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6

Future Prospects in Language and Communication for the Congenitally Deaf

GEORGE SPERLING

This chapter deals with four major issues concerning the improvement of the language and communication of congenitally deaf people. First, it is hypothesized that the more language people know, the easier it is for them to learn still more language. Based on this conjecture, it is argued that early acquisition of a manual sign language would enhance later development of other language skills—including those of oral–aural languages such as English. Second, it is hypothesized that the deaf child's language skills would be further aided by early acquisition of a written form of sign language. As there is not yet a written form of sign language (other than notational systems for linguistic analysis, see Liben, Chapter 1, and Bellugi & Klima, Chapter 3, this volume), some criteria for its development are discussed in this chapter. It is suggested here that it would be possible to create an ideal written language combining the good features of an ideographic language (such as Chinese) and of a phonetic language (such as English).

Two additional aspects of communication are considered briefly in this chapter. One concerns the development of a technology that would

provide an interpretable visual or tactual representation of speech. Despite extensive research with visual representations of speech, particularly for speech teaching, a visual representation of speech feasible for normal communication has not yet been developed. (See Nickerson, 1975, for a review of this area.) The last issue concerns developing inexpensive and widely available video communication services that would have particular utility for deaf people.

THE EARLY ACQUISITION OF LANGUAGE

—The more language a person knows, the easier it is to learn still more language.

This conjecture is really a slogan. Although it might be possible to create artificial situations where it fails, it is argued here that in practical situations the conjecture is so likely to be true, and is so important, that it should be taken as an operative principle. What the conjecture means is that there is negligible negative forward transfer in language learning. Whatever language task a person confronts now, and whatever language experiences he may have had in the past, he is better off for having had each of those experiences; conversely, having omitted any one of them would be disadvantageous. This kind of conjecture is also plausible in other domains involving highly practiced skills, such as performing on musical instruments. The more instruments one has learned to play, the easier any new instrument will be to learn. The greatest positive transfer occurs between similar instruments: piano–harpsichord; violin–viola; trumpet–French horn. But there are so many different subordinate skills in musical performance that there is positive transfer even between diverse pairs, especially from the first instrument studied to the second. The same applies to language.

The conjecture applies to forward transfer of skills. Backward transfer is frequently negative, particularly in early stages of learning. Thus, learning to play the viola may impair previously acquired skills on the violin (negative backward transfer) even though the violin skill enormously facilitates learning the viola (positive forward transfer). Knowing Spanish facilitates learning Portuguese or Italian, even though learning the new languages may interfere with retention of Spanish. But in language learning the net effect of new learning generally is positive—it does not produce more task-relevant forgetting than learning—and this is really the main point of the conjecture.

> *There is an* a priori *theoretical basis for expecting that "language knowledge facilitates language learning," namely, the classical and well established observation that associative learning is faster and more enduring per unit of effort than is rote learning. Each language learned after the first can benefit from associations to prior languages, and from the previously acquired concepts and skills.*
>
> *Associative learning and rote learning refer to pure cases—ends of a continuum on which is ordered the number of associations of a new item with items already in memory. In rote learning, associations are formed primarily among the materials being learned; in associative learning these are also formed, but the predominant associations are with material already in memory. We are all familiar with the methods of the stage mnemonicists who retain in their memory an ordered list of items, such as 1-chair, 2-clock, 3-table, 4-bookshelf, etc. and then "instantly" memorize new lists, such as the names of people in the audience, by inventing associations of the new names to the list items. By contrast, "rote learning" would consist of associating each new name only to the previous name. To state it more quantitatively: the greater the number of associations of new material to previously learned material, the easier it is to learn the new material.*

Of course, facilitation is not the only effect in learning. In the laboratory, where we emphasize the learning (often rote) of small, unconnected units of relatively meaningless material, interference effects are often quite large. There is proactive (forward) interference of materials learned-early upon later learning, and retroactive (backward) interference of materials learned-later upon earlier memories. But in natural language learning, the assertion here is that proactive interference is small relative to proactive facilitation.

The associative argument is an argument for the later utility of rich and varied early experience. But there is a unique role played by initial language learning that is more crucial than merely providing associations for later learning. Experience and observation can provide us with many facts about the world, even without language. To build intelligence—that is, intelligent behavior—we need concepts, not merely facts. In modern theories of memory, concepts function as nodes—organizing principles—in the memory structure; but it is not necessary to subscribe to a particular formal theory to appreciate the importance of concepts for new learning.

Some concepts are formed readily and naturally prior to language, such as the concept of "the same person" seen, heard, and touched in

various places. However, language facilitates even this kind of learning by assigning a name to the person. Other concepts, such as weight, volume, and spatial relationships, may, at first, have only minor linguistic components. While the language-deficient deaf child may acquire these elementary concepts as readily as normal-hearing children (Furth, 1966), the child with language—spoken or signed—has an irresistibly useful structure for organizing the facts of experience into concepts. The essence of human intellectual development is not merely the acquisition of elementary concepts, but also the acquisition of increasingly complex conceptual structures in which elementary concepts are used in increasingly complex combinations. Perhaps a child genius without language (or with a private language) could organize the elementary facts of his or her experience into a structure of concepts even more useful than that which the language of the community would have provided. I doubt it. But the competence as an adult in contemporary Western civilization requires substantially more. For the ordinary child, the possibility of ever achieving adult intellectual performance without language is absurdly small.

It is crucial here to distinguish the role of language as an interpersonal communicative medium from its role in organizing thought, even in the absence of interpersonal communications. Language communication may or may not be necessary for normal emotional development; the absence of language would certainly be a handicap. But full human intellectual development is impossible without language. This primacy of language (as opposed to speech) has been argued by some authors (e.g., Lenneberg, 1967; Moores, 1970) and taken for granted by others, but on the whole it simply has not received the weight it deserves in practical decisions regarding what is to be taught and when.

The conclusion we are led to by accepting the first conjecture is that children—all children—should learn as much language as possible, as early as possible, to facilitate their intellectual (and emotional) development. For deaf (and perhaps even for hearing) children, this means learning a manual sign language at about age 1:6. Even if the linguistic concepts of their early (sign) language are not isomorphic to those of their later (oral–aural) language, it will be easier to map the new concepts onto the old than to start from scratch with the new concepts. The communicative power of Ameslan—in terms of information rate and precision of expression—is quite comparable to that of spoken English (Bellugi, 1972; Bellugi & Fischer, 1972), and thus can serve deaf children and adults as adequately as a spoken language serves hearing children and adults.

Given that children have acquired one language, they may not wish to

acquire new ones, no matter how easy the learning process may be. For example, deaf children with a manual sign language may not wish to acquire spoken English, nor for that matter, may French Canadian children desire to learn English. These are important motivational problems. The attempt of the hearing community to prevent a later motivational problem by depriving the deaf child of early language, reminds me of the false mother who would have let King Solomon cleave the disputed child in two so that she would be sure to get her share. The ideal solution, of course, would be to give the deaf child such great language facility that bilingualism (signs and English) does not require overwhelming effort and motivation.

AN IDEAL WRITTEN LANGUAGE

As already noted, it is hypothesized that the deaf child would benefit from the early use of a written form of sign language. This section contains a discussion of what criteria should be used in developing such a written system. In discussing this problem, we consider some of the good and bad features of two classes of written languages: written Chinese or Japanese (Kanji) and written English or German. First, relating this to the previous discussion, some Chinese ideographs and Japanese Kanji are acquired at an earlier age than written English words (Sakamoto & Makita, 1973).

Any early advantage there may be to reading ideographs is quickly lost when schooling begins. In languages such as English or German, once the rules for phonetic or syllabic spelling are acquired—complicated though they may be—the child can bring his reading (and writing) vocabulary to within range of his spoken vocabulary in a relatively short time. On the other hand, Chinese and Japanese children spend a major portion of their education simply learning how to read and write ideographs. The Japanese educational system provides a beautiful example of both kinds of language learning. Children initially are taught to read Hiragana, letters that represent syllables, and then each year a certain number of Hiragana words must be learned as Kanji (e.g., 46 Kanji in first grade, 105 in second, 187, 205, 194, and 144 in successive years of elementary school). In Chinese schools the rate of learning ideographs is much greater, presumably because there is no phonetic or syllabic transcription of Chinese to fall back on (Leong, 1973).

The most interesting feature of a pure ideographic language is that it has no special relation to any particular spoken language. The various dialects of Chinese use the same written language. A literate Chinese

person in Japan who has no knowledge of Japanese can communicate reasonably well by writing (Wang, 1973). Insofar as ideographs represent concepts, they could be pronounced in any language—Japanese, Chinese, or even English. An American could learn to read Chinese without knowing a single word of spoken Chinese. One could imagine a world in which everyone used a universal written or signed language; it would merely be spoken differently in each of the different languages. If there were a universal manual sign language, the same sequence of signs would be translated into spoken English or French by a bilingual speaker of each respective language.

This most interesting feature of ideographic language also reflects its greatest problems. That is, the main trouble with the ideographic languages is that the written form has no relation to the spoken form, and thus it must be learned essentially as a new language. There also are other problems, too, with the Chinese–Japanese ideographs. The amount of effort that is required to master a substantial vocabulary suggests that Kanji are visually confusable. Perhaps this is a consequence of their being difficult to parse. Moreover, the parsing difficulty means it is difficult to order Kanji into a dictionary or to find an unfamiliar Kanji in such a dictionary. (Kanji are listed simply according to the number of strokes used in writing them.) For the same reason, Kanji are difficult to produce by typing or printing processes. There is, as yet, no convenient set of elementary strokes that can be efficiently typed to construct a Kanji in a way that is comparable to typing letters to construct a word. On the other hand, computers can be programmed to construct Kanji (Fujimura & Kagaya, 1972; Nagao, 1972), and the advent of cheap microprocessors may stimulate the development of a Kanjiwriter that would be comparable to a typewriter in cost and size.

The Japanese defend their Kanji transcription system by saying that they can code a given message into Kanji quicker than into a phonetic or syllabic transcription because fewer strokes are used in a Kanji than in writing the one or several words needed to express the same concept in a phonetic transcription. And Japanese bilinguals claim that reading a novel written in Kanji is much faster than reading the same book in a phonetically or syllabically transcribed language.

We should remark that the good features of ideographs do not depend on their being accurate—or even recognizable—pictorial representations of the concepts they represent. Some ideographs were pictorial at an early stage in the development of the language, but the ideographs have long since become stylized and standardized. To help students learn Kanji, stories are invented to explain how various features of a Kanji have been derived from a picture. Similar stories are invented for

manual signs to account for their origin (as noted by Bellugi during the discussions of this study group). This is an excellent illustration of the use of association to facilitate language learning, but most stories have little validity as history.

The advantage of phonetic written language is that the written and the spoken language can be translated from one form to the other by a manageable set of rules. Given familiarity with the rules, a speaker of the language can learn to read and to write in short order. Parsing and ordering are implied because there is only a limited set of symbols and because the order of transcription follows from the order of pronouncing. The written language can be typed, and dictionaries are easy to use because there is at least one unambiguous ordering of the words of the language and even unfamiliar words can be located. Before the age of printing and of dictionaries, the advantages of ideographic languages might have been balanced against these of phonetic languages; since that time, however, the pendulum has swung to phonetic languages.

I assert that it is possible, in principle, to produce a written language that combines the best features of phonetic and ideographic languages, a parsable ideographic language that is superior to either pure kind. Consider, for example, the set of strokes illustrated in Figure 6.1a, which can be combined to produce "ideographs" (6.1b) or "words" (6.1c). The ideographs can be treated as ideographs per se, but in fact rules can be made to guarantee a unique parsing. For example, the rule in Figure 6.1 is to read a character from top to bottom and then from left to right. Thus, these characters can be produced by a typewriter and they can be ordered just as the letter-by-letter word representations of Figure 6.1c can be ordered. Comparison of Figures 6.1b and 6.1c illustrates the enormous perceptual salience of ideographs relative to letter sequences.

The ability of subjects to learn to read texts composed of characters joined either as ideographs (Figure 6.1b) or as letter-by-letter words (as in Figure 6.1c) has been investigated in a restricted context by Brooks (1976). He found that after several hundred practice trials there was a reading advantage of the ideographic over the letter-by-letter word forms. He also studied the effect of parsing and found that the existence of a consistent parsing scheme was advantageous for both forms. This experimental demonstration of the superiority of parsable ideographs is encouraging, but it does not enable us a priori to predict the possible advantages of a cleverly designed set of parsable ideographs for a full vocabulary. Contending systems of orthography must be tested against each other to determine the best one.

Theoretically, the basis of the salience of ideographs can be understood in terms of *feature detectors,* postulated units of visual analysis. Al-
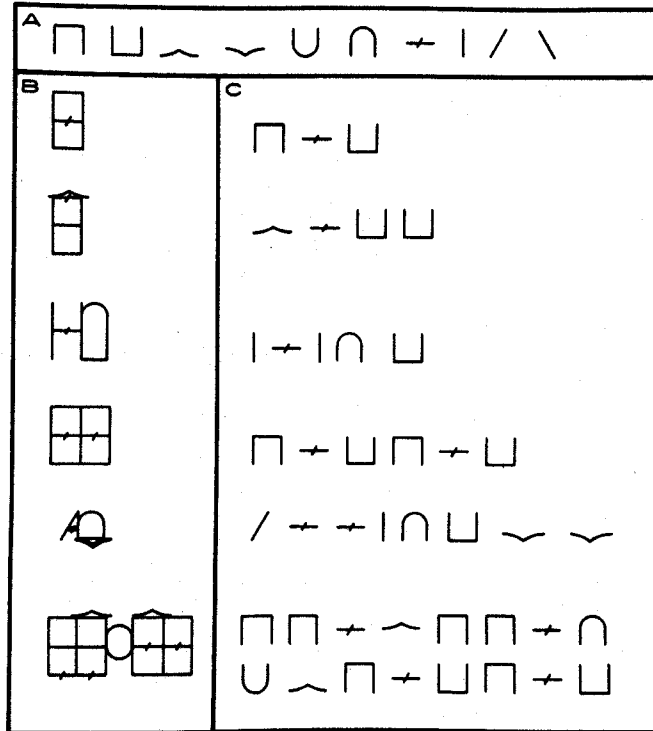
Figure 6.1 (a) An alphabet of 10 characters; (b) Some ideographs produced with the alphabet; (c) Letter-by-letter words. Parsings of the ideographs in (b).

though we do not know what the characteristics of the human sets of feature detectors are, we can think of them heuristically as detectors of straight lines (vertical, horizontal, diagonal, etc.), curved lines, intersections, angles, etc. When strokes are combined ideographically, they excite different classes of feature detectors from those excited by any of the individual parts. Thus, a richer assortment of new detectors is brought into play by arraying the strokes as an ideograph rather than linearly as a letter-by-letter word. The differences between the two alternative representations of words, ideographic and letter-by-letter, are analogous to the differences between decimal (0–9) and binary (0,1) representations of numbers. In most applications, people find binary representations of numbers so difficult to deal with that they translate them into octal or hexadecimal equivalents. The human visual system appears to deal more successfully with collections of many different fea-

tures in one place (ideographs, decimal numbers) than with collections of similar features in different places (letter-by-letter words, binary numbers).

The main advantages of a parsable ideographic language for deaf children are: (a) cleverly-designed ideographs probably can be learned at an earlier age than a wordlike written language; and (b) at a later age, when the parsing scheme is learned, new words can be added at the advantageous rates characteristic of phonetic and syllabic transcriptions.

But what language is to be represented by ideographs? The answer is obvious: a manual sign language such as Ameslan. "Phonetic," wordlike transcriptions of signs have been proposed by Stokoe, Casterline, and Croneberg (1965), but this system is cumbersome and does not have the appeal of ideographs. The goal is to produce a transcription of signs that is at least as descriptive of the signs themselves as, say, written English is descriptive of spoken English. The problem of inventing and obtaining acceptance of a suitable code for the ideographic, parsable transcription of signs is challenging. It simply has not received an amount of attention commensurate with the potential rewards of success.

CROSS-MODALITY TRANSFORMATION RULES AND SUPPLEMENTARY COMMUNICATION DEVICES

Supposing that the transcription problem is solved, and that a good written system related to sign language is developed, what are the consequences for educating the deaf child? We assume that the child is exposed intensively to the signed and the written language. As we have read in this volume, deaf infants apparently acquire manual signs as early as hearing children acquire speech, and perhaps even earlier because the motor control of the hands matures before motor control of the voice. We know we can design ideographs that can be learned earlier than letter-by-letter words so that a child with an ideographic language can have a headstart in reading. If the ideographs can be parsed, and if the parsing rules can be learned, then there is no reason for this reading advantage ever to be lost. With a superior written language, the reading advantage, and thus language development, of deaf children over hearing children, is more likely to grow than to diminish.

From this position of advanced rather than retarded development, the deaf child can hope to succeed in the problems of second and third language learning—that is, in learning to communicate with hearing people in their own vernacular. The normal, literate, hearing person

knows his language in four modes: hearing, speaking, reading, and writing. In phonetic languages, the various modes are connected so that there is basically only one language to be learned, plus three sets of rules. The first two sets of rules are actually skills: the transformations that enable us to go from hearing to speaking (imitation), and the transformations from reading to writing (copying). The third set consists of the phonetic transcription rules to connect the written and spoken forms. Of these three sets of rules, the deaf person has normal access to only one set: the rules connecting reading and writing (copying). The connection between lip reading and speaking is much more tenuous for the deaf person than is the connection between hearing and speaking for the hearing person (not to mention the extraordinary intrinsic difficulty of both of these language forms for the deaf person).

Similarly, phonetic transcription rules are of much less utility for a person who cannot hear speech than for one who can. Thus the deaf person who is attempting to communicate in the vernacular is faced with the task of acquiring, in effect, three new vocabularies instead of just one. The deaf person would certainly benefit from being advanced linguistically in sign language, as the more language he knew the easier it would be to acquire still more, but the difficulty remains formidable. Thus, it is important to consider other systems that could facilitate the communication process.

If a visually or tactually interpretable kind of sound spectrogram of speech could be developed—one of the sort being investigated by Nickerson (e.g., Nickerson & Stevens, 1973; see brief discussion by Liben, Chapter 1 of this volume)—it would go far toward facilitating the acquisition of spoken language by deaf people. A visual representation of speech could function analogously to the auditory information available to hearing people, with the remaining language forms derivable by rules analogous to those used by hearing people. Communicating in the vernacular would require acquisition of just one new language and two sets of rules, one connecting visual representations to speaking, and the other, the phonetic transcriptions connecting visual representations to written forms.

Finally, another mechanism that would be enormously useful for deaf people is the development of low-cost devices for visual communication. Such devices do exist, but currently the cost is prohibitive. For example, the National Technical Institute for the Deaf in Rochester, New York uses a Stromberg–Carlson system for internal video communication. However, when the Bell System offered a similar videotelephone (PIC-TUREPHONE®) service to the central Chicago business community on

a trial basis, there was so little demand that full-scale introduction of such service was indefinitely postponed. The interest in the system was not sufficient to meet the offering cost, which in Chicago was $87.25 a month for a PICTUREPHONE® station with 30 min of video connection time.

At a reasonable price, videomonitors located within individual homes and offices, and videotelephones located in homes and businesses throughout the country, would do much to ameliorate the communication handicap of deafness. Such visual communication would also provide an impetus for further development of manual sign languages. Person-to-person communication by video might require more language redundancy than direct face-to-face communication. But sign language might replace many of the functions that writing serves, and might make other functions more efficient, such as shopping by telephone at stores that offer "sign language spoken here."

In the development of video communication devices, it is notable that basic studies of the bandwidth (channel capacity) requirements for manual–visual communication have not yet been conducted. Comparable studies of spoken language provided useful insights into the nature of spoken language, and there may yet be much of interest to be learned about manual–visual communication from studies of the channel capacity needed to transmit this kind of communication. For example, it may be that by judicious choice of such factors as the number of pictures transmitted per second, the quality of each picture, the arrangement of lights, and the selection of background, that acceptable manual–visual video communication is possible even now with an affordable amount of channel capacity.

SUMMARY AND CONCLUSIONS

Three potential areas for development have been discussed: written language, sound transducers and translators, and video communications. The ratio of psychology to engineering is largest for the first and smallest for the last. The psychological and visual requirements of manual–visual video communication probably will not be difficult to specify; the problems are found in developing the technology to lower costs. The problem of building a sound transducer involves a more delicate balance between the limitations both of perception and of technology. But the problem of language transcription is strictly in the

realm of psychology: All the tools we need are already at hand. And because a written language could fundamentally change the way its users think, I believe a solution to this problem would have the most profound effects on society in general, and on deaf people in particular.

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