A Computer Simulation of American Sign Language

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Stokoe (1960) has designed a model of the structure of the American Sign Language (ASL) which is amenable to computer simulation. He has proposed that signs comprising the ASL lexicon are composed of three basic aspects, location (TAB), hand configuration (DEZ), and movement (SIG). He has identified a finite number of each of these elements, and he has proposed that they may be combined in various ways to constitute recognizable and meaningful signs. Recent reformulations have ventured some modifications (e.g., Stokoe, 1972), but the basic approach remains the same.

Such a conceptualization of ASL implies that if a computer were furnished a set of each of these types of elements, it ought to

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be able to compile the signs that are composed of the features in its repertoire It needs to be emphasized that such a computer simulation is not merely a matter of cartooning, although this lies within the capability of computer graphics to portray.

METHOD

APPARATUS. Our principal apparatus was an Owens-Illinois Digivue Plasma Display Unit attached to a Nova 1220 minicomputer. The Digivue Display Unit is an electronic device with a gas-filled display matrix and activating circuitry. An electrical signal is passed through each of two very fine wires at right angles to one another. When the gas is activated, it lights up at the point of intersection. There are 512 grid lines in each direction, making a total of 262,144 addressable points. Points can be written or erased at the rate of 50,000 dots per second.

The program language used was Graphic Basic, a version of Data General Corporation's time-shared BASIC, modified for use with the Digivue Display Unit (Fulton, 1974). Access to the computer was gained through the Digivue keyboard and through a teletypewriter. Paper tape output from the teletypewriter provided permanent storage of previously written programs.

PROCEDURE. As a concession to storage limitations, the project was, at first, limited to one-handed signs located on or near the face. An oval shape with stylized browline, nose, and mouth was stored in memory and served as the reference for any sign which the computer was required to generate

Hand configurations (DEZ) were constructed by joining coordinate points with line segments. The points were stored in the memory of the computer, and graphic commands were issued to form the line segments.

As a program was fed into the computer, it stored in memory information about the DEZ and the initial TAB while the face was drawn on the screen. Another series of subroutines drew the DEZ in its initial TAB and moved it to another TAB so as to represent a movement (SIG). If the sign required a change of DEZ, the program could call the new DEZ up from memory and place it in the sign's final position.

VALIDATION. The adequacy of the simulated signs rests with their intelligibility. Deaf and hearing persons who were fluent users of ASL were tested to verify that the graphic display yielded signs that could be recognized as part of the ASL lexicon.

RESULTS AND DISCUSSION

Thus far 11 DEZ, 8 TABs, and 7 SIGs have been programmed and stored on a single paper tape. If disc storage and the necessary interface were added to our Nova, it is likely that we could represent all 12 TABs, 19 DEZ, and 24 SIGs identified by Stokoe as primes of his model. Meanwhile, the subset of structural features programmed thus far constitute a suitable feasibility study of a computer simulation of ASL. The following results have been achieved

It has been verified that the features of ASL identified by Stokoe as structural elements may also function as distinctive features. The same DES and SIG executed with different TABs may result in signs with different meanings (*father* and *mother*, *summer* and *dry* in our data). The same TAB and SIG executed with different DEZ may also result in signs with different meanings (*who* and *lipread* in our data). Finally, the same DEZ and TAB with different SIGs may also result in signs with different meanings (*summer* and *wise*, *face* and *who* in our data).

Secondly, if any one of these aspects (TAB, DEZ, or SIG) of a sign is altered, the resulting sign compiled by the computer is likely to be "nonsense" in ASL. In our data, the 11 DEZ, 8 TABs, and 7 SIGs yield potentially 11 x 8 x 7 or 616 signs. Over 600 of them are nonsense. This indicates that most signs in ASL differ from one another in more than one distinctive feature. Also, since many signs change DEZ and involve more than one SIG, there is a low probability of confusing one sign with another, even when the signs are presented out of context.

Finally, our data indicate that the orientation of the hands also constitutes a distinctive feature in ASL. Inappropriate hand orientation can disrupt intelligibility even when the other three aspects are compiled correctly. Stokoe's model seems to be sufficiently robust to assimilate the required revision without altering his basic approach.

This computer simulation of ASL was limited to the structural features of individual signs, and it corresponds to a study of the phonological structure of spoken languages. (Stokoe refers to his analysis as CHEROLOGY after the Greek *cheir* or *hand.*) No attempt was made in this simulation to present the signs in a linguistic context or to represent the structure of AS sentences Future studies are planned in which the graphic display of individual signs will be subject to systematic distortion to discover whether TAB or SIG aspects of signs are perceived categorically by native users of ASL.

REFERENCES

Fulton, D. L. A Plasma-Panel interactive graphic system. *Proceedings of the Society for Information Display* 15(2):74-80, 1974.

Stokoe, W. C., Jr. Sign Language structure: An outline of the visual communication system of the American deaf. *Studies in Linguistics, Occasional Papers 8.* University of Buffalo Press 1960.

Stokoe, W. C. Jr. *Semiotics and human sign languages.* Mouton, The Hague, 1972.