motion were codable.
4. For combinations of pivots, the trajectory depends on how the movements are combined. If each pivot moves in the same direction (- Opposition), the trajectory produced appears arced in shape, e.g., an arm flap in which the arm pivots up from the shoulder as it also pivots up from the elbow. In contrast, if the two pivots in a combination move in opposing directions (+ Opposition), the trajectory produced appears linear, e.g., an arm push from the chest straight forward in which the shoulder pivots from from right to left (counter-clockwise) as the elbow pivots from left to right (clockwise).

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