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ARTIFICIAL LANGUAGE TRAINING IN GLOBAL APHASICS*

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Abstract—Natural language assessment and artificial language training were undertaken in seven globally aphasic patients sustaining left hemisphere damage. Initial assessment of natural language showed some semantic knowledge but no syntactic or grammatical ability. Words were distinguished from nonwords and words were spelled in the absence of semantic comprehension. These results are consistent with a prelinguistic coding of verbal stimuli as visual gnostic units.

Despite gross deficits in natural language, these patients were able to learn an artificial language system using cut-out paper symbols for words. Various levels of competence were attained ranging from the expression of relations between objects (same–different) to simple statements of action (subject–predicate–direct object). Other tests of conceptual–cognitive capacity revealed potential for abstraction and conceptual thought. It is proposed that despite massive language loss, globally aphasic patients retain a rich conceptual system and at least some capacity for symbolization and primitive linguistic functions.

INTRODUCTION

LANGUAGE and speech processes are impaired in patients sustaining lesions to the dominant usually left hemisphere. Massive damage may render the individual globally aphasic, depriving him of all functional language. The potential capacity for linguistic operations of the remaining cortex remains largely unknown. Recent studies on split-brain patients, however, have revealed that the right hemisphere may have greater linguistic capacity than has previously been assumed [1]. The right disconnected hemisphere in these patients has some semantic, though apparently no syntactic knowledge.

Damage to language processes causing aphasia may leave prelinguistic cognitive functions intact. The capacity for abstraction on nonverbal tests has sometimes been found to be no more impaired in aphasics than in other brain damaged patients [2, 3, 4]. The present research examines the conceptual functions and capacity for symbolization in global aphasics. The extent of left hemisphere damage in these patients permits us to observe both the breakdown in natural language and the nature and extent of the remaining conceptual system.

During the initial phase of this study, a pre-experimental assessment of natural language and perceptual cognitive capacity was carried out. The language tests are concerned with both semantic and syntactic knowledge as well as basic perceptual "judgements" involved in word–nonword recognition. Testing these lower limits of language related processes has been largely neglected in existing tests of aphasia. The experimental phase of the study is

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concerned with the capacity of the global aphasic to learn an artificial language system based on a system originally developed for the chimpanzee [5].

Case material

Seven brain damaged patients from the Institute for Rehabilitation Medicine, New York University Medical Center were studied over the course of a year. All the patients were right handed and suffered from right hemiplegia and global aphasia subsequent to a cardiovascular accident. The diagnosis of global aphasia was made by the Department of Speech Pathology on the basis of scores on an interview, the Functional Communication Profile [6], and the Neurosensory Center Comprehensive Examination for Aphasia [7]. All patients scored substantially below the cut off point for diagnosis of global aphasia.

Language capacity was severely impaired in all modalities. None of the patients had any functional expressive capacities. Their oral productions were confined to one or two word automatisms or phonetic jargon. The patients did not produce this jargon in specific situations, but tended to continuously emit it throughout a session. None of the patients could write spontaneously or from dictation. Copying was also severely impaired.

The receptive aspects of language were slightly less impaired than the expressive. Auditory comprehension was sometimes demonstrated for a few words, but no commands. This comprehension, however, was erratic and unreliable. The only capacity in which patients showed any difference was reading; their comprehension scores across patients ranged from 26·6 to 73·3 per cent of all words tested. It should be noted that this written comprehension is for three letter high frequency words. None of the patients retained the ability to read more difficult words or sentences of any length.

Despite their global aphasia, all patients were alert and well motivated. Their ages ranged from 59 (one patient) to 84 (one patient), with a median age of 62. Educational levels ranged from elementary school through college educated. All patients were seen at least three months post-stroke for the purpose of insuring physiological stability.

PRE-EXPERIMENTAL ASSESSMENT

Natural language

We tested selected aspects of natural language for two purposes. First, we wished to establish a pre-experimental baseline of the functional aspects of residual natural language. In order to be included in the artificial language program patients had to be severely or completely impaired in these tests of grammar and syntax. Only from such impairment could one assume minimal or no contribution of the "speech" areas to the performance of the artificial language system. The second purpose of the assessment was concerned with the most primitive aspects of language, words considered as a class of stimuli. We tested if patients could still distinguish words as visuo-verbal units. This elemental capacity was the first in the series of natural language tests.

Words as units. The ability to distinguish between word and nonword was tested by requiring the subjects to sort words and nonsense syllables into two distinct piles on a table before them.† The test was administered to six patients, four of whom made the discrimination easily by the third sort trail. Two patients, RG and IG were unable to make the distinction, and their data on this test has been excluded from further analysis. For the patients who passed the test almost no sort errors were made. A total of 60 word–nonword distinctions was made by each patient. On the third session two patients made one error out of the 60 sort responses and two patients made two errors.

To test the possibility that the word–nonword distinction had been made on a semantic basis, a picture association test was used as an indication of patients' knowledge of the real words. Percentage of words correctly identified on the first trial of the first session ranged from 26·6 to 73·3 per cent, with a mean of 52·45 per cent. Comprehension tests of these words were run from two to six times after the initial session. This multiple testing revealed that over all patients, those words which were correct on the initial trail were also correct on only 59 per cent of the subsequent trials.

Since both the words and the nonsense syllables were of the CVC type (consonant–vowel–consonant), the distinction could not have been made by the application of a structural rule. Furthermore, when patients were required to sort potential words (CVC nonsense syllables) from non-potential words (CCC nonsense syllables), they were unable to perform the task.

The observations that most patients could discriminate words from nonsense syllables led to the further question of whether they could group these words together by part of speech. Patients were required to sort nouns vs. adjectives, verbs vs. adjectives, and nouns vs. verbs. After repeated trials none of the six patients were able to do this sort by word class.

† Both words and nonwords consisted of three letters, consonant–vowel–consonant (CVC). Words were nouns, verbs, and adjectives, ten of each class, of highest frequency of occurrence in English [8]. Nonsense syllables were chosen for highest associative meaningfulness [9].

Patients were tested for their ability to spell, to manipulate letters to form a word. They were given the cut-out letters necessary to spell the word; the letters were given in jumbled order. The association picture was also present. The subjects' task was indicated by presentation of a board with three blank spaces, and demonstration by the experimenter. The words were a subset of those from the word-nonword discrimination set. Four of the six patients were able to spell all words given. The two patients unable to spell (IG and RG) were also those unable to make the word-nonword distinction. Two of the patients (DW and ED) had semantic knowledge of all presented words, but two patients demonstrated semantic knowledge of only 18 per cent (JA) and 20 per cent (AM) of the words, which they nevertheless spelled correctly.

Four patients hospitalized for disabilities not involving cerebral lesion were given the above tests. The patients were of approximately the same age as the aphasics. None of the normals had any difficulty with any test: word-nonword discrimination, sorting by part of speech, sorting by structural rule for words (CCC vs. CVC). All were able to present their sorting rationale.

Four patients sorted word-nonword correctly while they demonstrated a low level of comprehension of the words, no knowledge of word class, and no apparent knowledge of potential word structure. There are two bases of familiarity upon which the discrimination might have been performed. The words and syllables might have been differentiated by "internally" reading the unit and discriminating those sound units which were familiar (words) from those unfamiliar (nonsense syllables). Such auditory matching, however, would not have sufficed for all discriminations as many of the nonsense syllables, when phonetically pronounced, are real words.

A tenable hypotheses, however, seems to be one of visual matching, considering the CVC as a visually familiar (i.e. visuo-verbal) unit. Without semantic comprehension, subjects could have discriminated between words and nonsense units on a visual familiarity basis.

Syntactic functions. A series of tests was run to determine if the residual language in these patients was in any way functional, that is, usable in a syntactic context. As with the preceding tests, presentation of test material was visual; all required responses were manual, such as pointing or manipulating the sequence of word cards. All words used in these tests had been correctly identified at least once by the particular patient on a picture association test.

Patients were tested for their recognition of the singular and plural form of nouns. Given a picture depicting either one or two instances of an object, they were to point to the correct word form. None of the four patients tested showed any knowledge of plurality. A subsequent test of inflectional agreement, correspondence between plurality of subject and verb, was also failed by all patients.

Basic recognition of a meaningful syntactical construction was tested by presentation of three, three-word constructions, only one of which was meaningful and grammatical. The other two constructions contained the same words but in jumbled order. None of the three patients tested were able to point to the correct construction, even when given a picture as a visual aid.

Sentence formation was tested in like manner, with the words printed on cards and presented in jumbled order. Given a picture as cue, none of the three patients tested were able to correctly order the words to form a sentence. Errors showed no pattern either between or within subjects.

We called the relation between sentences in which the subject and direct object is reversed relational transformations. (e.g. "girl hits boy" and "boy hits girl.") Six relational transformations were made with pictures corresponding to each construction. Neither of the two patients given this test was able to match the construction with the corresponding picture.

Perceptual–cognitive assessment

Despite their severe deficiencies in natural language, these globally aphasic patients appeared both responsive and aware of their surroundings. They seemed to notice incongruities and inappropriate use of objects; they responded appropriately to pictures of various stimuli by facial expressions and gestures. These observations led to the inquiry into the cognitive capacity of these languageless patients. This area of assessment is still in the process of revision and amplification and the observations presented here comprise only an initial impression.

Patients were shown pictures of various objects, animals, plants, people, and scenes and required to sort these pictures into piles. The sorting hypothesis was predetermined by the investigator and one correct sort was performed by her for purposes of demonstration. The patient was then given the pictures one at a time, and it was indicated that he was to choose to which of the two piles the picture belonged. Each pile was headed with a lead picture establishing the classification. The conceptual hypotheses underlying the sorting were both broad, such as the differentiation between animate and inanimate, and narrow, such as edible and inedible meats. The progressive broadening of classification required the patient to group pictures together which on a previous sort had been distinguished from each other. Conceptual flexibility was thus a necessity for adoption of the hypothesis and correct sort.

The sorting classifications used and the number of patients correctly performing the sort are as follows: ANIMATE VS. INANIMATE (2/3), animal vs. plant (2/2), human vs. animal (4/4), fruit vs. vegetable (2/2), male vs. female (2/2), child vs. adult (3/4), parts of the body: components of the head vs. torso and extremities (3/3), edible vs. inedible animals (1/2), kitchen vs. workshop items (1/1), clothes vs. nonclothes

(1/1), machines of transportation vs. other machines (1/1); INDOOR VS. OUTDOOR (1/1), city vs. country (1/1), water scenes vs. wood scenes (1/1), purely nature scenes vs. scenes with man-made buildings/ objects (1/1), natural earth elements (rocks, caves, hills, etc.) vs. celestial elements (rain, snow, sky, sun etc.) (1/1). A total of four patients were given various combinations of these sorts.

Patients DW and FA had no difficulty with any of the sorting tasks. Patient IG was presented with five different sorts, and failed only one of them, that differentiating between edible vs. inedible animals. Patient ED was presented with eight sorting tasks; she experienced difficulty with two of these, animate vs. inanimate and child vs. adult. Despite the first of these failures, however, ED was able to distinguish between people vs. animals, and things vs. animals. Apparently her difficulty lay in grouping animals, plants, and people together as a group.

Other than in these specified instances, all patients seized upon the sorting hypotheses quickly, within three or four corrected sorts.

OBSERVATIONS

Artificial language training

All seven patients were given varying degrees of artificial language training. The system used was a modification of one originally developed by PREMACK [5] for chimpanzees. The primary elements of the system are symbols, varying in color size and shape, which are functionally equivalent to words. The symbol/words were cut out from colored paper, and sentences were written by arranging the words from left to right on a table top. The system has several properties designed to facilitate learning: first, since words are permanent visual symbols, sentences can remain indefinitely, surmounting the memory problem that is acute in either a vocal or gestural system where the signals are transient. This could be of critical importance for dealing with brain damaged patients, most of whom have memory deficits. Second, a simplified training program is made possible by the fact that the experimenter makes the words, while the subject merely uses them. Since the experimenter controls the words, he can modulate the difficulty of any problem. In the limiting case, he can make only one word available to the subject, thus assuring a form of errorless training.

The subject was always taught each new word as the only unknown in a string of known words. Strings or sentences were, at first, extremely simple, consisting, for example, of the word "same" placed between two like objects, or the word "different" placed between two unlike objects. As the training progressed, the number of nonlinguistic elements in a string decreased until finally the string consisted exclusively of words, as in "Andrea (experimenter's name) give John (patient's name) water."

A preliminary to the explicit language training is the formation of a social relation between the patient and the trainer. Trivial as this may seem, the relationship between patient and trainer is a pivotal point of the entire procedure. During these initial meetings, patient's preferences must be scanned in order to find both the context and the reinforcer for the training. One patient, for example, a Mr. J.A., was a card shark both before and after his stroke. His motivation to learn the system was radically enhanced when the symbols were introduced in the context of a game of cards. Another patient was a carpenter, and so the objects chosen to illustrate object relations were nuts, bolts, and screws of various sizes and shapes. He was able to judge screws as identical or different with more accuracy than the experimenter, so fine were his discriminations.

Generally, reward for correct performance was social, i.e. the trainer smiled, expressed pleasure, patted the subject, and so forth. Additional reinforcers such as food and candy were sometimes also used. The training procedure, then, was highly individualistic, geared to the individual patient. As motivation is frequently low in brain damaged patients, this aspect of training is crucial.

In general, in all phases of training, the presentation of new material was done errorlessly. That is, for the first few trials the only response open to the patient was the correct one; gradually a choice was presented, but only after each of the choices had been errorlessly introduced. The first task presented to the subject was a same–different discrimination between two objects. With the use of match-to-sample procedures we first established a number of objects for which the patient was capable of making a matching a response. These objects were then used in teaching the words "same" and "different". The patient was presented with two objects, either A–A or A–B, and was shaped to place between them either the symbol for "same" or "different", resulting in the declarative-type strings: "A same A," and "A different B." After a number of errorless trials on each form, the patient was given both words at the same time and was required to choose between them. If there was evidence for learning we proceeded to the next step, otherwise the errorless trials were repeated and learning was again addressed with the choice procedure.

Once the patient had learned to use the simple predicates "same–different," the interrogative was introduced. The forms given the patient can already be regarded as questions, but only implicit ones. The instruction one might use in giving the same tests to a verbally competent subject would quite likely make the question explicit, e.g. "Are these two objects the same or different?" We made the question explicit by introducing an interrogative particle, so that rather than giving two objects set slightly apart, e.g. A A, the patient was henceforth given two objects with the blank space between them marked by an interrogative particle, e.g. A?A or A?B. The patient was taught to answer the question by removing the interrogative particle and substituting the appropriate predicate, either "same" or "different."

Even at this early stage, the interrogative can take two forms: not only "A?A" (or "A?B"), but also, "? same A (or "? different A"). A paraphrase in the first case would be, "What is the relation between A and A (B)?" In this case the alternatives given the patient were the predicate "same" or "different." A paraphrase in the second case would be "What is the same as A?" or "What is different from A?" In this case, the patient was given not the words but rather the objects A or B. In both cases, the patient's task was the same: remove the interrogative particle and make the proper substitution, i.e. introduce the missing element that appropriately completes the construction.

A highly encouraging indication of learning was shown by patients who required many trials to learn the first question form, but were either correct from the start or required only a few trials to learn the second form.

The patient's training was carried out with a small set of objects, e.g. A was a cup in some cases and B a spoon. Once the patient demonstrated learning on the choice trials, he was given a transfer test, requiring that he make the same choices for objects not used in the training. Random common objects that had never been used in training were presented to a subject for analysis and manipulation. If the patient failed the transfer test, training was continued until such a test was passed. All seven patients learned successfully the various phases of the same–different construction and the interrogative. The average length of time necessary for learning was approximately a month. One of the patients was tested four months after termination of training and dismissal from the hospital and was still able to correctly perform the task.

The patients were taught negation following training on same–different. A symbol was given for "no" which could be applied to "same" to form "no same" or to "different" to form "no different". In the errorless stage of training "no" was physically appended to either "same" or "different" so that "no-same" and "no-different" were single words. The patient was presented with two question forms, "A?A" and "A?B" and given the words "no-different" in the first case and "no-same" in the second. After the patients successfully substituted the single word "no-same" and "no-different" for the interrogative marker, "no" was detached from the predicates, given to the patient as an independent unit, and the patient was required to insert the two words, "no" and "same" or "no" and "different" in proper order in substitution for the interrogative marker in the questions "A?A" and "A?B."

To assess learning the patient was given the three words "no," "same" and "different" in the presence of both questions "A?A" and "A?B." Although patients generally answered correctly, the test failed to assess learning for the negative since most patients preferred the simpler form, e.g. "same" rather than "no different" or "different" rather than "no same." Successful tests of learning were made by giving the patients: (1) "A?A" and "A?B" with "same" and "no" as alternatives and (2) "A?A" and "A?B" with "different" and "no" as the alternatives. In addition, patients were tested by being given the second question form: "? no same A" and "? no different A" with the objects A and B as alternatives. Five of the seven patients passed these tests and the transfer tests as well; in the latter new objects were substituted for the training items A and B. The remaining two patients were not given training as they were dismissed from the hospital. Negating the affirmative ("not same") was learned more readily by all the patients than was negating the negative ("no different").

The patient's lexicon was increased by teaching them a few nouns, verbs, and personal names. Each of these words was taught by associating a symbol with an object, action, or agent in the context of a simple social transaction. An object was placed before the patient along with the symbol for the object and the patient was required to place the symbol on the writing surface, after which he was given the object. The first object was replaced by a second one, along with the word appropriate to it, and the subject was again required to place the name on the writing surface in order to obtain the object. This training too was errorless, as was all training in the initial stages. Learning was assessed as usual by choice trials in which one object was presented along with two words and the subject was required to use the word appropriate to the object.

Personal names for experimenter and patients were taught simply by hanging a duplicate of the person's name symbol around his neck. Verbs were taught similarly by association. For example, the trainer wrote "Andrea stir water," "Andrea" and "water" being established words and "stir" the new word; she then stirred the water. Next she wrote "John (the patient's name) stir water" and arranged for him to carry out the same action, using passive guidance in the beginning when necessary. Comprehension and production were taught simultaneously. The trainer gave the patient an incomplete sentence, e.g. "Andrea ? water," a set of three to five words, then carried out an action, e.g. stirred the water, and required the patient to complete the string in such a way that the resulting sentence correctly described the trainer's action, e.g. "Andrea stir water."

Once the patient was able to make proper substitutions for the interrogative marker, the difficulty of his task was increased. He was required not only to complete incomplete sentences, but to compose sentences from scratch. On these occasions the patient was presented with two or more personal names, several verbs, and several nouns and required to choose and order the symbols so that the resulting sentence accurately described the action of the experimenter. The words learned in this phase varied with the patient since the training was flexibly geared to the individual patient. An example of the words learned by three of the patients is "water," "Tang," (an orange drink) "give," "take," "stir," "pour," and "Andrea," "Mike," and "John" (i.e. patient's own name). One of the most encouraging findings in both the sentence completion and sentence composition phase of the training was the fact that even when the patient erred, his errors indicated a knowledge of word form class. For instance, if the subject erred in completing a sentence "? stir water" and "Mike pour ?" in the first case he used an incorrect personal name (but not a noun or a verb) and in the second case an incorrect noun (but not a personal name or a verb). Notice also that at this stage the patient has progressed from strings consisting of both object and language elements (e.g. "A same A") to strings consisting exclusively of language elements, e.g. "Andrea stir water." Two of the patients, as shown in Fig. 1, progressed to

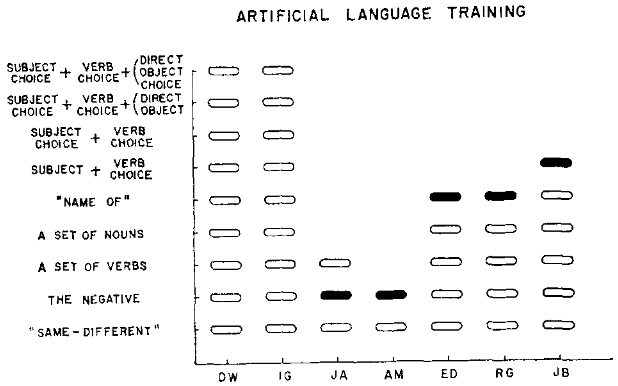

FIG. 1. Extent of artificial language training achieved for each of seven patients. Open squares indicate successful completion of phase: shaded squares indicate training in progress at time of hospital dismissal.

this level. They were able to produce and comprehend sentences at about the 80 per cent level of accuracy, and also showed a rudimentary knowledge of word form classes. The progress of the other patients suggested that they too could have progressed to this level if training had continued. Their training was discontinued for administrative reasons, i.e. because of patient discharge from the hospital, and not for lack of ability to handle the training.

DISCUSSION

In striking contrast to the functional deficits with natural language commonly seen in global aphasics, the foregoing observations suggest each still has the ability to learn an artificial language. Using cut-out symbols which served as "words," each with a referent, the global aphasics demonstrated the capacity to learn simple constructions. They were by no means examples of "simple" learning, however. Even the most elementary constructions used, such as same–different, required the knowledge and application of the concept identity–nonidentity. Additionally, successfully completed generalization tests argued against the notion that this relational statement between objects was made purely on a simple associative, S–R basis.

Training of two of the patients progressed sufficiently far to allow them to express and comprehend simple declarative statements. Although these statements were simple sentences, composed of subject–predicate–direct object, they involved the syntactic use of symbols. The underlying deficit accompanying loss of language has frequently been characterized along the line of HEAD's [10] theoretical notion of aphasia as an impairment in symbolic formulation and expression. The results of the present study indicate that to interpret such a notion in any absolute sense, however, would be misleading. Aphasia may impair symbolization but even in global aphasia the capacity for using symbols is not totally abolished.

With respect to the breakdown of natural language, it is of interest to note that linguistic units such as words can be stored separately from their meaning or semantic correlates. Patients were able to make a word-nonword distinction without necessarily having semantic knowledge of the correctly sorted words. Since they were able to discriminate between CVC words and CVC nonsense syllables, correct performance can not be accounted for by orthographic considerations. Also, when word structure was specifically tested, none of the patients could make the distinction between potential and nonpotential word structures. The results are consistent with the idea that words are in part stored as visuo-verbal units.

The observations on patients' spelling ability are also in line with the foregoing hypothesis about the storage of language related letter groups as visuo-verbal units. Patients were able to spell words for which they had no demonstrated semantic comprehension. This same kind of behavior was also seen in the right hemisphere in split-brain patients [1]. A strategy which might have accounted for the successful performance seen here would be that the patient manipulated the letters randomly until such time as a letter order was produced which corresponded to an internal gnostic or visuo-verbal unit. The observation that patients paid little or no attention to the pictures given as aids supports this view. Also, one of the target words could be rearranged to spell another valid word (dog–god); when by chance one patient made the latter, he was satisfied with that answer despite the presence of the picture of a dog. Spelling also seemed more random than purposeful because of the patients' inability to spell anything if given the choice of the whole alphabet. They could not pick out the necessary letters for a word; they could only manipulate the correct subset. These findings are in essential agreement with a recent study which shows the superiority of left visual field-right hemisphere for word matching [11]. The massive left hemisphere damage in the globally aphasic patients raises the possibility that a visual match strategy in word discrimination and spelling was largely undertaken by the right hemisphere.

It is possible that the basic cognitive mechanisms which underlie language are shared by both hemispheres. Conceptual tests of the present study indicate that there is great cognitive potential in patients sustaining major left hemispheric lesions. The patients tested here made sophisticated conceptual judgments in the perceptual-cognitive sorting tests. They were able to ascertain the salient features of the discrimination, abstract the underlying hypothesis or concept, and apply it in replicating the pictorial sort. Furthermore, they were able to collapse or expand categories as the degree of supraordination was changed.

The overall picture which emerges, therefore, is that global aphasic patients may not suffer cognitive impairments in direct proportion to their language impairment. Indeed, the foregoing suggests that rather sophisticated and abstract symbolic thought can be carried out in patients having been rendered essentially languageless from massive strokes.

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Résumé—On a entrepris l'apprentissage d'un langage artificiel après avoir évalué le langage naturel chez sept patients globalement aphasiques à la suite d'atteinte hémisphérique gauche. L'évaluation initiale du langage naturel permettait de constater quelques connaissances sémantiques mais aucune capacité syntactique ni grammaticale. Les mots étaient distingués des non mots et les mots étaient épelés en l'absence de compréhension sémantique. Ces résultats s'accordent avec un codage prélinguistique des stimulus verbaux en tant qu'unités gnostiques visuelles. En dépit d'grand déficit du langage naturel, des malades étaient capables d'apprendre un système de langage artificiel en utilisant comme mots des symboles, en l'occurence des formes découpées dans du papier de couleur. Des niveaux divers de compétence étaient ainsi atteints, allant de l'expression des relations entre objets (semblable-différent) à la simple formulation d'action (sujet-prédicat-objet direct). D'autres tests de capacité cognitive conceptuelle révélaient une certeine potentialité par l'abstraction et la pensée conceptuelle. On avance que, en dépit d'un déficit massif du langage, les sujets globalement aphasiques retiennent un riche système conceptuel et au moins quelques capacités de symbolisation et quelques fonctions linguistiques primitives.

Zusammenfassung—Bei sieben Fällen von gemischter Aphasie, die eine linkshemispärische Schädigung erlitten hatten, wurde das natürliche Sprachvermögen geprüft und ein künstliches Sprachtraining vorgenommen. Die anfängliche Bestandsaufnahme der natürlichen Sprache zeigte ein gewisses semantisches Wissen, aber keine Fähigkeiten im Bereich von Syntax und Grammatik. Worte wurden von Nicht-Worten unterschieden, und die Worte wurden ohne semantisches Verständnis buchstabiert. Diese Resultate kann man auffassen als ein praelinguistisches Kodieren verbaler Reize als visuelle gnostische Einheiten.

Trotz erheblicher Mängel in der natürlichen Sprache waren diese Patienten in der Lage, ein künstliches Sprachsystem zu erlernen, indem sie ausgeschnittene Papiersymbole für Worte gebrauchten. Es wurden unterschiedliche Leistungen erzielt, die von der Ausdrucksfähigkeit für die Beziehung zwischen Objekten (gleich-ungleich) reichte bis zu einfachen Feststellungen der Handlung (Subjekt–Praedikat–Objekt). Andere Prüfungen der begrifflich-kognitiven Fähigkeiten zeigten das Vorhandensein von Abstraktionsvermögen und begrifflichem Denken auf. So behaupten wir, daß bei gemischt-aphasischen Patienten trotz massiven Sprachverlustes ein reichhaltiges Begriffssystem und zumindest eine gewisse Fähigkeit für Symbolisation und primitive Sprachleistungen erhalten bleiben.