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PERCEPTION AND PRODUCTION IN A VISUALLY
BASED LANGUAGE*

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Whether or not speech is special (as some would argue), it seems to us that there
remain questions of great theoretical import concerning the relationship between
speech and language; namely, What would language be like without speech? What
properties of the complex phenomenon we call language—including its production
and perception—are due to the mode of expression, i.e., due to the channel in which
the more abstract entities are realized as physical, perceptible stuff, and what proper-
ties are due to some broader linguistic faculty or to cognition in general? What sort
of stamp does sound itself put on language? What would be the effect of other possible
modes?

Our small research group consisting of personnel at The Salk Institute and at the
University of California at San Diego is approaching these questions by using an
experimental situation provided by nature, that in which human beings are born
def or become deaf during the prelingual period. We have purposely restricted our
study to deaf people who are offspring of deaf parents and who learned as their
first primary language the visual-gestural language called American Sign Language
(ASL). By analyzing a language that utilizes a visual rather than an auditory mode
of perception, and a gestural rather than a vocal mode of production, we can begin
to address the problem of the relationship between language and its physical
realization.

In this presentation we shall report on some of the findings of our studies includ-
ing: 1) The status of sign language in terms of general visual symbolism and, in par-
ticular, the relationship between sign language and pantomime; 2) the way signs
seem to be encoded and stored, according to results of experiments in the short-term
memory paradigm and evidence from slips of the hand; 3) historical change in signs
of ASL; and 4) the structure of sign language with special focus on the differences
between sign language (ASL in particular) and spoken language (English in partic-
ular). Our emphasis will be on the interaction between the mode (in this case, the
visual-gestural) and the more abstract linguistic and cognitive aspects of language.

To begin with, however, it is best to dispel some misconceptions that commonly
arise concerning the sign languages of the deaf. First, there is no single universal
sign language. Rather, there are many different sign languages, just as there are many
different spoken languages. These differ from one another most obviously in the form
of the signs which they use, but also in the kinds of grammatical devices employed.
Thus, despite the common written language in America and Great Britain, the sign

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language used in America (ASL) is quite unrelated to the one used in Great Britain. The two sign languages are mutually incomprehensible. ASL is no more a universal gestural language than is any other individual sign language; nor is ASL either a derivative or a degenerate form of written or spoken English, although it has certainly been affected by its contact with English. ASL developed "naturally" in whatever way languages arise, change, and evolve.

Let us turn now to what might be expected of sign language in light of properties thought to be associated with visual symbols in general. In a provocative article, Roman Jakobson, writing primarily about painting and film, differentiates the structural characteristics of the visual versus the auditory symbol. According to Jakobson, while a complex auditory symbol consists generally of successive serial constituents, a complex visual symbol involves a series of simultaneous constituents. (In later sections of this paper, we shall see that simultaneity is an important characteristic of sign language.) Another essential difference between visual and auditory symbols, according to Jakobson, is that with visual symbols there is a definite tendency to "reify"—to connect the symbols with objects, to ascribe mimesis to them, to view them as elements of an imitative art. On the other hand, Jakobson asserts, verbal and musical (i.e., auditory) symbols are characteristically resolvable into discrete, highly patterned components that do not exist as such in nature but are instead constructed ad hoc.

In his discussion, Jakobson happens to treat that part of visual semiotics which is nonlinguistic. But what is the situation when the sole language learned by an individual in a natural way is indeed visual, as is the case with sign languages learned by the congenitally deaf?

**THE PANTOMIMIC ORIGIN OF SOME SIGNS**

As de Saussure and many of his predecessors pointed out, the lexical items of spoken language are essentially arbitrary. The form of the English word "cat" has no direct relation to the form of a cat; the form of the word "bird" has no relation to any aspect of the representation of a bird; the form of the word "tree" has no relation to the actual appearance of a tree. In American Sign Language, we find, at first glance, that there is a considerable lack of arbitrariness in the form of many signs. Consider the following mimetic relations:

1) The sign CAT† representing the whiskers of a cat;
2) The sign BIRD representing the opening and closing of the beak of a bird; and
3) The sign TREE, using the arm and hand to represent the trunk and branches of a tree.

We must immediately add that few signs are so clearly transparent in their iconicity that a nonsigner can guess their meaning without some additional cues. Usually it is not possible for a nonsigner to guess even the topic of conversation in deaf communication, though, of course, this should be possible in pantomime. Nevertheless, many of the signs in a visual language like ASL appear to be far less arbitrary than the words of a spoken language.

It appears to us that (certainly from the point of view of their history) such signs are indeed motivated in the sense we have been describing: that is, they may well have begun from some sort of representation of objects, some sort of at-

† In this paper, we use an English translation-equivalent gloss to represent a sign. If more than one word is required to translate a single sign, the words are connected with hyphens. The form of the gloss has, of course, nothing to do with the form of the sign.
tempt to act out, mime, imitate an object or action. We find that when new signs are invented on the spur of the moment, particularly new signs for concrete objects with distinctive shapes or typical movements, the iconic associations are often quite pronounced. This suggests that one possible way of analyzing the formational principles of ASL would be to consider the individual sign as an unanalyzable whole, a kind of gestalt-like unit. The obvious and very critical question, however, is not: How do a few novel signs appear to a naive hearing nonsigner? Rather, it is: How do deaf people whose primary native language is ASL process signs?

**HOW ARE SIGNS CODED? EVIDENCE FROM MEMORY EXPERIMENTS**

As one means of approaching this question in an experimental context, we designed a series of short-term memory studies (reported in References 2, 3, and other forthcoming papers). On videotape we presented sequences of commonly known signs to deaf college students whose native language is ASL, and we required immediate, ordered recall. We then analyzed the many errors† our subjects made for clues to the way in which they had coded and processed the signs. We found that intrusion errors did not reflect, as they do for hearing subjects, the sound structure of the English words equivalent to the ASL signs (e.g., “cat” was never misremembered as “cot”). The errors also did not reflect the visual form of the equivalent English words in terms of the letters used to spell them, or their general shape (e.g., “cat” was never misremembered as “oat”). Nor did the errors reflect an essentially semantic organization in the processing and remembering of signs in this experiment (e.g., “cat” was not misremembered as “animal” or “dog”).

Finally, the errors did not reflect, as might reasonably have been expected, the somewhat more iconic or representational character of the basic meaningful units of sign language. Rather, what we found was that a significant number of multiply occurring intrusion errors made by deaf subjects to signs were based on purely formational properties of the signs themselves. Let us consider the errors for the signs cited earlier:

1) The errors for the sign CAT, which seemed to represent the whiskers of a cat,

†An “intrusion error” in our short-term memory experiments is a response that is not an item on the list presented nor on the immediately prior list. Intrusion errors in short-term memory are traditionally used to investigate the nature of the encoding processes. Conrad, Sperling, and others have shown that for hearing subjects verbal items (words or letters) are encoded in phonological form.
did not include "whiskers," "purr," "paws," "meow," "claws," "fur," or any other attributes that might be included iconically in the delineation of a cat along with its whiskers. But more than one deaf person misremembered the sign as INDIAN. The two signs—CAT and INDIAN—are each made with one hand only, each made on the cheek, and each made with the same handshape; in fact, they differ only in the particular movement involved, a brushing movement for CAT and two contact points for INDIAN.

2) The errors for the sign BIRD did not include "beak," "wing," "soar," "chirp," "feeder," or some other representational aspect of the referent. But more than one deaf person misremembered the sign BIRD as NEWSPAPER. The sign for BIRD and the sign for NEWSPAPER are each made with the same handshape and each involves the same movement; they differ only in the place of articulation—BIRD is made on the mouth and NEWSPAPER is made on the palm of the hand.

3) The errors for TREE did not include "trunk," "branch," or "leaf," but NOON was given by several subjects. The signs are similar in all respects except movement.

Indeed, most of the multiply occurring intrusion errors made by deaf subjects were visually similar to the original sign presented on the test, and visually similar in specific and predictable ways. The errors tended to preserve the relationship of the hands of the original sign presented; i.e., if the sign was a one-handed sign, the error was a one-handed sign, etc. But more significant than that, the majority of multiple
errors differed from the sign presented in one aspect only. Our results were thus consistent with a theory that the signs of ASL are actually coded by the deaf in terms of a limited set of formational parameters, such as Hand Configuration, Place of Articulation, Orientation, and Movement.§—parameters that in this context, are essentially arbitrary in terms of meaning.

HOW ARE SIGNS ORGANIZED? EVIDENCE FROM PRODUCTION

There are also certain phenomena of everyday signing behavior (e.g., from production of signs in discourse) that support the results of these experiments, suggesting the functional independence of the parameters of ASL. Especially revealing is one class of spontaneous errors that occur in sign production, the “slips of the hand” that appear when some aspects of an intended message are transposed. (A similar phenomenon in spoken language, slips of the tongue, is discussed by Fromkin.⁹)

If signs were stored as wholistic gestures, one might expect that the only errors would be transpositions of whole signs. Occasionally it does happen that entire signs in an intended message are interchanged. For example, one signer intended to sign TASTE-IT, MAYBE LIKE-IT, meaning “Taste it and maybe you'll like it,” but she actually produced, LIKE-IT, MAYBE TASTE-IT. However, such global transpositions are very rare.

In most of the signing errors we have collected, it is not whole signs, but rather individual formational parameters of signs that are interchanged. The resulting gestures produced are often not actual signs of ASL at all. For example, one deaf person intended to sign SICK and TIRED. She transposed the Hand Configurations of the two signs, producing the first gesture with the Movement, Orientation, and Location of SICK, but with the Hand Configuration of TIRED; and the second gesture

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§We use the term “formational parameters” to refer to those aspects described first by Stokoe⁶,⁷ which make up the individual sign. He described three aspects of a sign: 1) the place where it is made, 2) the distinctive configuration of the hand or hands in making it, and 3) the action of the hand or hands. Later descriptions have added other parameters, such as orientation of the hands.
with the Movement, Orientation, and Location of TIRED, but the Hand Configuration of SICK. This is more or less analogous to "tick and sired" in English, but in the signed slip of the hand, the errors are not actual signs of ASL.

Although the most frequently interchanged aspects of signs are in Hand Configuration, slips of the hand involving Movement, Orientation, and Place of Articulation have also occurred in our data. This evidence further supports the hypothesis that the linguistic parameters posited for ASL are psychologically real for fluent deaf signers.

Let us consider again the more general question: Do signs of ASL have an iconic aspect? Undoubtedly many do, and this may be just what one should expect from primary visual symbols and our tendency to "reify" them. But at the same time, our memory studies and our observations of everyday behavior involving slips of the hand reveal that there is another, perhaps parallel, level of organization. At this other level, even those signs which retain some representational aspects appear to be processed by native signers as being constituted of a limited set of recurring elements that are themselves arbitrary in terms of meaning. The coexistence of the iconic and the arbitrary aspects may seem paradoxical. However, a study of recent historical change in signs may provide some clues to help resolve this paradox.

HISTORICAL CHANGE IN SIGNS: FROM ICONICITY TO ARBITRARINESS

In order to investigate historical change in signs, we have studied films of some elderly deaf signers made in the early part of this century, as well as certain sign language manuals published just after the turn of the century (cf. Long,9). In addition, we have interviewed (on videotape) elderly deaf signers, asking them for their recollections of signs that have changed during the past fifty years or so.

ASL has, in its contemporary form, lost a great deal of its transparency. Over time, signs have become less pantomimic or imitative and have assumed arbitrary shapes. The change is in the direction of more systematic aspects of the language. For example, in a 1913 film, the sign for BODY was made by moving both hands downward in parallel from the shoulders to the hips, outlining the contours of the body, as it were. The sign used today for BODY is made with the two hands in the same Orientation as before, but with two touches: one at the chest, and another above the waist. We note that there are many ASL signs made with two touches in one area, such as HOME, YESTERDAY, WE, QUEEN, BACHELOR. It is our assumption that the older ASL sign for BODY has become modified in a way that makes it like other contemporary ASL signs in terms of Movement.

Another example is the sign for SWEETHEART. According to elderly informants, this sign used to be made over the region of the heart with the two hands coming together at the edge of the little fingers in the shape of a valentine heart. No other ASL sign has this point of contact. The sign for SWEETHEART is now made on the center line of the body with the hands in contact at the knuckles. This is a type of contact occurring in a number of other current ASL signs (GAME, ACCIDENT, etc.)

Frischberg10 notes an historical trend that limits the expression of lexical content to the hands. She has found many examples of signs that used to require a certain facial expression or body movement simultaneous with articulation by the hand. Over the years, the required body movement or facial expression dropped out or transferred to the hands. As a result, these signs are now made with the hands alone.

For example, the old sign for PATIENT was made with the thumb at the lips as the head bowed downward. The bowing movement of the head is now performed by a movement of the hand—the thumb moves downward across the lips while the head
remains stationary. Similarly, the sign THINK originally involved resting an index finger on the forehead and moving the head in a circular motion. The present sign for THINK now involves a circular motion of the index finger near the forehead as the head itself remains still.

We see that historical change in signs gives some clues to what appear to be systematic pressures in ASL. The direction of change is often toward some recurring element or prime that is found in already existing signs of the language. Even those new signs coined on the spur of the moment which have marked iconic associations tend to constrain their iconicity to fit the system, by utilizing a limited set of recurring formational elements.

**Simultaneity in Sign Language**

What, then, is the nature of this set of recurring elements which figure in the internal organization of the individual sign, and how does the sign compare with the word of spoken language? In spoken language, even at the level of the word, the sequential arrangements of elements is paramount, both phonologically and morphologically. For example, "cats," the plural of "cat," consists of four phonological segments in sequence: /k/, /æ/, /t/, and /s/. At another level of analysis there are two morphological units in sequence, "cat" and the plural morpheme, which in this case has the shape "-s." (In some of their possible orderings, these phonological segments also render the English words "stack," "tax," "scat," "cast," "task," "acts," "axed," "sacked," and "asked.") Although simultaneity is also represented in the word—for example, tone and intonation occur at the same time as articulation—it is generally secondary.

But if the organization of the word in spoken language is primarily sequential, the organizational principle of the individual sign in sign language is primarily simultaneous. A sign is characterized by the simultaneous occurrence of: 1) one of a limited set of Hand Configurations, which have 2) a restricted set of Orientations and relations to other parts of the body, involved in 3) specific Movements, made in 4) specific Manners of Articulation, at 5) a restricted set of Places of Articulation.

Even the sorts of modulation of meaning that are often realized within the word of spoken language by affixation—i.e., sequential modification—are characteristically represented within the sign of sign language by some simultaneous change in Movement or in some other parameter. Take the following as an example of the difference between the modulation of meaning in English and in ASL. For instance,
the modulation of the lexical item "blue" to achieve the meaning of "somewhat blue in color" consists, in spoken English, of the sequential addition of the morpheme "-ish" to the item "blue." In American Sign Language the parallel modulation to change BLUE to BLUISH is accomplished by the simultaneous superimposition of a lassness of Hand Configuration and a "suspendedness" in the quality of Movement on the citation form of the sign: BLUE.

But does the simultaneity that characterizes the structure of the individual sign and its regular morphological modifications also permeate higher levels of structure, such as syntax? Since two hands are available for signing, an extreme form of simultaneity is logically possible at the syntactic level; for example, one could sign GIRL with the right hand and, at the same time, EAT with the left hand for "the girl is eating." But in ordinary conversational signing, this type of simultaneity does not usually occur; i.e., the lexically specified subject or object of a predicate is not regularly expressed simultaneously with the sign for the predicate itself. We do find use of a deictic sign like THERE (index finger pointing to a locus in sign space) occurring simultaneously with a lexical sign (e.g., GIRL), but two lexical signs do not ordinarily occur at the same time.

In other words, at the syntactic level sign language has a decidedly segmental aspect: one distinct sign follows another sequentially. But even here, other aspects of sign language syntax, such as those used to specify grammatical relations and pronominal reference, often rely not on the sequential order in which the signs occur in the sentence, but rather on the articulated use of space. The ASL analogue of pronominal reference is accomplished by associating a specific locus in signing space with a noun in the utterance, which will subsequently be referred to by "pointing" to that locus (as, for example, in the deictic sign THERE just mentioned). Similarly, verbs in ASL may actually incorporate these spatial loci in their form to indicate grammatical relations like subject and object. 11

RESTRICTIONS ON THE FORM OF SIGNS: THE USE OF TWO ARTICULATORS

The fact that ASL has at its disposal the two hands but that in everyday signing the two hands are rarely, if ever, used to make two distinct lexical signs simultaneously raises a more general question. What are the effects of having, in the two hands, two distinct and independent articulators, and what are the restrictions on these possibilities? The characteristics of ASL that follow seem to us to be reasonable candidates for exemplifying restrictions on the form or use of a language, restrictions that are directly related to production and perception.

Even in single signs that make use of the two hands, there are restrictions on the independence of the hands. By way of introduction, we note that there are three classes of signs in ASL, characterized by different arrangements of the hands. We have calculated the proportion of each of these classes in a corpus of more than 2,000 signs from the Dictionary of American Sign Language (Stokoe et al.?). About 40% of the signs are made with one hand only. The rest of the signs are made with two hands, but in two different kinds of arrangements. About 35% of ASL signs are made with both hands active, and sharing the same Movement. The other 25% are made with an active hand acting on the other hand, which is used as a base for the sign. It is in the signs made with two hands that restrictions on the independent use of the hands arise.

Consider first, the type of sign which is made with both hands active. 15 There are

15 We note in passing that there are some minimal pairs of signs which differ only in that, say, sign A is made with one hand and sign B is made with both hands; in all other respects, the signs A and B are identical. Such pairs of signs include YELLOW and PLAY; PURPLE and PARTY.
significant restrictions on the form of individual signs of this class: the two hands must have the same Movement. Not only is there required symmetry of Movement, there is also in general a symmetry of Handshape as well. (The two hands may, however, be in different Places of Articulation, as in the signs NOTHING, SICK, or AWFUL.) The restrictions resulting in symmetry of Movement and Handshape in such signs are powerful ones, as is evidenced by certain historical facts. Frishberg\textsuperscript{10} notes that when formerly one-handed signs become two-handed signs, both hands assume the same Movement and Hand Configuration as in the original sign. This is seen in the historical change which ANGRY, HURRY, and DIE have undergone in the past fifty years.

The second type of sign using the two hands involves an active hand operating on a base hand. In this class of signs, the Handshape of the two articulators may be (but need not be) symmetrical. But again we note an historical tendency toward such symmetry. Some signs of this class in which the hands originally had different shapes are now symmetrical in Hand Configuration (e.g., DEPEND, LAST, SHORT, WORLD). Facilitation of articulation certainly suggests itself in such cases.

There are no special restrictions on the Handshape of the active hand in signs involving an active and a base hand. The base hand, however, if not symmetrical in shape to the active hand, is restricted to a small set of six frequently occurring Handshapes, which account for 69% of all the entries in the Dictionary of ASL. In an experimental study of perceptual confusions of Handshapes under varying levels of visual "noise," these base Handshapes were found to be, on the average, more resistant to distortion by visual noise than were the other Handshapes of ASL.\textsuperscript{12}

Thus we see that there are definite restrictions on the form of ASL signs with respect to the independence of the two hands. Whereas there are minimal pairs of ASL signs that differ only in the use of one hand as contrasted with two hands, in no case are there minimal pairs in which the two signs are distinguished only by the particular hand—right versus left—that is active in making the sign.

We can relate this to some informal observations we have made of deaf people in our research group. One young woman is distinctly left-hand dominant (Harris test); she invariably makes signs in citation form using her left hand as dominant or active. She also consistently uses her left hand as dominant in everyday signing. Her performance is in distinct contrast to the other deaf researchers in our group, who are right-hand dominant and use their right hand consistently as the active hand in signing. None of these signers show any tendency to alternate in the use of the hands in nonpoetic, nonnarrative signing. In other words, it makes no difference which hand is used as active in signing; the choice depends on the hand dominance of the individual signer. Of course, there remains the interesting question of whether this observed characteristic of the form of ASL signs represents a universal of sign languages.

**Creativity in a Two-Handed Language**

We have now pointed out some physical possibilities in the production of signs that are not realized in everyday communication, including: 1) making two lexical signs simultaneously; and 2) alternating left and right hands in consecutive signs. Both of these possibilities depend on the existence of two independent articulators—the two hands—in producing sign language. Such possibilities, of course, do not arise in spoken language. In sign language they are allowed by the mode, and yet seem to be restricted in ordinary usage. However, we have found that these very possibilities are, in fact, realized in special self-conscious, preplanned, or rehearsed linguistic activities such as plays on signs and sign-poetry.\textsuperscript{13}

We have made a collection of plays-on-signs by searching through our videotapes of deaf people signing and by noting instances as they occurred in everyday deaf
communication among the members of our research group. Several processes of sign-play have come to light which are special to sign language itself, i.e., special to a visual-gestural language. Among these are the overlapping of two signs by making two signs at the same time or by holding a sign (or part of one) with one hand and making a second distinct sign with the other. As an example, one deaf person wanted to indicate an ambivalence of feeling about leaving for a new situation. He signed EXCITED and DEPRESSED at the same time, making “half” of each sign with either hand. Thus he compressed into one unit the expression of two contradictory—but simultaneously held—emotions.

**Signs Made Simultaneously**

EXCITED/DEPRESSED

Through studies of poetic sign, or “art sign,” created by members of the National Theater of the Deaf, we have been investigating a poetic tradition in sign language that is evolving in our own time. We have discovered several processes characteristic of poetic signing; among them are the overlapping of two signs (just as in sign-plays), and alternation in the use of right and left hands. The latter process results in a balance between the two hands and a more symmetrical use of the space in which the poem is produced.

**Summary**

We have discussed aspects of production and perception in a visually based language, focusing on those properties of language that are due to the mode in which the language arose and on those which seem to be due instead to more general linguistic faculties. We asked specifically: What is the special effect of the visual-gestural mode on the form of sign language?

We described first the roots of sign language in pantomime and showed that signs are clearly less arbitrary than words of spoken language, as might well be expected with visual symbols. We gave evidence, however, that despite their iconic origin, signs are processed, coded, and organized by the deaf in terms of recurring formal parameters, essentially arbitrary with respect to meaning. Furthermore, we showed by studies of historical change in signs how the linguistic system affects the iconic gestures of the language, molding them into an organized, more arbitrary, system. Throughout this discussion, we emphasized the essentially different nature of the organization of a visual language, basically simultaneous rather than sequential. This difference in organization extends even to the modulation of meaning in signs.
Finally, we discussed some physical possibilities in the production of signs that are not realized in everyday communication. We pointed out that in self-conscious preplanned linguistic activities, such as plays on signs and art-sign, these possibilities—special to a language in a visual-gestural mode—are utilized. Our studies support what insightful observers have already noticed about the general differences between the visual and the auditory, and show that these general differences are strikingly evident in the special case of a language that has evolved for the eye instead of for the ear.

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