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Author(s): William C. Stokoe

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SIGN LANGUAGE STRUCTURE ♦9661

William C. Stokoe

Director, Linguistics Research Laboratory, Gallaudet College, Washington, D.C. 20002

SIGN LANGUAGE AND SIGN LANGUAGES

The designation "sign language" has been used for a wide variety of semiotic systems ranging from the expression of emotions in men and animals (24) to the transmission and reception of genuinely linguistic structures. Sign language is a misnomer, however, when such structures result from spoken language processing up to the point where gestured signs replace the vocal output. The kind of sign language research reviewed here contemplates human cultural systems in which not just the output signal but also the processes for forming words and sentences operate without any connection to speech or sound. Sign languages of this kind are used for interaction by members of deaf populations as spoken languages are used by those who can hear. Other sign languages may more or less completely and unambiguously mediate general or special interaction (6, 7, 57, 87), but these are generally learned and used by persons already competent in some spoken language, and hence they differ from sign languages acquired as their native languages by persons who cannot hear speech and by children of deaf parents (82). Research reviewed here is primarily or entirely concerned with sign languages of deaf populations, and in what follows it is these languages that will be meant by the term "sign languages."

Reasons for studying sign languages and the results of such research also show wide variety. Earliest to emerge was educational research: from 1880 when a congress of educators in Milan decided that deaf children should see and use no sign language in their educational experience, incredible as this may seem to those unacquainted with the rise of "oralism" (2, 25, 40). Recent research reveals the inevitable effect on children who cannot hear of depriving them of sign language (23); it also strongly indicates the use of bilingual strategies (16, 21). In another direction, sign language research has helped focus new consideration of the origins and evolution of language

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(12, 81, 83–85) [see especially (39) for an overview]. Sign language research has played a major role in testing the capacity of apes for learning a natural language appropriate to their physiology (38). Sign language research is now pursued by linguists, though their interest comes recently (106, p. 149; 88). Sociolinguistic and psycholinguistic research began somewhat earlier (50, 58, 107–109), and those interested in child development from sociolinguistic (50), psychiatric (61, 68), and cognitive (55, 102), as well as from formal linguistic perspectives (106) have also investigated sign languages. Additional reasons for making sign languages the object of research appear in the reports from various disciplines in the journal *Sign Language Studies* (74).

One of the first questions asked by those unacquainted with the subject is whether sign language is universal. The long persistence of this question should in itself sufficiently indicate that no easy or categorical answer can be given. Human use of faces, hands, arms and other body parts to signal is of course universal, found not only in all cultures but akin also to behavior observed in other species (24, 71). When organized into word-forming and sentence-forming systems, however, as happens in the natural languages of deaf people, these bodily expressed signals—and especially syntactic combinations of them—become linguistic signs belonging to a unique grammatical-lexical system. Not only do deaf people of different nations have different sign languages, deaf groups in large nations, or in smaller divisions where mobility is limited, often use mutually unintelligible languages or dialects. The national spoken language has little or no effect on the nature of the sign language used by a national deaf population; American Sign Language (ASL) and British Sign Language show far more dissimilarity than do, for instance, ASL and French Sign Language. Research by Battison & Jordan (10) with signers from 18 nations has confirmed these observations; but there is more to the question of universality. These researchers also questioned and tested their informants, usually in pairs, and found that while there may be great or slight difference (often the latter condition causes more misunderstanding) between sign languages, deaf people who travel are skillful to varying degrees (10, 43) at communicating with "foreigners" (i.e. deaf people who use different languages). This international communication is established and maintained, either consciously or out of awareness, by relaxing the strict rules of the communicator's sign language and using gestures, mime, and whatever people do to communicate across language barriers—except that deaf people through long practice are demonstrably more adept than others at this ad hoc use of everything but vocal sounds to communicate (10, 43). It may be that this almost uncanny skill of deaf signers contributes as much as general unfamiliarity with sign languages to the popular impression that simply to gesture is to be understood.

Not only ignorance but also confusion in nomenclature leads to misconceptions about sign languages. Mime, gesture, signing, and sign language are terms often used as rough synonyms, but it should be possible to give them a developmental ordering. Willing parties of an encounter, with no more in common than their humanity, can use *mime* to express ideas of some complexity. *Gestures* seem by comparison with miming to signify parts instead of wholes. *Signing,* useful as a cover term, also suggests conventionalization of actions more referential than most gestures. *Sign language,* as the term is being used here, refers to systems with actual grammars but with "gSign" (gesturally produced) not "sSign" (vocally produced) outputs (83). Alternatively, this same progression may be viewed as the relationship of the sign producer to the semiotic system. In mime the person miming is central to the sign and actually becomes the sign. A gesture allows its producer to be more detached, less involved, than does mime; consequently part of the body and not the whole person is the sign vehicle and the direct focus of the watcher's attention. In signing a sign language, the sign producer becomes still further detached, so that the sign language system plays a larger role—as in all languages, there is a sharing of control between the individual and the system (89).

The term "nonverbal" is rarely used in the research here reviewed, but it is a term so deeply ingrained in the thought and writing of unsophisticated observers of behavior that it cannot be ignored (70). Arguing that study of highly organized systems helps one to understand the more difficult because less organized behaviors, the Danish anthropologist Kuschel has suggested that those who would observe and comment sensibly on nonverbal communicative behavior would do well to look first at sign languages (52). An emerging, coherent field of study in which a number of disciplines converge to study much the same phenomena has been given a classical name "coenetics" (22, 104), though it has also been known as face-to-face interaction (46, 48). Whether this field is conceived of as semiotic, ethological, behavioral, or anthropological, it has the advantage of opening up now, when a general systems approach is in favor and when sign languages can be considered on the same basis as are spoken languages.

LINGUISTIC STRUCTURE OF SIGN LANGUAGES

The central focus in this review is the structure, as it is being disclosed by research, of the most studied of sign languages, American Sign Language (ASL). Attention is also given to information available about other sign languages—from Rennell Island, a Polynesian outlier in the Solomons (51); from southern France (64), Japan (62), Denmark (36, 77a), Israel (69), Taiwan (77), China (110), Providence Island in the Caribbean (103), and the Enga tribe of New Guinea (47). A rough chronological outline of

research efforts fits fairly well a division of sign language structure into *phonology, morphology,* and *semology* [Trager's 1953 division of linguistics (97)], here interpreted as (*a*) the organization of the physical phenomena by which sign languages find expression; (*b*) the structure of sign morphemes and their selection, distribution, and co-occurrence, as well as their principles of arrangement (syntax); and (*c*) the relation of meanings to sign words and sign sentences.

Phonology

The first modern investigation of ASL structure (78) began in 1955–56 [Tervoort's 1953 dissertation (96) describes what the writer calls "the esoteric system" of signs used by deaf schoolchildren, dependent on the Dutch spoken around them, and not apparently persistent across successive school generations]. During 1955 and the next year or two, familiarity with the Trager & Smith *Outline of English Structure* (99) greatly aided the learning of manual signs as a vocabulary for teaching deaf college students, because the Outline uses minimal pair contrast for isolating the structure points of phonology. At this stage, the task was learning signs not learning sign language (Then, as now, instruction was carried on in "simultaneous communication," i.e. English expressed in spoken words and simultaneous manual glosses.) In 1957 the Summer Linguistics Institute with Smith and Trager made it plain that segmental analysis would not work: these manual "words" of a sign language could not be analyzed precisely, as spoken words are analyzed, into sequential submorphemic segments. The difference, as Hockett recently stated it (39, p. 274), amounts to "a significant difference in *syntactic dimensionality*" (emphasis his); i.e. elements in spoken languages can only be arranged linearly in the dimension of time (except for stress and intonation), but sign language allows and exploits (89) "the geometry of the field in which the constituents of a message are displayed," which includes "three dimensions of space and one of time" (39).

Although phonetic and phonemic and morphophonemic analysis could not be done without change in the instrumentation, the principles of linguistic structure in levels certainly did apply to signed languages, systems of the same order of complexity as spoken languages. An important foundation for sign language research was gained in the summer institute: a language is a system such that no part of it is independent of the rest of it, but a language is also itself one set of systems which *in toto* constitute a culture (35, 98). From the outset, then, it was clear both that ASL operates as a language and that it is the language of a community of deaf persons. [The deaf community of metropolitan Washington has been denumerated and described by Schein (66); and Schein & Delk (67) have surveyed the U.S.

deaf population, the linguistic community of ASL that functions as a cultural enclave or subculture in the midst of the larger culture.]

Two years of intensive study followed this anthropological linguistic introduction. The sign language utterances of many signers were observed; sign conversations were filmed and repeatedly studied; hypotheses about ASL grammar were tested with colleague-informants; and while more and more minimal pairs were sought to establish structure points, a continuing search was being made for a way to deal with the contrasts discovered. The central problem was that the components of a sign are simultaneous, while linguistic analysis and notation from ancient times deals with the segmental, successive arrangement of word components. In the midst of this study, the solution seemed to come of itself, as a conviction that signs are unitary acts which must be looked at in different ways if different *aspects* of their structure are to be seen. This resolution is as old as the Athenian Zeno and derives ultimately from the nature of human vision and the difference of retinal cells receptive to movement and to detail (73). As Shands phrases it,

> Observation is limited to either the one [form] or the other [movement]: one cannot examine an extremity in physiological operation while at the same time dissecting it (as an "object") to find its structural characteristics. The integrated whole, structure-in-action, can exist nowhere except in the *imagination* ... (73, p. 117).

In producing a sign language utterance, some part (or parts) of the signer's body acts. If the active part is mobile enough, there are various places in which the action may occur, i.e. begin, take place, or end. But the action, the active part, and the place are all present simultaneously. The problem is to see what composes signs (i.e. what elements they can be decomposed into) when signs are taken as equivalents of words or morphemes of spoken languages. Signs cannot be performed one aspect at a time, as speakers can utter one segment of sound at a time. Signers can of course display handshapes of manual signs ad libitum, but they cannot demonstrate any significant sign action without using something to make that action somewhere. By an act of the imagination, however, it is possible to "look at" a sign *as if* one could see its action only or its active element only or its location only. In this way *three aspects* of a manual sign of sign language are distinguished, not by segmentation, it must be reemphasized, but by imagination; these were first called (78) the aspects *dez* (the designator, what acts), *sig* (signation, the action), and *tab* (the tabula, the place).

Although the original analysis treated briefly the apparently central role of facial expression, eye gaze, and head action in sign language syntax (78, pp. 61–67), the descriptions of the three aspects can be read as if they applied only to manually produced signs—a serious misreading. In the

sequel it seems unfortunate that so much attention was focused on the manual activity in the first full-length study of ASL and so little on other than manual activity. Some of the more recent studies to their detriment treat manual activity as if it were the entire transmission system of the language, analogous to vocal activity in spoken languages. In a reported discussion (44, p. 242), Liberman, Bellugi, Klima, Stokoe, and Studdert-Kennedy seem to speak as if the features of the manual signs they are discussing were the features of sign language itself. Feature analyses have been attempted but limited to features of handshape (9; 54; 59; 106, pp. 15–70) and location (45). The problem of levels is apparent in all this. In speech, the phonemic components of a morpheme can be segmented in time at one level, while morphemes so composed succeed one another in time, and the acoustic or articulatory features on each constituent phoneme are simultaneous. In sign language the aspects (what acts, the action, and where) are themselves simultaneous or virtually so, but so are their features; e.g. "what acts" may be (right) forearm *horizontal* and *pronated,* fingers (all) *extended* and spread, etc. So described, this aspect includes features of hand configuration and of the so-called "parameter of orientation" (32, 78, 86, 106). In the same sign at the same time, "action" may be separated into such features as *rotatory* (pronating and supinating muscles), *oscillatory* (alternating muscle contractions), *rapid,* and *brief.* But in this sign so described the action is relatively featureless: those features on the active part that specify the forearm's position and location make any further location notes redundant. [This location, of many signs, was called "zero-tab" in (78), and has also been called neutral or unmarked location.] Although the foregoing specification seems to identify features on one level, to put aspects consisting of these (italicized) features at a higher level of organization and the sign described (meaning 'so-so' or 'yes and no') at a still higher level, research has not yet solved the problem of levels. There is clear likelihood that what is here called the sign may be a manual morpheme that requires one or more nonmanual features or even morphemes to combine with it to become a word of ASL.

Not just features and aspects but also morphemes of ASL may be in a watcher's view simultaneously, and during two decades of research the three levels—feature, aspect, morpheme—have been variously located. In 1960 West treated handshapes, actions, and places acted on as the morphemes of Plains Indian sign language (79, 105). From 1960 to 1965 morphemes were treated as the simultaneous combinations of such aspects; in 1972 it was suggested that a sign is composed of at least one manual morpheme and one "facial" morpheme (80). More recently, feature analysis has at times treated aspects themselves as features and at other times treated details of the hand active in manual signs as the features on a (manual)

phoneme (32, 54, 106). In the discussion already referred to, Klima (13) concurred with the view that features are partly empirical and partly metaphorical and stated that "this concern has led him away from the term *features* to the term *parameters,* which is linguistically neutral" (44, p. 242). More often in recent research the term *parameter* is used for what is here called an aspect. There is more in this than a quibble over words, which a nonlinguist might suspect: the basic issue is whether with its feature, aspect or phoneme, and morpheme level a sign language has the organization of a language or has not. In plain terms, research to date has resoundingly established the affirmative.

To say what empirical phenomena are operating at what level of phonological or linguistic organization remains a problem, but a problem that may be more easily dealt with given two changes of focus. The imaginative separation of a sign into aspects calls for cognitive scanning; the measurement of parameters, unless they are metaphorical, calls for visual observation of which human vision is incapable (73). Whether two signs manually produced and observed to be similar are indeed two words of a sign language, or are permissible variants of one word, depends more on the competence of the language users than on the size or nature of the physical difference. This is of course an axiom of systematic linguistics, and it presupposes a developed science of phonetics; but in sign languages there are no sequences of phones to be segmented. Hence there is no way to separate structure and motion from structure-in-motion except to pretend that each aspect may be perceived and produced without the others.

The second change is more literally a change in focus. It is to look not at hands alone but at everything that acts significantly when a signer is engaged in signing. Siple (76) found that signers of ASL focus their gaze on the face, taking in much hand action with nonfoveal vision; i.e. signers look at faces, focusing the central vision on the face or an area a little larger than the face; their peripheral vision is thus used for what it is best at, detecting movement. Work on the other than manual activity in signing (3, 5) and research in progress by Baker shows lexical, syntactic, and discourse regulating functions (4) in actions not made with the hands.

Psycholinguistic experimentation provides another way to determine levels of linguistic organization. Bellugi's experiments with signers' short-term memory for signs (14, 15, 50) and with "slips of the hand" (50, pp. 125–46) show that signs are remembered by signers as three-aspect structures: the intrusion errors signers in the experiments make are signs identical with the target in two out of three aspects and bear no semantic relation to the target sign; e.g. "key" (X-hand on other hand) remembered as "apple" (X-hand on the cheek), with identical action. This research first reported in 1972 (15) not only established the psychological reality of the three aspects of manual

signs but also went far in persuading psychologists, psycholinguists, and educators of deaf children that the language outlined in 1960 might be worth study and educational experimentation. The effect was dramatic. In the decade from 1960 a structural outline (78) and a dictionary on linguistic principles (91) and little else appeared. With the 1970s, however, the psycholinguistic research of Bellugi and colleagues began (50); experimentation with teaching signs to chimpanzees made the language even more visible (38); sociolinguistic study begun by Woodward (107–109) widened the base of sign language knowledge; and a journal, *Sign Language Studies* (74), provided a forum for research in many disciplines of signing and similar behavior. [Begun under the auspices of the Research Center for Language Studies at Indiana University at the instance of T. A. Sebeok, the journal appeared semiannually in 1972 and became a U.S. published quarterly in 1975; support from the American Council of Learned Societies, the Center for Applied Linguistics, and the National Science Foundation also substantially supported sign language research.]

Notation

It is likely that future treatments of sign language structure will use multilevel notation (5, 80); current research using the Facial Action Coding System of Ekman & Friesen (26, 27) has not yet reduced the nearly 50 facial units of that system to a smaller number of changes or displays significant at various levels of sign organization. Whether the purpose is phonetic (to describe the visible units used linguistically in all sign languages) or phonemic (to identify the significant contrasts in the aspects of one sign language), it is necessary to consider the separated and simultaneous nature of kinesis. A human signal source can use separate body parts simultaneously either as components of one lexical item (e.g. "Where?" has both manual and facial activity in its realization), or as components of a phrase (e.g. "I never saw it" can be signed with one hand making "never," the other making "saw it," and face and eyes indicating "I").

Meanwhile, those who write about sign language have two choices: to use English word glosses (customarily in capitals) to represent signs, or to use a notation system for manual aspects with added lines for notes on other than manual activity. The former choice entails little typographic complication but runs the risk of all word-for-word translation. In its favor is the richness of the English vocabulary [e.g. various extramanual accompaniments of the ASL sign meaning "sick" (50, pp. 247–49) might be indicated by writing SICK, INDISPOSED, SICKLY, etc as glosses; but English lexicon and modulated ASL signs do not match well, and Klima & Bellugi (50, pp. 264–69) offer instead 12 features and 8 phrases to describe the modulated sign]. The second choice of notation strategy is often made

because there exists a serviceable system for notation of manual sign aspects (78) and a lexicon of some 3000 signs listed according to this system (91).

A Dictionary of American Sign Language on Linguistic Principles (DASL) (91) is still the only sign language dictionary that lists signs instead of words (17). Recent research has added substantially to the information on signs and sign language in DASL, but its notation system, based on the tri-aspectual analysis, can be adapted easily to phonetic distinctions in signing or to the phonology of other sign languages. The DASL convention is to use first place for the tab symbol (location of action), second place for the dez (what acts), and third place for the sig(nificant action) in writing a manual sign.

The high frequency of signs unmarked for location (neutral or zero tab) makes it possible to write many signs with two place (dez and sig) notation; but double-dez (i.e. two active hand) signs are also frequent; in this case "Ø" is used for tab and the next two symbols refer to the active hands. How many locations and hand configurations are significant in ASL has been debated (9, 50, 106), but DASL uses, besides the zero symbol, eleven symbols devised to be iconic (e.g. '⌒' for forehead). Field researchers and those encountering an undescribed sign language may add symbols as needed [e.g. a Polynesian signer seated cross-legged may touch the ground in front of him or touch his knees (92)—locations of course unused in ASL]. The growing use of computers to reduce the chores of notation may make it possible to dispense with such graphic symbols and still retain the essence of this notation system by listing significant locations and assigning to each a unique numeral. This can also be done with symbols for what acts and actions.

Nineteen simple symbols are used in DASL for the configuration of what acts, when that is a hand or hands. These are augmented by diacritical marks; e.g. "A" stands for closed hand, but "Å" indicates the closed hand with the thumb extended fully from it. This example illustrates the adaptability of DASL notation: Sallagoïty (64) gives this extended thumb handshape the symbol "1" instead of "Å" in his notation, because southern French signers use the thumb-up hand for "one"—unlike ASL signers, who use extended index finger pointed upward for the numeral. Because extended index, held horizontally, denotes "g" in the American manual alphabet, this configuration was given the symbol "G" in DASL notation. Just which handshapes are used for basic contrast in sign languages and in specific sign languages has not been determined with precision; investigators may wish to consider these and other matters presented in A Field Guide for Sign Language Research (92), as well as the separate but useful pairing of handshapes with alphabetic and numerical symbols (20).

The 24 symbols for sign action used in DASL resulted from analyzing

sign action into relatively simple movements, and consequently the action of a single sign might require several sig symbols for its notation. Vertically arranged, these show simultaneously performed individual actions, and show successive movements when written left to right. Research since DASL, especially that reported in *The Signs of Language* (50), has shown how the action used to express inflection, derivation, or modification ("modulation") (50) can be separated from the action that belongs to the lexical base itself. For instance, if a revision were to be made now of DASL, the discoveries of Supalla & Newport (93) could be used to allow separate listing of noun and verb forms, with tab and dez identical but difference in the components of action showing the distinction.

One final notational matter: in the context of manual signs, or manually produced morphemes, it is important to be as faithful as possible in notation both to linguistic distinctions and to physical differences. Besides diacritical marks to show different handshapes, in DASL subscripts and prescripts are used on dez symbols (and on manual tab symbols). These do not indicate differences in handshape but important differences in what acts that might be termed differences in "presentation" or "positioning" (the term "orientation" implies or reveals an external criterion). Handshapes may be identical but presented with a vertical, horizontal, pronated, supinated, or non-rotated forearm, and so contrast. In DASL the symbol to mean elbow as tab is prefixed to a handshape symbol to indicate forearm prominence, especially verticality. Two other symbols, italic or script *a* and the same character inverted, are unique in the notation system: they function as tab symbols, as dez symbols, and as sig symbols. In notation they present graphically the essence of aspectual analysis.

A notable characteristic of human forearm structure and function is its capability of rotation: muscles acting on the radius and ulna can turn it radius-inward, pronate it; turn it radius-outward, supinate it; or can leave it unrotated. All sign languages appear to make use of this capability in all three aspects of their manual activity. Pronated, the forearm presents the back of the hand or the wrist or forearm as location for sign action. Supinated, it presents the inner surfaces as tab (The tab symbols are respectively a large italic *a* inverted and the same letter right side up.) But the pronated forearm may also present an active handshape (e.g. "B_b" the flat hand) palm downward. An unrotated forearm presents the same handshape but with ulnar edge downward ("B"). In ASL three signs, for "school," "money," and "stop, cessation," are so distinguished ($B_a B_b{}^{x\cdot}$; $B_a B_a{}^{x\cdot}$; and $B_a B^x$). Finally, the muscular action of pronation may be seen as the action of a sign, as it is in the ASL sign for "bet." Supination is also significant action, as in the sign OTHER (ϕA^a).

This triple role of forearm rotation directly exhibits the nature of aspectual analysis. Physiologically the muscular actions are identical. But when seen as having been *done,* they may either have prepared a hand-arm to be the location of a sign or have presented an arm-handshape to be what acts in a sign. The contrast between *done* and *doing* (73) also signifies: when seen as happening, pronating action and supinating action become significant action in a sign.

Morphology

MORPHEMES   If it has become apparent that research cannot yet formally describe ASL phonology and determine the levels corresponding to distinctive features, phonemes, and morphemes with any great degree of certainty, it will come as no surprise that the state of the art of accounting for the morpheme structures, classes, distribution, derivation, modification, and combination is less advanced. This caveat should not be taken as any detraction from excellent and detailed examination of parts of ASL grammar by Battison (9), Klima & Bellugi (50), Wilbur (106), Hoffmeister (42), and Lane & Grosjean (55). The state of the art needs no apology when the length of time that signed languages have been under study is contrasted with the time devoted to the analysis of spoken languages. One way to sum up what has gone before and to look at the critical region in which sign phonology and sign morphology interconnect is to look at morphology on the aspectual lines already epistemologically established. Aspectual analysis relies on imagination (i.e. looking at a sign *as if* its action, its location, and its active agent could somehow be seen in isolation). In fact, the action of a sign, what acts in a sign, and location (when this is not redundant information) are subject to empirical confirmation; they are just not temporally isolable. An attempt to show both aspectual analysis and the synthesis of structure and movement made by actual sign behavior is presented in Figure 1.

The graphic display of Figure 1 shows that formational characteristics of a sign language cannot be represented on a simple semilattice, which has the property of continuing, nonintersecting divergence. In the lower right of Figure 1, the lines show that the aspects of action and location—which were separated by supposing that one might exist without the other—actually converge, as of course happens when some kinds of sign action act upon some part of a signer's body. Such action is not disembodied but requires a hand or hands to make it, and so all three aspects will come together if the right side of the diagram is extended. The dotted lines to the right might terminate in designated body parts (forehead, cheek, neck,
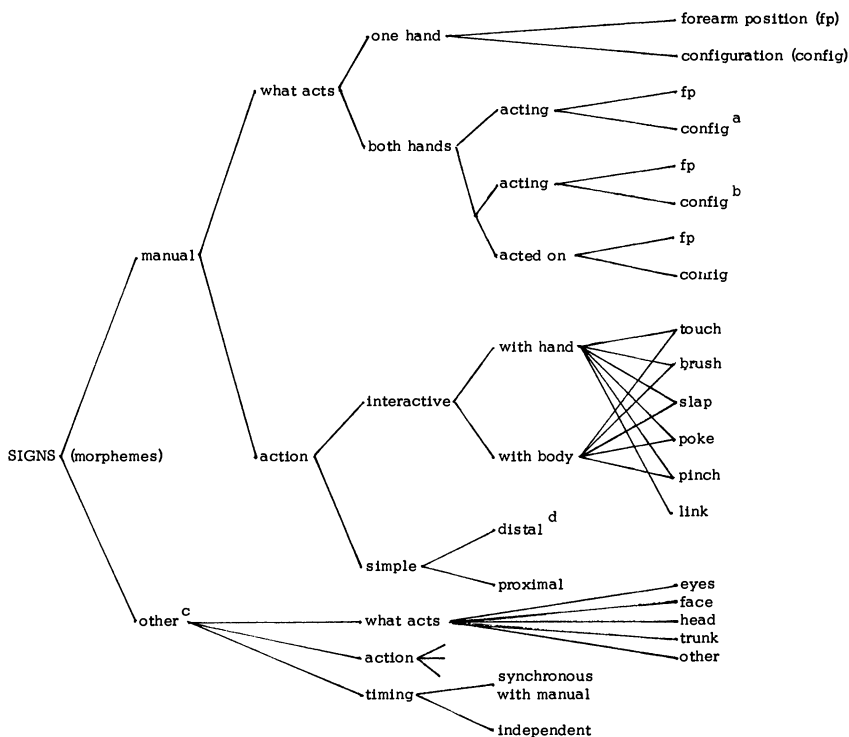
Figure 1 showing a tree diagram of formational division:

SIGNS (morphemes)
- manual
  - what acts
    - one hand
      - forearm position (fp)
      - configuration (config)
    - both hands
      - acting — fp, config [a]
      - acting — fp, config [b]
      - acted on — fp, config
  - action
    - interactive
      - with hand
      - with body
      - (touch, brush, slap, poke, pinch, link)
    - simple
      - distal [d]
      - proximal
- other [c]
  - what acts — eyes, face, head, trunk, other
  - action
  - timing
    - synchronous with manual
    - independent

Figure 1 Formational division of sign language morphemes.

[a]When both hands are active in a sign, they must have the same configuration (config), perform the same action (parallel, opposite, or alternately), use the same location (or right and left parts of it), and show identical or opposite forearm position (fp)—Battison's "Symmetry Condition" (8, p. 33).

[b]When the hands have different configurations in a sign, one must be the acting hand, the other acted upon, in which case the acted-on hand is restricted to a few simple or unmarked handshapes (config); i.e. fist thumb-aligned, fist thumb-opposed, open, open-spread, index, fist with thumb and index tips opposed (A, S, B, 5, G, bO)—Battison's "Dominance Condition" (8, p. 35).

[c]Evidence for the existence and significance in ASL of nonmanual active elements is gathered in Baker & Padden (5).

[d]Distal musculature acts on fingers and hands, proximal on forearm and upper arm. Besides difference in the characteristic sizes of distal and proximal action, there is a difference in the ennervation of these two sets of muscles dependent on different brain stem connections [Kimura (49)].

shoulder, etc), but all this is dominated not by a location node but by the action node. In fact, the diagram shows what has been increasingly apparent in recent research, that the tripartite aspectual analysis is by no means equipotent. No location node has been included in Figure 1 because when

the forearm positioning and configuration of the active hand along with the details of its action are sufficiently specified, the place or places that the hand appears will already have been entailed. For example, in the signs translated "know" and "have," what acts is the slightly curved hand on an upright supinated acute elbow forearm. The action in both signs is movement toward the signer, in the former by elbow flexing only, in the latter by elbow flexing and shoulder flexing. Therefore the sign KNOW ends with fingertips on forehead; the sign HAVE ends with fingertips on the chest. If the muscle control—which is where all sign action comes from—is accurate, head or chest will be the termination of the action, whether analysis of sign structure makes them part of a phonemic inventory or not. The criterion of simplicity makes a specification of what acts and the action sufficient; though of course it is convenient to use location for description and notation.

The tentative picture of morpheme structure in Figure 1 is far from complete, not only because research has not yet extended the node marked "other," but also because as shown, it may be extended in two suggestive ways: by addition of the positions, configurations, actions, and body parts (locations) that keep words of ASL separate, it becomes a chart of ASL phonemes; and by listing all the positions, configurations, etc of all known sign languages, it becomes phonetic chart.

VERBS   When attention is turned from sign formation to classes of signs and the relation of these two systems, the shortness of time devoted to such study becomes apparent. Very early, verbs in discourse were found to be given interrogative or stative force by nonmanual sign activity; e.g. the manual REMEMBER is made a question or a response by suitable eye and head motion (78, pp. 66–67). In DASL (91, pp. 279–86) notice is taken of other sign verbs that change direction of action according to the direction of transitivity—toward the first person signer as patient, away from third person as agent, etc. Signs that incorporate an element of action to change their meaning to its negative are also identified in DASL. In 1972–1973, Woodward used sociolinguistic methods to examine these two subclasses of verb signs, also verbs that reduplicate part of or all of their action aspect (107–109). He found them to be good tests of whether a signer has competence in the language or knowledge merely of the citation forms of the signs; he found also that a signer's competence in this portion of verb grammar implies full membership in the sign language community. Fischer & Gough, in a 1973 manuscript (29) [published in 1978 (30)] examined many of the directional, reduplicational, and other action-modified characteristics of sign verbs. Ellenberger & Steyaert (28) found in a study of a deaf child's acquisition of ASL from deaf signing parents that many of these character-

istics of sign verb grammar, though apparently iconic (e.g. moving the "give" sign from giver toward recipient), are not learned early while a child is producing uninflected words, but come to the child's performance only at the stage of more sophisticated grammatical learning. Battison (9) studied a number of relatively new ASL verbs, borrowed from English fingerspelled words but restructured; e.g. *all* retains the initial "A" handshape of the fingerspelled word and the final "L" handshape, but adds to this distal action one of four proximal actions (using one or both hands) to express one of four different kinds of completeness: members of a group, items on a list, time from past to present, or the entirety of something abstract (9, pp. 152–57). Further studies of sign language verbs are reported in (50) and (106).

NOUNS   ASL nouns like sign verbs have become much better known during the recent phase of sign language research. Little was observed about nouns at first except that in some of them repeating part or all of the action made them plural. In this as in other parts of ASL grammar, fascination with the iconicity of gestural signs may have deflected investigators' attention from linguistic system. This situation was dramatically changed when Supalla & Newport (93) presented 100 pairs of signs identical in aspect except for differences along the dimension of "manner of movement": continuous or hold manner of movement for the verb form, restrained manner and repetition for the noun forms (50, pp. 295–93). Linguists with some interest in sign languages were speculating in the mid-seventies that the nonvocal mode of transmission made it unlikely that signers could distinguish nouns from verbs; Supalla, who described what everyone since has been able to see, is a native signer and member of an extensive deaf signing community.

PRONOUNS   Personal pronouns, an interface between a language and its users, intricately link linguistic and social structure. Personal pronouns in sign languages seem at first sight simplicity itself (1): a signer points at self, at person signed to, at other person designated. If all situations of language use involved only these persons, the illusion might reflect reality. In fact, even the simple combinations of these three persons (e.g. you and I but not him, she and I but not you, all three of us, etc.) constitute a logical set of 11 members if dual is a full system and 8 members if only singular and plural are used (37, 85). Inspection of a large number of the world's spoken languages reveals that only two or three possess 11 words (or 8 words) to designate uniquely each member of the logical set; all the rest have fewer pronoun words so that one form must refer ambiguously to more than one term in the set (e.g. English *you, we*). But ASL and other sign languages

easily distinguish each member of the logical set by using a distinctively different sign. Moreover, the action of a sign pronoun can include and exclude; finger extension separates singular from dual from trial from plural forms; modification of sign action incorporates further distinction in plurals such as "all of you" versus "each of you"; and in ASL, handshape changes can separate possessive and reflexive or emphatic forms. Friedman's 1975 treatment of space, time, and person reference (31) is the first published study of pronouns in ASL. More recently, Hoffmeister (42) has made a longitudinal study of the acquisition of pronouns and related grammatical features by a deaf child of deaf signing parents, and finds the earliest pointing behavior retained, diversified, and ramified until it accounts for much structure in adult competence. This last makes an interesting semiotic progression, from index sign to (manifold linguistic) symbol; and it seems to be parallel in ontology to Frishberg's account of historical change, from icon to arbitrary symbol (33).

Interrogative pronouns are well represented in ASL and show considerable regional variation in form. Their manual forms seem even more than other manual signs to demand appropriate facial, eye, head, and other action to be correctly expressed and understood. They make an interesting sign class for another reason; although they are among the earliest vocabulary items taught to hearing persons, who will in all likelihood use signs in English word order, the serious student of ASL finds their use and position in sentences of ASL quite different from the grammar of *wh*-words in English; e.g. a *which* question in English usually begins with *which;* the same question translated into ASL is likely to end with the sign translated "which."

CLASSIFIERS   Possibly to be counted as a kind of pronoun, is a special class of signs that share some of the functions of collective nouns and indefinite pronouns in English. These signs were called "classifiers" by Kegl & Wilbur (45). ASL like many languages requires special forms to go with antecedents semantically classified; e.g. "something long and thin," "something hollow," "something self-propelled." In ASL these classifiers serve differentially in slots where English allows only *it, he/him,* or *she/her.*

Syntax

The class of sign words called classifiers makes a natural transition from morpheme classes to morpheme combining. Because of the incompleteness of our knowledge and the difficulty of determining levels of sign language structure, two kinds of combination will be treated in this section: first the more intimate combination of compounding, affixation, incorporation, and blending, and second the less intimate combination of signs in phrases and longer constructions. Nor is it possible to treat these combinations without

reference to formational change. Categorization of morphemes of spoken languages into six or eight or more "parts of speech" seems inappropriate for ASL and other languages that have a four-dimensional field in which to arrange combinations.

Compound signs, defined as two signs complete in all three aspects uttered one after the other to express a single lexical item, may or may not be characteristic of natural sign languages; it is certain at least that this means of rendering the meaning of one French word was central to the *signes méthodiques* coined by Épée and Sicard and still in use by the time of Lambert (53), whose dictionary of French sign language appeared in 1865. Current educational practice also favors the use of two or more complete signs to render the etymons and derivational particles (in order) of English words, with the intention of so making signs an automatic means of teaching the grammar and lexicon of English. The strong tendency in ASL, however, is to reduce such compounds (8; 9; 33, 106, pp. 78–80), and to create its own combinations at the aspectual not the whole-sign level. Thus (50, pp. 198–224) a sign meaning "streaker" is created out of signs meaning "naked" and "zoom-off"; the last already in its action combines movement away from the signer with handshape change ("L" hand to pinched thumb and forefinger, "baby-O"); the new sign begins with the "open-8" handshape of "naked" and ends with the pinch. The economy is easily calculated: compounding imposed on a sign language by nonsigners comprises two signs, six aspects; but the compounding in Bellugi and Klima's example results in a sign with one tab aspect (the pronated forearm shared by all three signs), one complex action (handshape change in "naked" and "streaker" with outward movement), and one starting handshape. The result is three aspects, not six.

Classifiers, as mentioned above, are not only reserved for certain semantically grouped referents but are also unusual in phonological structure. While signs have three aspects, what acts, action, and location, classifiers have only what acts: a distinctive configuration and presentation. Action[1] is not part of any classifier sign, and the classifier sign is free to move into any location manual signs can reach. If action appears to accompany a classifier handshape, it is a proposition and not a word that is being signed; e.g. the "person" classifier moved toward the signer translates "That one came toward me." Another example: the "walking" classifier used of animate beings moved in an arc and then up and outward might mean "It walked in a wide circle then went up the hill and out of sight."

This gets fully into syntax. Just as interesting as the action-less structure

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[1]Supalla & Newport (personal communication) treat a classifier as a complete sign performable in isolation, calling the action a "hold"; i.e. without movement.

of classifier signs is the ease with which verbs of motion in ASL give up their citation-form handshapes to adopt the handshape of the classifier used as agent with them. And adverbs of manner in ASL may become still more parasitic, appearing in combination with verbs and classifiers as components of action superimposed on the verb action that the classifier handshape is performing (50, pt. iii). This is what is seen, however, when the focus is on manual activity alone; in wider focus, a signer by using a range of behaviors from trunk motion to eye movement can add additional semantic features to the combination of classifier, verb, and adverb manual activity. Not just the separation of signs into traditional parts of speech but also the clear-cut Indo-European distinction between word and sentence seem foreign to sign language grammar. Nevertheless, as Wilbur says, "a variety of syntactic rules exist in ASL, many appreciably different from English. However, none of these rules indicates that ASL is extraordinary with respect to other languages of the world ..." (106, p. 148).

An important breakthrough in understanding the syntax of ASL was made by Liddell (56). In spoken languages change in word order or special formatives (*wh*-words) often distinguish sentences combined to make one subordinate to the other from the same sentences joined coordinately. For a time linguists supposed ASL defective, lacking means to embed, subordinate, or otherwise distinguish relative clauses. Liddell, however, found that while conjoined sign sentences and the same sentences in dependent/main clause relationship were identical manually, there were very definite contrasts in the head, eye, and facial behavior of signers producing these two kinds of sentence combinations. Without going into detail, it can be said that for a dependent clause, a signer, during the production of that sequence of signs, departs from the expression and/or head position normally used and resumes it when the manual signs of the main clause are being produced.

SEMOLOGY

One definite effect of sign language research is refinement of linguistic theory. Saussure's dictum that a linguistic sign must be arbitrary (65, p. 65) can be defended; if it were not so, the human species would speak with one tongue and the lion would be "lion" because that is its name, and so on for the name of everything. But Saussure's semiotic-linguistic theory generalizes from insufficient evidence when it is pushed into this syllogism which seems to be part of the belief system of many of the language sciences:

Linguistics signs are arbitrary
Some signs are iconic (motivated)
Therefore such signs are not linguistic.

If Saussure had considered the sign languages of deaf communities, as some of his countrymen earlier had done, he might have seen with Pierce, a superior semiotician, that arbitrariness, iconicity, and indexicality are not mutually exclusive properties of a sign but are variously distributed in sign-to-signified relationships. The misunderstanding that iconicity is antithetical to language may come from supposing that *langue* is a system based entirely in *parole*. The speech channel by its nature as sign producer effectively precludes much iconicity; there is little opportunity (except for a few onomatopoetic words and some sound symbolism) for a stream of sound to resemble anything else. Sign languages, on the contrary, by operating in the three dimensions of space and one of time (39, 89), have sign nouns similar in appearance to all or part of what they name. Similarly, many sign verbs resemble in motion, direction, or manner some characteristic of the action, process, or state that they denote. Such signs are iconic to degrees that might be determined, but they are also arbitrary by virtue of belonging to a specific sign language. The psycholinguistic hypothesis that such signs must be "transparent" (i.e. immediately interpretable) to those ignorant of the sign language (18) has been disproved repeatedly by psycholinguistic experimentation (41, 50, 63), but the popular belief that sign language is universal persists. A cultural orientation effectively corrects such global views of the nature of sign vehicles, sign denotata, and their relationship. Kuschel found a sign language used by one deaf (and mute) man and his associates on a remote island (51), but found also that some of its most iconic and indexic signs were interpretable only by the language users themselves; others could be interpreted at once by members of the same culture in other parts of the island chain who had no contact with the signers; still other signs, but only these, could be interpreted with ease by members of dissimilar cultures. Quite clearly, the ability to interpret the signs in only one of these three subsets is a different order of ability from understanding or producing utterances of the sign language.

Some of the signs in any sign language are likely to be interpretable across cultures, given the human propensity to gesture. But as Kuschel has pointed out (51), only when what is signified is a common item in all cultures, only when the gesture representing it is also pancultural, and only when that feature of it represented is universally recognized as the one most salient, will the interpretability be pancultural. The facial expressions of six basic emotions studied by Ekman & Friesen (26) may be prime examples of such universal signs. In contrast, iconic signs as linguistic symbols may be arbitrary as well and so uninterpretable; e.g. a tooth-pulling gesture means "brother" in Rennell Island sign language, but only Kangobai's contemporaries recall that his own brother had a tooth pulled by missionaries (51).

Once the theory had been developed that linguistic signs could be *both* iconic and arbitrary rather than *either/or,* Brown (19) could begin to explore the degree to which sign-signified resemblance may facilitate learning of vocabulary; and McIntire (59) and others could more profitably investigate why iconicity may help explain why deaf children of deaf parents produce syntactic utterances earlier than other children normally do.

A change in linguistic theory to admit iconicity in linguistic signs may illuminate more than ontology. As Hockett has recently pointed out (39), duality of patterning is not only possible in signed language but in early gestural or multimodal languaging of hominids may have been a feature long before there was a spoken language. The "syntactic dimensionality" Hockett discusses (39, p. 274) also implies directionality: it is more likely that a linguistic sign system expressed in space and time evolved into a system compressed into the one dimension of time than that the relatively more encoded sound-sequence system gave rise to the more iconic and indexic four-dimensional system. Abstract, parallel, and context-conditioned encoding of the kind needed to compress linguistic structures into sound signals (1) has all the look of an evolutionary result, not a starting point. Human infants perform language functions with facial expression, body posture, hand and arm activity, and vocalizations well before they can put linguistic structures into spoken form (100). Sign language research has made it possible to see that gestural expression suffices for linguistic symbolization as well as opening new lines of investigation.

Larger Signs

An even more interesting topic than iconicity in individual signs is iconicity in complex linguistic signals. If a report in spoken form states, for example, that a hen found a grain of wheat, the order of elements, SVO, may seem to resemble, if not reality, the perception of it mediated by the speaker's culture. But if the report is that a dog chased a fox, it may be supposed that the fox's running or presence or scent occasions the dog's pursuit; if so, the order OSV or OVS resembles more the organization of the event in the mind of the speaker. The question of order in ASL has been much debated (106, Chap. 4), but in this context it also should be made clear that a sign language can preserve iconicity despite relatively free ordering of S, V, and O. In the example, if signed by any but a rank beginner, the signs for fox and dog would be well separated in "signing space" and consequently the action of the verb sign would go from pursuer to pursued. Like an inflected language, then, ASL allows freedom in temporal placement of S, V, and O. The spatial ordering, which is inherent in a sign language, preserves the

meaning and shows relation of a verb to its arguments, whatever the order of performance in time.

An unexpected fact about this iconism of a sign sentence to the event it signifies was discovered by Ellenberger & Steyaert (28). In a longitudinal study of a deaf child's acquisition of ASL, they found that this iconicity, very prominent in the parents' utterances, did not appear in the early production but only at the later stage when children generally are mastering the grammatical and syntactical subtleties of the adult language. There is nothing "natural," in the sense of externally motivated, in the kind of spatial iconism that sign language sentences show; it is a resemblance of signifier to signified that must be acquired along with and as part of the syntactic competence the linguistic community expects; and it is not an automatic result of the gestural expression of transitive or other predicate structures.

The way that a signer of ASL may tell another "She's looking at me" has obvious indexical and iconic features: the forearm is extended toward the person (present or not) referred to; the index and second fingers (iconic of light beams toward the eyes?) are bent by wrist action toward the signer. Nevertheless, this three-part transitive proposition, which has the appearance of a single sign (hand forearm-dez, action toward, location), is of course the result of syntactic processes that restructure the constituent signs themselves. The citation forms of the three signs are given below from left to right in the order a beginning sign language learner might sign them, and below each sign are listed vertically the aspects of what acts (as forearm positioning and handshape) and action:

	SHE	LOOK-AT	ME
DEZ	*horizontal, oblique, pronated*	vertical, pronated	flexed *supinated*
	index finger	*V-hand*	index finger
SIG	outward movement (elbow extends)	outward movement (elbow extends)	*inward movement* (elbow flexes)

As signed by a competent signer among others, however, this proposition has only two aspects (italicized features above show the source of these):

	SHE'S LOOKING-AT ME
DEZ	{ horizontal, oblique, supinated { V-hand
SIG	inward movement (wrist flexes)

The work of a number of investigators since 1970 has made this as well as more complex parsing tasks possible with the result that what was formerly called "sign-mime" is now seen to be quite regular working of the grammar of ASL. Instead of seeing a vague resemblance between a piece of signed discourse and what it describes, investigators can now point out just what word forming and sentence forming processes are at work. In the typical stretch that follows, the signer uses one classifier handshape throughout, keeping it in continuous and often complex motion, while using a rapid sequence of facial expression and head position changes as well as occasional interventions of the nondominant hand, now as what acts in a simultaneous sign, again as acted-on location marker. Signer: (*a*) "vehicle" classifier (thumb, index, middle finger extended and spread on horizontal unrotated forearm) moves forward; (*b*) left hand loosely closed thrusts up on vertical supinated forearm and opens to spread into slightly concave 5-hand; (*c*) 3-hand wrist bends sharply to left and moves to signer's left in short undulating movement; (*d*) same hand now curves to right along now horizontal prone left forearm terminated by full spread L-hand; (*e*) traces line of L-hand thumb; (*f*) turns and moves right; (*g*) tilts (with wrist flexion and pronation) and moves outward and upward; (*h*) stops with a short drop onto back of upraised pronated left hand.

A bilingual signer seeing this would translate it something like what follows: "Drive straight ahead (*a*) to the first traffic light (*b*); make a sharp left (*c*); go along a bumpy road (*d*); bear right where the road forks (left L-hand) (*e*); keep curving right (*f*); then left up the hill (*g*) to the top, and there you are (*h*)." (Example reproduces as nearly as memory allows demonstration by Carol Padden at NATO Sign Language Conference in Copenhagen, August 1979, of a passage she attributed to Ted Supalla, another native signer.)

There is no miming in this example. If a signer wished to describe the difficulties of following these directions with the intent of emphasizing the personal involvement, some element of mime might easily be added; e.g. at some point the two-hand sign (DRIVE v./CAR n.) could be inserted and the signer behind it could assume appropriate miming expressions. In such a case, body movement instead of slight classifier hand movement would depict the bumpy road, and so on. But the highly personal experience of driving and the highly referential giving of directions both use the grammar of the same spatio-temporal language. Each is "iconic" in a different way; in the example as given the focus is on the vehicle and its route; with mime added the focus is on the driver and his or her reactions. Both scales of representation (car length reduced to classifier hand length, and full-size driving position and driver) and other scales as well are available to any signer competent in ASL (Bernard Bragg, personal communication). And

such performances, though they bring a sense of recognition when shown with simultaneous or later translation, owe nothing to any inevitable or natural motivation of a sign by its referent. Both are basically language not histrionic performances.

Here again a difference in levels, that between syntax and semology, in the Tragerian schema (97), seems to be obscured. The focus is not on syntactic structures or the arrangement of words in phrases and sentences but on how and why some kinds of meaning are represented in words and other kinds in sentences. It may be permissible in the light of what has been discovered to suggest that when the linguistic representation of the world in words and in sentences is roughly similar from language to language and culture to culture, (in other words, when we confront language universals), the nature of the human species, especially its brain, central nervous system, and vision, bring about the similarity. But when differences do show up, especially in the economy of effort seen when a transitive SVO sentence looks like a single sign word, these differences should not be taken as evidence that the basic linguistic structures of signed languages and spoken languages are noncomparable—still less, as has been done, should differences be taken as evidence that users of sign language show cognitive deficits. Rather, the differences ought to be sought in the nature of vision and of hearing as language channels and in the different dimensions of sound signals and spatiotemporal signals.

PROSPECTS

Sufficient study of the structure of natural sign languages used by deaf populations has so far been done to open several promising lines for future investigation. As noted above, the linguistic structure of ASL, the most studied of these languages to date, still contains unsolved problems. As these are investigated it seems certain that more of the structure relating signed and spoken utterances to thought, to the brain, and to mind will be revealed; the difference between signed and spoken symbolization provides a basis for more accurate observation of language than is provided by speech alone.

Another promising line is that leading to determination of a crucial question, whether language lies on an evolutionary continuum with animal communication. The use of sign language with other primates has only begun, but its results surely indicate the usefulness of further experimentation (38). The recent negative assessment of several chimpanzees' and a gorilla's sentence generating capability by Terrace et al (95) does not diminish the extent or value of what has been learned; none of the apes have created sentences as Chomsky defines sentence, nor, it might be argued,

does the production of any human primate under 3 or 4 years of age fully meet the rigorous criterion. Further experiments may benefit from increased knowledge of how ASL can make a three element or longer sentence look like a single sign: of course with few exceptions the animals did not see ASL—their human companions and teachers used signs as if they were English words. Parallel with these uses of sign language knowledge are the continuing archaeological and inferential investigations of the evolution of language and the relation of audible to visible signaling.

An area of investigation hardly touched until now is the ethnography of deaf societies (90)—not just as minorities within dominant cultures but as models of human organization and reasonably complete cultural systems operating in a four-sense world. The more knowledge that comes to light about the structure of sign languages the more knowledge and understanding may be brought to bear on the problems of translation not just into and out of signed and spoken language texts but also to and from different cultures.

The growing field of neurolinguistics also makes use of knowledge gained from sign language studies. The relation of vision to brain centers, brain lateralization, muscle control, and hearing may well be illuminated in unsuspected ways by examining the cognitive, linguistic, and kinetic behavior of monolingual and multilingual signers. Work in this field (e.g. 49) should also assist investigators of signed and spoken language production (34), and of learning of signs and words and meanings (19). Finally, in an era when applications of science to social problems are actively sought, it is gratifying to see that study of sign language has positively affected the educational and socioeconomic life of deaf people in the United States (101) and elsewhere.

References have been made throughout this chapter to numerous sources of additional information in relation to specific points. For a fuller view of the whole field, one might begin with *Sign Language Structure* (78). *A Dictionary of American Sign Language* (91) is valuable for the extent of its lexicon, Croneberg's sociolinguistic essays (91, pp. 297–319), and other information; but it needs to be supplemented by reports of more recent scholarship. *Battison's Lexical Borrowing in American Sign Language* (9) comes as close as any hearing person's study to presenting an insider's view; Wilbur's *American Sign Language and Sign Systems* (106) surveys recent scholarship, including much unpublished work with a leaning toward linguistic formalism; *The Signs of Language* (50) by Klima and Bellugi and ten subsidiary authors reviews several years of in-depth investigation centered in psycholinguistic theory and method. See also Sebeok (72) and Lane & Grosjean (55) for additional perspective. Those who wish to keep current with sign language research of course follow the reports and articles in *Sign Language Studies* (74).

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