COMPUTER-AIDED LANGUAGE DEVELOPMENT

IN NONSPEAKING

MENTALLY DISTURBED CHILDREN

BY

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COMPUTER SCIENCE DEPARTMENT

School of Humanities and Sciences

STANFORD UNIVERSITY

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Introduction

A majestic absurdity characterizes our classification system in
psychiatry. Since there is such poor agreement among diagnosticians,
the categories of classification are unreliable. And since there is
little correlation between diagnosis, signs and symptoms, the categories
are of doubtful validity. Problems of classification are shunned by
clinicians who confuse classification (forming classes in a collection
of objects) with identification (identifying an object as a member of
a class). Yet a more satisfactory taxonomy is crucial for clinical
practice, and in particular for future research designed to yield
dependable knowledge.

In the studies to be reported here we were faced with the usual
diagnostic confusions found in the classification of mental disorders
among children. Children from psychiatric institutions were referred
to us, Each child had been studied at length and their records contained
the familiar terms "brain-damaged', 'aphasic", 'autistic', 'mentally
retarded', 'schizophrenic*. The most common terms were 'schizophrenic'
and 'autistic', but often these seemed only to stand for 'mentally
disturbed'. Some writers in the field equate autism with childhood
schizophrenia while others insist these are two distinct classes of
disorders (see Rimland, 1964).

Since the field lacks agreed upon ways of defining a diagnostic
class, identifying cases as members of that class and settling on a
name for the class concept, we decided to use everyday descriptive
definitions. A descriptive definition uses commonly accepted meanings of a term.

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Thus a 'nonspeaking' child means one who does not use speech for social communication. We considered the children "mentally disturbed' since there was agreement at this level of description on the part of the referring psychiatric institutions.

We accepted referred children on the basis of a consensually observable property; namely, absent or greatly limited speech,, We wanted to try out a computer-aided method of developing language in a variety of favorable and unfavorable cases in order to learn more about the advantages and limitations of the techniques involved, Thus the work consisted of empirical tests and clinical trials rather than controlled experimentation,

Our interest was primarily in the language dysfunctions of these disturbed children. Our remedial efforts were in the direction of developing and augmenting language functions in nonspeaking children who had been non-participant in, and resistant to, social influence by means of linguistic communication. This computer-aided method was focused directly and solely on language functions, It was not designed as-a method of treatment for mental disorders,, Its intent was to help nonspeaking disturbed children to acquire or augment language in the hope that they might then utilize speech in social communication, The Justification for this pragmatic attempt to develop language rested on a correlation between poor outcome and absence of speech in childhood mental disorders.

Two studies in the literature have indicated that the prognosis for 'autistic' children is correlated with the presence or absence of

speech, Eisenberg and Kanner (1956) report a follow-up of 63 cases,
Of the children possessing speech after age 5, 16 of 32 cases made a
fair to good adjustment. Of the $1 nonspeaking children only one
improved to a state rated as fair adjustment. However , only 3 of these
63 cases received weekly or twice weekly therapy and 2 of these 3 improved,
The remainder received custodial care characteristic of private insti-
tutions and state hospitals, Bettelheim (1967) reports on intensive
psychological treatment of 40 cases, 32 improving and 8 failing. Of
the 8 failures 6 were nonspeaking children but 8 of 14 nonspeaking
cases improved to a level of fair to good adjustment, While it is
difficult to judge whether these two studies have comparable samples
of 'autism' and each study suffers from sampling biases, the outcomes
provide some evidence that absence of speech is correlated with poor
prognosis whether the child receives treatment or not, This opinion
is further corroborated by clinical impressions of experienced practitioners
with whom we have discussed the problem,

There seem to be a number of different ways in which nonspeaking
disturbed children can be helped to acquire speech, No one claims
it- is easy, We have heard anecdotal accounts of speech development
from therapists of children receiving play therapy, speech therapy
and other types of remedial efforts having no formal name, As mentioned
above, Bettelheim's treatment method, which involved much more than
language functions, succeeded in developing speech in 8 of 14 non-
speaking children,

The recent, literature contains reports involving operant conditioning
methods, Using food rewards Lovaas (1766) had some success in producing

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imitative speaking of single words in mute 'schizophrenic' children. Six children acquired a small vocabulary but did not voluntarily engage in propositional conversation.

Hewett (1965), also using operant conditioning methods with a 4-1/2 year-old boy, succeeded in producing a 32-word vocabulary in 6 months and 150 words 8 months later. It remained to be seen at the time of Hewett's report whether the child would use his vocabulary in linguistic communication.

Goodwin', using an Edison Response Environment (a 'talking type-writer'), has had some success in facilitating language in several disturbed children.

Conventional psychotherapeutic and conditioning methods are slow, involve daily sessions lasting many hours and require great human effort on the part of therapists, as well as children. A computer-aided method would be a worthwhile alternative if it could yield equal or better results in a shorter time and with less effort costs to the participants.

Our interest in a computer-based method for developing language in nonspeaking disturbed children derived from several sources. First, we were interested in the general problem of using computers in the problems of psychiatry, as for example through computer simulation of belief systems (Colby, 1967) and man-machine dialogues (Colby and Enea, 1967). Second, the work of Suppes (1966) and Moore (1963) indicates that normal children learn reading, writing, set theory and arithmetic rapidly and enjoyably using computer-controlled keyboards and displays. Third, we were impressed by the observation of many workers

1 Goodwin, M. A. Personal communication.

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regarding %he great preoccupation of some disturbed children with
mechanical. objects which they can manipulate and control. Since
language acquisition in a normal child results from interactions
with people (relations which disturbed children find difficult),
perhaps nonspeaking children of this sort would find a machine such
as a computer-controlled keyboard and display a more acceptable source
for linguistic interaction. Hence we were trying to take advantage
. of a child's faseina%ion wi%h machines by providing him with a speaking
and writing machine to play with. Instead of a person controlling
a child, the child can control this machine? making it talk and
display symbols a% his will.

Language is often described as used for expression and as an
instrument; for social influence, But during normal language acquisi-
tion, it is also used by children as a toy, Our method offered each
child a means of playing with language, Our hunch that children
might enjoy %his activity was further supported by some preliminary
experience with normal children who delighted in the play and whose
speech was greatly excited by it during and after %he sessions, If
a nonspeaking disturbed child could become in%eres%ed in this sort
of play and begin to enjoy developing language as play rather than
work, %he hope was that he would transfer his use of language from a
computer context to other social contexts. If a disturbed child talks,
there is a greater chance of understanding what troubles him and
helping him wi%h it.

Method

Initially we tried using a teletype connected to a Digital
Equipment Corporation PDP-1 in the Zeus time-sharing system at
Stanford.[1,2] Prom comparative experiences with a dozen normal children
we then found a Philco display to be more exciting and dramatic than
a teletype. The symbols and pictures on such a display fill a screen
reminiscent of a television screen. Also the screen allows a child
to point to a letter or picture, to trace symbols with his finger
and to 'feel' the figures appearing before him. All this aids him
in his eventual attempts to draw symbols on his own. We wanted the
method to excite several sensory and motor modalities simultaneously.

The display device consists of an 8 by 10 inch screen and a
keyboard whose keys when struck produce on the screen English letters,
numbers, logical and mathematical symbols, words, phrases and pictures
of objects. The display occupies about half of a 10' by 10' room.
A speaker and two microphones, one for tape recording and monitoring
the sessions and one for recording into the program, are present.
Most of the time a 'sitter' stays in the room with the child during
his play. The sitter tries (it is hard) not to interfere or correct
the child who is mainly left alone to play with the console at his own pace.
Some children can be alone in the room but it is unfeasible for others.

In the early stages we had a sitter present (1) to protect the equipment during aggressive outbursts (2) to be available for any social dialogue a child attempts (3) to repeat the sounds of letters and words made by the computer system and (4) to excite the attention of easily distracted children who lapse into daydreaming or who, if left alone, would sit in a corner of the room. It must be emphasized that it is not a computer alone in the interaction but a man aided by a computer. Each session lasted from 30-40 minutes with frequent breaks depending on the interest span of the child. The frequency of sessions was from 1-3 times per week. Since some of the children came from 150 miles away, they could be seen only once a week.

Normal children who were invited to see the system were told that it was a machine for children to play with. All of them simply started typing and immediately discovered some of its interesting properties. Some disturbed children began this way also while others had to be shown how the system works.

The program is divided into 'games' of varying complexity. The sitter or the child can evoke a particular game by typing certain fixed patterns of symbols.

Game 1:

This is the simplest game and we started all children with it. When a child strikes a key, its represented symbol appears on the screen and a voice from the speaker pronounces an appropriate sound. For example, if the letter A appears, the voice says "A".

The symbol alternates between a large and small representation, The voice is that of an adult man or woman who speaks clearly but not professionally,, At times the recordings are those of children's voices, Because of the time-sharing system, the voice response is slower than ideal for some children but others learn thereby to slow down and to listen, The taped voices can be turned off to allow the sitter to speak the symbols, The idea of this game is to acquaint . the child with letters and numbers in their spoken and written forms. He learns that an action on his part produces a visible and audible response from the machine,

Game 2:

In this game only letters and numbers appear on the screen. Without the child striking a key, a letter or symbol appears on the screen and the voice pronounces it, sometimes along with hints as to where the key might be found, If the child strikes any key other than that of the letter shown nothing happens, I-n 15 seconds the letter is pronounced again,, Another 15 seconds passes if the child does no% match the letter presented and then a new letter appears on the screen wi%h vocal accompaniment, If the child matches the Petter, it is duplicated to the right of the original? pronounced again and a new letter is presented or a picture associated with a letter appears, e.g. a drawing of a bird is associated with the letter "B" . The idea of this matching game is to show the child a correlation between the symbol on the screen and its representation on the keyboard,

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Game 3

When the child strikes a key a small capital letter is displayed
again with the voice accompaniment, and when the next key is struck
that letter appears on the screen to the right of the previous letter.
The third letter appears to the right of the second and so on for five
letters in a row. In this game a child can erase the entire screen by
striking the tab key. A child can fill up the screen with several rows
of symbols. When the space is exhausted, the top row is automatically
erased, the other rows move up and the bottom row is made available
for new characters. The idea of this game is to demonstrate that in
written language characters are put together from left to right. Also
it offers an opportunity to control symbols by making them appear and
disappear.

Game 4:

When the child strikes a key, its letter is displayed with voice
accompaniment, next a blank and then a word appears with an arrow
pointing to the symbol as follows:

$$D \qquad \underset{\uparrow}{DOG}$$

The voice pronounces the word or utters a phrase using the word, e.g.
"D like in DOG". Words and phrases which appeal to a particular child
are included as well as words which appeal to many children, e.g. 'ice
cream'. The intent is to show the child that letters make up words
and that words make up phrases.

Game 5:

When a key is struck, a large symbol or letter appears on the
screen without voice accompaniment. A red light on a microphone goes

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on and stays on for 10 seconds, During this time whatever is said into the microphone is recorded by the computer and when the red light goes off, what is said is immediately played back, The intention of this game is to show the child he can speak to the machine and receive in response his own voice, If one desires, the child's voice can be permanently associated with a character so that in all the games he will hear his own voice when he strikes the key on which his voice was recorded,

Game 6:

In this game words can be constructed on the screen with an arrow pointing to any letter which one wants to emphasize, Words up to 10 characters are permitted, This idea here is to allow the child to practice making favorite letters or part of words which then can be saved as a permanent part of his program,

Game 7:

The sitter or child can type a word which appears on the screen without voice accompaniment, For the sitter, the purpose of the game is to %es% whether or not the child can read, For example,? if the word 'dog' is displayed and the child says 'dog" or 'bow-wow' or indicates in some other way he recognizes the word, we judge he can read,

Game 8:

In the absence of a satisfactory automatic voice-recognizing device? we used a person sitting in another room at a console which controls %he child's screen,, A letter is displayed wi%h voice accompaniment and if the child responds with an utterance, the listener in the other room causes the letter to be duplicated on the child's screen,,

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Initially any utterance is accepted by the Listener, Over time the child must improve his approximation to the taped voice in order to make the second symbol appear on the screen. The intent of this game is to appeal. to a child's interest in verbal magic by showing him that his speech can cause things to happen on the screen. Speech can control objects in the world.

Game 9:

Pictures of animals, birds and objects of interest to a child can be made to appear on the screen (a) by striking certain keys (b) by saying the word for the picture desired. The sitter points out features of the picture to the child, e.g. wings on the bird, to increase the child's vocabulary. Also sentences are associated with the pictures so that a child can imitate phrases as well as single words, e.g. 'birds fly', 'mice eat cheese'. Children who avoid the pronoun 'I' can be started using it by the sitter pointing to the eye of a pictured animal and pronouncing the homonym 'eye'.

Game 10:

A drawing of a small star appears on the screen, A child can move it around using a light pen or by verbal command, In the latter case, a listener in the adjoining room moves the star with a light pen, Initially simple commands are used by the sitter as illustrations, 'up', 'down', and "around" , 'dance back and forth', etc. Again the intent is to show a child that objects can be controlled by speech and to encourage verbalization, first of words and then of phrases.

Game 11:

A phrase or sentence is associated with each key. When the key is struck, the voice utters the associated phrase or sentence. Once a child has become accustomed to some of the expressions, words are omitted from them. For example, the initial expression is "We all scream for ice cream". Later the voice says "We all scream for ___ " and the child is expected to fill in the missing words. Making the correct completions offers a challenge to the child.

There are several additional techniques used in this method. We encourage the mothers, foster mothers, counselors, etc. of the children to expose them daily to TV, especially to Captain Kangaroo and cartoons. Television provides a rich linguistic environment correlated with visual experience. Many of the initial words used in the program came from TV commercials and cartoons.

To facilitate transfer of learning, we encourage those looking after the children to point out words and letters appearing in the environment, e.g. on vehicles and on signs. Reading his favorite stories to a child is also promoted. In addition we suggest the children spend a few minutes each day drawing one or two letters with a felt pen on a large pad, allowing an unlimited amount of paper. Play with typewriters, taper&orders, and talking toys is also recommended. All of these ancillary techniques are intended to excite a child's interest in language as something which can be played with and controlled.

During the year 1967 we worked with a total of 10 children,
A% the time of writing this report (December 1967) we are continuing
to work with some of them as well as with new eases,   Each case will
be briefly described to indicate the sorts of events which took place,
The children will be identified by a code initial. If a child spoke
more than when he started, be was rated improved. If no increase in
speech occurred, he was rated as unimproved.

Case 1:

L. was a 7year-old boy who bad spoken a few brand names and
unclearly pronounced words between ages 3-4 but then became silent.
He spent hours playing with toy trains and his only spoken utterance
consisted of ' ch-ch ', apparently referring to train sounds.

In session 1 he immediately began typing, pointed to the symbols
appearing on the screen and uttered a high pitched "ee" sound. He kept
a yo-yo in his left 'hand, After 25 minutes he made an "0" sound in
imitation of the machine, His interest continued hi gh until the session
ended, (We have found this to be a good prognostic sign; namely that
if a child takes to the machine promptly and has to be interrupted
after 30-40 minutes, then his progress will, be rapid,)

L. pronounced his first word "arrow" in 'response to the machine in
session 2. In session 3 he put down his familiar left-hand object and
typed with both bands, He began to practice other words silently, first

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making mouth movements several times and then uttering the word. He
abandoned his gaze-aversion posture and looked at the sitter when
pointing to a letter or saying it, His pronunciation was slurred.

By session 7 his "ee" whine disappeared and he was offering words
freely. His housemother reported he called her by name for the first
time. He became more assertive with other children and even aggressive
which was in marked contrast to his previous passive avoidant behavior.
(We have noticed this increase in aggressive behavior with increase
in speech acquisition in several children, see Cases 3,6,9.)

In sessions 12-16 he showed signs of learning transfer, pointing
to letters on books, posters and signs and pronouncing them. He also
began uttering imitated sentences, e.g. "I like it". The driver who
brought him to our laboratory reported he practiced a lot both on the
way and on the return trip, naming objects in the countryside,

Since his pronunciation was so poor a dysarthria was initially
suspected. Tests now revealed no dysarthria and as his vocabulary
increased his pronunciation improved. For session 24 his parents
brought him to the laboratory. He cried, screamed and would have
nothing to do with the machine or the sitter. (We noticed this adverse
effect of the presence of parents with other children.) In the next
session, without 'his parents there, he was his jolly, laughing self.

In sessions 26-32 he began testing the limits of the sitter playing
hard to catch, ignoring the console as if he now knew what it was for.
He volunteered names of objects in the room to the sitter. We felt
now was the time for teachers to take over his language development
and we discontinued our work with him,, He had 32 sessions, about

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16 hours over a period of 4 months. His linguistic development was rated as improved.

Case 2:

N. was a 9 year-old 'schizophrenic' boy who had rarely been heard to speak intelligibly. He was very frightened in the first two sessions but by session 3 he began to play with the machine. He held his hands over his ears whenever the voice spoke. He hummed, gazed at the ceiling and often smiled to himself.

By session 5 he began to vocalize but no clear words appeared. He laughed a lot at the symbols on the screen. His first imitated word was "slash" in session 7. When the computer system broke down and there were several people in the room he used, he refused to enter the room.

In sessions 10-15 he uttered several imitated words and pronounced many of the letters. He continued to laugh and chuckle at some secret joke. Often he attempted to disguise his pronunciation of a letter which previously we had heard him say clearly. In session 12 he said "I don't want to" showing both his reluctance and an ability to speak sentences. We felt he was able to talk but refused to and enjoyed the struggle to get him to. After session 18 his visits to our laboratory were discontinued due to an administrative decision on the part of the referring psychiatric institution.

He had 18 sessions, 9 hours, over a period of 2 months. He was rated improved.

Case 3:

B. was an 11 year-old boy who had been heard to utter 15-20 words during his life. His first exposure was to a teletype which he avoided but which interested him. When introduced to the Philco display he refused to enter the room. But later in this session, when no one was in the room, he entered and struck a few keys. In the first sessions he glared at us angrily and replied with a scream or hand gesture when spoken to.

After 4 sessions in which he would not enter the room we decided, after consulting with his housemother, to force him in. At first he screeched loudly, pushed the keys but refused to look at the screen. In sessions 5-7 he had to be forced into the room but from then on entered voluntarily. He screeched piercingly and did not imitate the machine% voice. From session 8 on he continued screeching but began to utter a variety of new sounds, some of which were disguises of the letters on the screen. In session 10, B. put his hand over his mouth to keep himself from talking. When he pronounced a word he looked frightened. Although he said little in our laboratory, he began to say a few words at the home in which he lived. In sessions 11-15 he struggled to hold back saying words. His housemother reported he was becoming more alert and interested in events around him.

By session 16 he showed he knew most of the letters. Each session he screeched his objection to participating in the procedure. He resisted it but was interested in it. He became more aggressive in his everyday behavior. In session 18 he said "Hi" to the sitter and replied "I know" when he was shown '2+2=4' on the screen.

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In sessions 24-26 he showed slow changes, When he spoke a word
or phrase, it was pronounced clearly, He was reported as speaking
much more at home than at the laboratory, He seemed bored, angry
and holding out against us. His gestures became more appropriate;
e.g. waving bye-bye instead of using bizarre hand movements,

At the time of writing (December 1967) he has had 26 sessions,
about 10 hours over 7 months, His language development was rated
as improved,

Case 4:

N. was a 12 year-old severely disturbed girl who had never been
heard to utter a word except "no". She screamed often, had frequent
tantrums and feared many situations,

In the first session she screamed most of the time, Her attention
to the console lasted only a few minutes before she ran out of the room,
She showed some interest in the machine and struck a few keys, From
sessions 2 on we allowed her to enter and leave the room whenever she
wished, She learned to strike those keys which did not produce anything
on the screen. Her main activity while with us consisted of pulling
apart eucalyptus leaves and smelling them. (They have a strong, heady,
camphor-like odor,) She showed no speech imitations at all and often
fell to the floor kicking, screaming and arching her back.

N.'s characteristic sound was that of heavy breathing, In session 6
these pants at times sounded like a syllable "whoosh". She spent 5 minutes
in the room one time and 25 minutes the next time. In session 8 she
quietly pushed the keys and watched the screen attentively. She would

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also look at the sitter reflectively as if about to say something but only a scream or a "whoosh" sound came out. If left alone, she would sit in a corner of the room sniffing leaves and ignoring the machine,

She seemed to have language comprehension, at Least for simple commands . Her counselors believed her to be hopeless both psychiatrically and linguistically,,

From sessions 9-14 there was no change,   In session 15 she uttered a few syllables "chuh" and "puh".   In session 17 she uttered the sound "pretz" in imitation of the machine saying "pretzel" (one of her favorite foods),,   In session 19 she said "tutu" (for "turtle") both in response to a picture of a turtle on the screen and when asked by us to say the word,   She screamed less and her huff-puff sounds became more extended into syllabic forms,   Her progress was extremely slow compared to the other children

In session 27 she said "tu"and"I" but looked very frightened after making these utterances,   She made a "sh" sound which we interpreted as a command to herself not to speak,   At this point we rated her as unimproved after 27 sessions,, about 8-10 hours, over a period of 6 months, We are continuing to work with her in the hope some linguistic improvement will occur,

Case 5:

S. is a 6 year-old boy whose parents were both psychotic. He made sounds and occasionally uttered words such as "dog" and "car".

He was very curious about the machine and became fascinated in the first session, making a cluckingsoundin response to the voice,   In the second session he began imitating the "I" sound, From session 3

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he asked a question of the sitter, "Play with this?" and pointed to the light pen, He began to point out letters en autos to other people saying "T", "P", etc.

In session 8 he imitated the characteristic screeches and cries of two of the other children, He continued to imitate the machine and enjoyed the play greatly. By session 13 he knew all the letters and could play Game 2, the matching game, easily, He learned to read and type words and 'began to draw letters and words on a pad, In session 16 he brought a toy train. Since he was interested in trains and cars the words in his program referred to the parts and functions of these machines, He became much happier, smiled a 10% and greeted people, He decorated his room with drawings of trains, cars, words and letters,

After session 20 his first propositional speech began, He addressed sentences to his counselors, some imitating the machine and some self-constructed, Some of his pronunciations were unclear; e.g., "pish" for "fish".

He has had 28 sessions, about 14 hours, over 6 months, He was rated as improved, We plan to continue a while longer but he is close to the point where people can take over his language development.

Case 6:

M. was a 12 year-old boy who had no speech but could understand language. He made many peculiar hand and head motions. He continuously jiggled a small object in one hand.

In session 1 he said nothing. In session 2 he made a "Go" sound in imitation of the machine, In session 3 he repeated a few of the letters in disguised form, To prevent himself from speaking he would

curl his tongue around in the bottom of his mouth. He made his first verbal social communication to his counselor, saying "Ga". At the machine his attention would drift off with an increased rate of jiggling until the sitter brought him back to the screen by tapping it and repeating the voice sounds. Previously a very isolated child, his social communication by sounds increased., He learned to swim, something 'he refused to participate in previously,

In session 6 he tried multi-syllable sounds "Ga-ga-ga-ga" in response to the machines "twinkle, twinkle little star". His first recognized word was "cookie" in session 9. He became much more aggressive and assertive with both adults and children, In session 10 he was very upset for unknown reasons, crying and refusing to play with the console, In the next session he was happy again, He enjoyed physical play with the sitter, slapping and poking him tentatively. At this point his language behavior did not progress much but his general behavior in the sessions changed greatly, The school teacher who worked with him reported that of all the children M. had changed the most dramatically in his everyday behavior,

By session 15 he still spent much of his time laughing and playing with the sitter, testing his limits to see how much of not playing with the machine he could get away with. He correctly imitated the syllables in "kangaroo"., He laughed at some of the absurdities we included in his program, e.g. when he struck the call key, the machine replied, "hello, M.". In session 17 he said "0", "9", and "E" repeatedly, He curled his tongue whenever he wanted to stop. In session 18 he began to pay close attention to what happened on the screen,

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He had 18 sessions, 7-8 hours, over 5 months, He was rated as
improved and we are continuing to work with him,

Case 7:

P. was a 12 year-old very docile, sloth-like nonspeaking boy,
He understood language and at times volunteered a mispronounced word,

In session 1 he slowly and methodically tried each key on the
keyboard, making a verbal response to a few of them,,   To command the
star in session 2 he said "Go light" instead of "Go right".   He enjoyed
the play and smiled a bit at some of the machine's absurd responses,

In session 3 he was less zombie-like. He imitated some of the
letters, even saying them before the voice accompaniment of the machine,
In session 6 he began to imitate sentences, He laughed freely, spoke
the sitter's name and showed he knew all the letters.

In session 7 he was much more alive. He concentrated on the games,
He mentioned the sitters name frequently when away from the laboratory,

At this point his parents decided to withdraw him from the insti-
tution in which he was living and to keep him at home.,   We wrote the
parents about our work with him, stating our interest in helping him
with his language problems, The parents did not reply,

He had 7 sessions, about 3 hours, over 2 months.   He was rated
as improved.

case 8:

C. was a 9 year-old boy who made unintelligible sounds,, He was
wild, impulsive, impatient and short-tempered,

In the first session he took to %he machine immediately, He laughed

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but did not speak, In session 2 he particularly enjoyed Game 3 in

which he could erase'-out symbols, He said something close to "era-out"

in imitation of the sitter. He was easily frustrated. It was hard

for him to slow down striking the keys in order to hear the machine's

voice. He had violent tantrums when one of the other children teased

him,,

In session 4 he was extremely upset by his mother's presence in

the laboratory, Any prohibition threw him into a tantrum of screaming,

In session 5 he was calmer and only pouted when the machine would

not do his bidding. When shown the star he sang the first few bars of

"Silent Night". He showed he already knew many of the letters and

words, His house mother reported that he spoke in repeated stereotyped

sounds,

In sessions 6-9 he began to speak words with a highly garbled pro-

nunciation, He became interested in drawing letters and would print

a word if the sitter told him each letter. In session 10 he spoke

many words and sentences both imitating the machine and volunteering.

His house mother reported he had "come alive" in these two months.

In session 13 he learned to type and speak the numbers above 9. His

pronunciation began to clear and others began to understand what he

was asking for when he made a request. Being able now to communicate

his wishes, which others could do something about, he found himself

less often frustrated and thus less given to tantrums. This change

in his impatient short temperedness was striking to all who knew him,

By session 14 he was talking freely and volunteering sentences to

a variety of people, He conversed with the machine as if it could

understand him, His house mother reported he surprised hes with
new sentences every day,

He had 17 sessions, 8 hours, over 4 months. He was rated as
improved and we are continuing to work with him.

Case 9:

E. was a six year-old boy who had a vocabulary of many words but
who did not use them appropriately. He d-id not imitate or volunteer
sentences,

Although he enjoyed the machine in the first session,, he Post
interest after 15 minutes. In session 2 he repeated several letters
after the voice with correct pronunciation. He approached various
people saying "'bulb, bulb" apparently meaning he wanted a light bulb
(a toy his mother forbade him) to play with. His speech was very
robot-like, without inflection.

In sessions 3-4 he began to resist playing with the machine,
preferring to show interest in other objects in the booth, We felt
he knew what our purposes were regarding his speech and he busied
himself in thwarting them, He exclaimed "Daddy!" in response to a
picture of a large upright duck.

But in session 6, although he still had short attention, he began
to try crude sentences in imitation of the machine. One of our problems
was getting his mother to let him watch television. E. was in a power
struggle with his mother, withholding feces being his major weapon,

En session 7 he imitated both machine and sitter well. If asked
a letter he did not know, he would reel off a list of words he did
know, "Mommy, Doctor, purple grape, bulb". He recognized and spoke

the letter "A" before the machine's voice pronounced it.

His mother reported his vocabulary was expanding rapidly. He watched Captain Kangaroo daily on television, laughing, humming and talking in response to it. In session 10 he attempted an approximation of the 6 word sentence "The cow jumped over the moon." This was in contrast to his offering only one word at a time at home.

After session PO his mother reported he was trying 2-3 word sentences at home. In sessions 11-14 he continued to try longer sentences, having many pronunciation problems and dropping some of the words. In session 15 the sitter easily taught him to sing the first line of "Jingle Bells". After session 16 he said to his father at home "You know the cow jumped over the moon."

In session 18 he showed a confusion understandable in this context, i.e. he would repeat a question rather than answer it. We could not tell whether he actually had a poor memory or whether he was electively disguising his memory abilities.

He became more aggressive with adults and children. His mother reported he volunteered multi-word sentences. In session 21 he uttered a few, sentences to the sitter.

At this point his mother enrolled him in a school for the educationally handicapped. It was too difficult to schedule him both for school and for our laboratory so we discontinued. He was rated as improved.

Case 10:

D, was a 3 year-old boy who had never uttered a word. He made humming sounds and comfort-discomfort cries. He never babbled as a baby and did not appear to have any language comprehension. He was considered

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to be aphasic and/or autistic,

In session 1 he played with the keys but did not look at the screen and made no sounds, In the second session he became interested in the screen and traced letters with his finger, In session 4 he said "nine" twice in imitation of the machine, But from sessions 5-21 he uttered no further words,, He cried a great deal in objectionto being forced to stay in the room and play with the machine, At home learned to respond . to the word "kiss" but showed no other indication of understanding the simplest commands or references,

D. was an extremely hyperactive and negativisitic child, He had to be watched every minute or he would run away. His mother reported he seemed eager to come to the sessions but once there he became very resistant to influence, We increased his sessions to three times a week with little effect, At times he did seem tounderstand words but simply shut them out. Apart from crying in protest, his only sounds were a rare "mm-m". He refused to put anything in his mouth, His mother reported he would neither blow nor suck, At home he began to make a greater variety of sounds but none were used for communication, Slowly he began to show signs of some language comprehension, fetching objects on command and responding to "Where's Daddy?" by running to the window to see his homecoming father, In the sessions he made sotto voce sounds to himself,, At times he would listen to the machine voice and watch the screen. In session 34 he enjoyed playing with the red-light micropohone but said nothing, He was the slowest in responding of all the children in this group.

In the sessions he would wave bye-bye when the voice said "bye-bye". He also learned to clap hands when the voice said "H is for clap hands," At home he was very difficult to manage and began to wear his parents down, His father suffered a coronary attack and his mother began seeing a psychiatrist who put D. on a tranquilizer to control his hyperactivity. By session 44 his mother reported his comprehension vocabulary was increasing slowly since he responded appropriately to "coat", "shoe",, etc.

At the time of writing this report he had 44 sessions, about 20 hours, over a period of 6 months, He was rated as unimproved, We are continuing to work with him in twice-a-week sessions,

Results

With this sort of heterogeneous sample it is unjustified to construct an ordinal or even partially ordered measurement scale along which the children can reliably be compared with one another. We rated each child as improved or unimproved relative to his own starting point. As mentioned, if a child's speech increased he was rated improved. If it did not, he was rated unimproved.

In a group of 10 nonspeaking disturbed children, 8 improved in their language development while 2 did not. Three reached the level of propositional speech. This improvement rate of 80% is encouraging, particularly since it was achieved in such a short period of time and with such little effort compared with other methods of developing language.

Discussion

Language acquisition in normal children is believed to occur as
species-specific behavior in humans according to a rough maturational
and developmental timetable (Lenneberg, 1966). If a child does not
develop speech by 36 months, the disorder is serious and a search for
the trouble **begins.**

Deafness, organic brain disease and mental retardation are the
first conditions to be considered. Developmental aphasia or apraxia
and a mental disorder, either singularly or in combination with the
above conditions, are further possibilities. While the neurophysio-
logical mechanisms for speech are unknown, aphasias and apraxias are
considered to represent physical inabilities. Absent or limited speech
on the basis of a mental disorder is currently considered to be volun-
tary and elective. It is often difficult to determine whether a given
child has the physical ability to speak when no one has ever heard
him speak. One aid in making this determination is a voice-activated
tape-recorder which can be used to record the child's sleep-speech,
if any.

Some of our nonspeaking children were able to comprehend language
and to speak a few words intelligibly. Rut for reasons which are not
well understood by anyone, they did not speak at all or offered idio-
syncratic expressions in particular contexts. All the children we
worked with showed periods of great resistance and negativism towards
our efforts. **At** one time they would be greatly interested in the
games and at another time they would balk at all attempts to get them

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to play with the machine.

Normal children do not have to be taught to speak by any special methods. They build up language functions through an ability to combine linguistic data provided by the environment with cognitive-affective capacities. All but one of our children seemed to possess this ability but resisted using it. Why they chose to be silent remained mysterious. We assumed each child had some purpose for his silence. Our task was trying to help the child to speak without knowing specifically what his concepts and beliefs were about nonspeaking. Nor did we know explicitly why he would so strongly resist efforts to budge his position. We assumed he felt threatened in some way and that he was obeying a self-generated, and perhaps linguistically formulated, imperative not to speak. Lacking further information, we could not infer much beyond these rough assumptions.

We often found it difficult to estimate how much language comprehension and speaking ability a given child had. A variety of observers would offer us information about words or sentences they had heard from the child and recall instances of comprehension. All the children made some sounds. Some would imitate single words or phrases and some would at times volunteer an unintelligible utterance. When a child volunteers a single word, the proposition involved can be obscure to an observer. For example, when looking at the rain, a child may say 'wet'. What proposition does he have in mind — 'the rain is wet', 'I like it wet', 'water is wet'? As with a normal child, someone who knows him well can often guess the proposition being referred to by a single word. Our goal was to move from sounds to words to sentences, at first imi-

tated and then volunteered. It is when a child voluntarily participates in propositional speech, sharing his ideas with others, that linguistic communication can be considered within the normal limits.

Some of our children achieved this goal of volunteered propositional speech. Others improved from single-word utterances to sentences. Some of the children changed their personal-social as well as linguistic be-havior during the period of treatment. Can these effects be attributed to the application of this method? It would seem a reasonable hypothesis to believe so but the data from this sample cannot exclude plausible alternative hypotheses. All of our children were receiving concomitantly a variety of treatments. How should the credit be distributed? To ans-wer questions regarding the effectiveness of this computer-based method one would need a controlled experimental design with comparable homo-geneous samples of children. Cur purpose in reporting this work is simply to describe what we have done and what happened. We believe the results thus far are sufficiently promising to justify further studies in this direction.

Using uncontrolled data from heterogeneous sample it is futile to attempt to develop a reliable explanatory theory. It is a fact of our empirical observation that there is something about the experience of playing with this computer-controlled systems which excites and inter-ests both normal and disturbed children. If there exist some built-in mechanisms which resonate to linguistic output, then this method might be assumed to excite them. We speculated about essential variables but did not attempt anything which might be called theory. And from a practical viewpoint, we recognize we have not yet found the most power-

ful techniques of which the method is capable. Further intuitive inventiveness is required.

Nonspeaking disturbed children reject using linguistic communication. Attempts to change them might be perceived by the children as threatening. Hence the question of regressive effects must be considered. Faced with the loss of a cherished coping mechanism (if that be the case), a child might regress further and attempt some other means of withdrawing. Although we were alert to the possibility of some children becoming more disturbed, it did not occur in this group.

Finally, the question of using computers for this purpose should be discussed briefly. Many of the techniques in the method described above could be carried out without a computer. We have encouraged a number of workers in the field who do not have access to a computer to try these techniques using typewriters, slide projectors, language toys, and other devices which are simple and inexpensive to buy or construct. The main advantage of a computer-controlled system is its great consistency and imperturbability. It can be viewed as a catalytic agent which enters into an interaction and accelerates a process without being changed itself. Disturbed children do not resist learning: they resist being taught by people. One trouble with human therapists and teachers is that, being human, they tend to become tired, bored, angry and inconsistent in their approach. They vary in their interactions with children and become thereby changed themselves, often with negative effects. Disturbed nonspeaking children need a stable, consistent, patient, and tireless agent for language development. For this a computer is ideal.

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Future Prospects

There are a number of ways in which this computer-aided method could be improved. We hope other workers will be encouraged by our results to do so.

Regarding computer hardware, there is no need to use a large time-shared machine. In fact a time-shared situation, with a large number of users, tends to slow down the response time. A better system would involve a small computer with a few terminals which are devoted entirely to language development problems. Psychiatric centers and speech pathology institutes should have their own special-purpose computer hardware. Dozens of children a day could be run on such a system. The system could be used not only for language problems in children but also for adult aphasias.

A great variety of programs could be written for a flexible special-purpose system. For example, the symbols and drawings appearing on the screen can be animated. Motion is an important part of the concept of many verbs. Also computer-controlled toys are possible in which the behavior of the toys can be controlled by typed or spoken commands.

Finally, little experimental work has been done in investigating childhood mental disorders from an information processing standpoint. Many believe that 'autistic' children suffer from some specific cognitive or affective deficiencies. However, these ideas have not been explored sufficiently. A variety of tests and experiments could be introduced while a child is playing with a computer-based system able to control symbols and objects. Cognitive and affective processes of children

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who reject being tested by people but accept a computer-based situation would become accessible for systematic study.

Summary

Experience with a computer-based method for aiding language development in nonspeaking mentally disturbed children has been described.   Out of a group of 10 children 8 improved linguistically while 2 were unimproved.   Problems connected with the method and its future prospects were briefly discussed.

References

(1) Bettelheim, B. *The Empty Fortress,* The Free Press, New York (1967).

(2) Colby, K. M.   Computer simulation of change in personal belief
        systems. *Behavioral Science*, 12, 248-253, (1967).

(3) Colby, K. M. and Enea, H. Heuristic methods for computer under-
        standing of natural language in context-restricted on-line
        dialogues. *Mathematical Biosciences*, 1, 1-25 (1967).

(4) Eisenberg, L. and Kanner, L.   Early infantile autism, 1943-1955.
        American Journal of Orthopsychiatry, 26, 556-566, $1956).

(5) Hewett, F. M.   Teaching speech to an autistic child through operant
        conditioning. *American Journal of Orthopsychiatry*, 35,
        927-936, (1965).

(6) Lenneberg, E. H.   The natural history of language. pp. 219-252.
        In *The Genesis of Language*, Smith, F. and Miller, G.A. (Eds.),
        M.I.T. Press, Cambridge, Massachusetts (1966).

(7) Lovaas, 0. I.   Some studies on the treatment of childhood schizo-
        phrenia. Paper presented at Third Psychotherapy Research
        Conference, Chicago, (1966).

(8) Moore, 0. K. Autotelic responsive environments and exceptional
        children. Report published by Responsive Environments Founda-
        tion, 1-53, (1963).

(9) Rimland, B. *Infantile Autism*, Appleton-Century-Crofts, New York,
        (1964).

(10) Suppes, P. The uses of computers in education. *Scientific Ameri-
        can,* 215, 206-220, (1966).