

Teaching Language to an Ape

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Teaching Language to an Ape

Sarah, a young chimpanzee, has a reading and writing vocabulary of about 130 "words." Her understanding goes beyond the meaning of words and includes the concepts of class and sentence structure

by Ann James Premack and David Premack

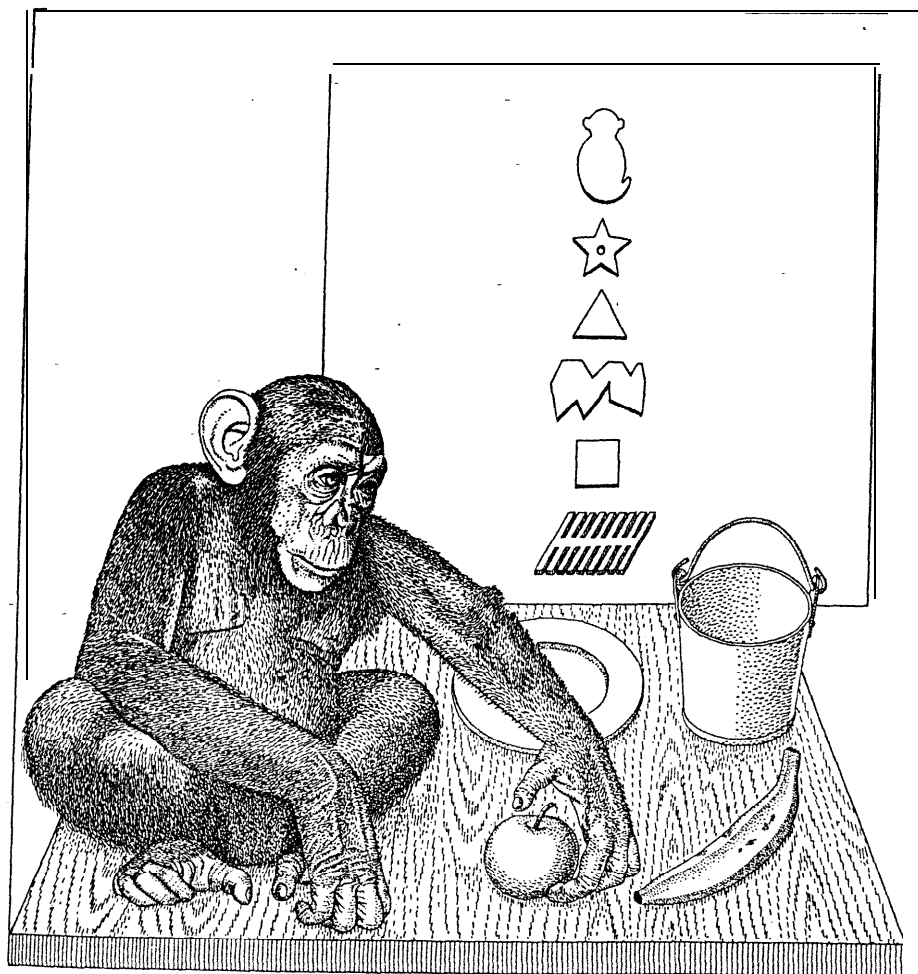
Over the past 40 years several efforts have been made to teach a chimpanzee human language. In the early 1930's Winthrop and Luella Kellogg raised a female chimpanzee named Gua along with their infant son; at the age of 16 months Gua could un-

derstand about 100 words, but she never did try to speak them. In the 1940's Keith and Cathy Hayes raised a chimpanzee named Vicki in their home; she learned a large number of words and with some difficulty could mouth the words "mama," "papa" and "cup." More

recently Allen and Beatrice Gardner have taught their chimpanzee Washoe to communicate in the American Sign Language with her fingers and hands. Since 1966 in our laboratory at the University of California at Santa Barbara we have been teaching Sarah to read and write with variously shaped and colored pieces of plastic, each representing a word; Sarah has a vocabulary of about 130 terms that she uses with a reliability of between 75 and 80 percent.

Why try to teach human language to an ape? In our own case the motive was to better define the fundamental nature of language. It is often said that language is unique to the human species. Yet it is now well known that many other animals have elaborate communication systems of their own. It seems clear that language is a general system of which human language is a particular, albeit remarkably refined, form. Indeed, it is possible that certain features of human language that are considered to be uniquely human belong to the more general system, and that these features can be distinguished from those that are unique to the human information-processing regime. If, for example, an ape can be taught the rudiments of human language, it should clarify the dividing line between the general system and the human one.

There was much evidence that the chimpanzee was a good candidate for the acquisition of language before we began our project. In their natural environment chimpanzees have an extensive vocal "call system." In captivity the chimpanzee has been taught to sort pictures into classes: animate and inanimate, old and young, male and female. Moreover, the animal can classify the same item in different ways depending

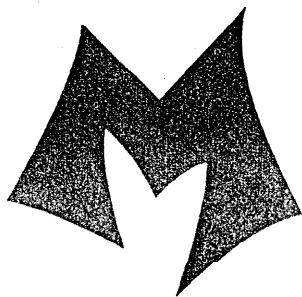


SARAH, after reading the message "Sarah insert apple pail banana dish" on the magnetic board, performed the appropriate actions. To be able to make the correct interpretation that she should put the apple in the pail and the banana in the dish (not the apple, pail and banana in the dish) the chimpanzee had to understand sentence structure rather than just word order. In actual tests most symbols were colored (see illustration on opposite page).

NOUNS



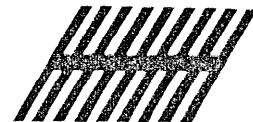
SARAH



MARY



PAIL



DISH



CHOCOLATE



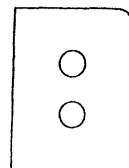
APPLE



BANANA



APRICOT



RAISIN

VERBS



IS



GIVE



TAKE

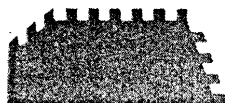


INSERT



WASH

CONCEPTS/CONDITIONALS



SAME



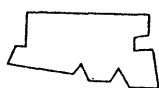
DIFFERENT



NO-NOT



NAME OF



COLOR OF



?



IF-THEN

ADJECTIVES (COLORS)



RED



YELLOW



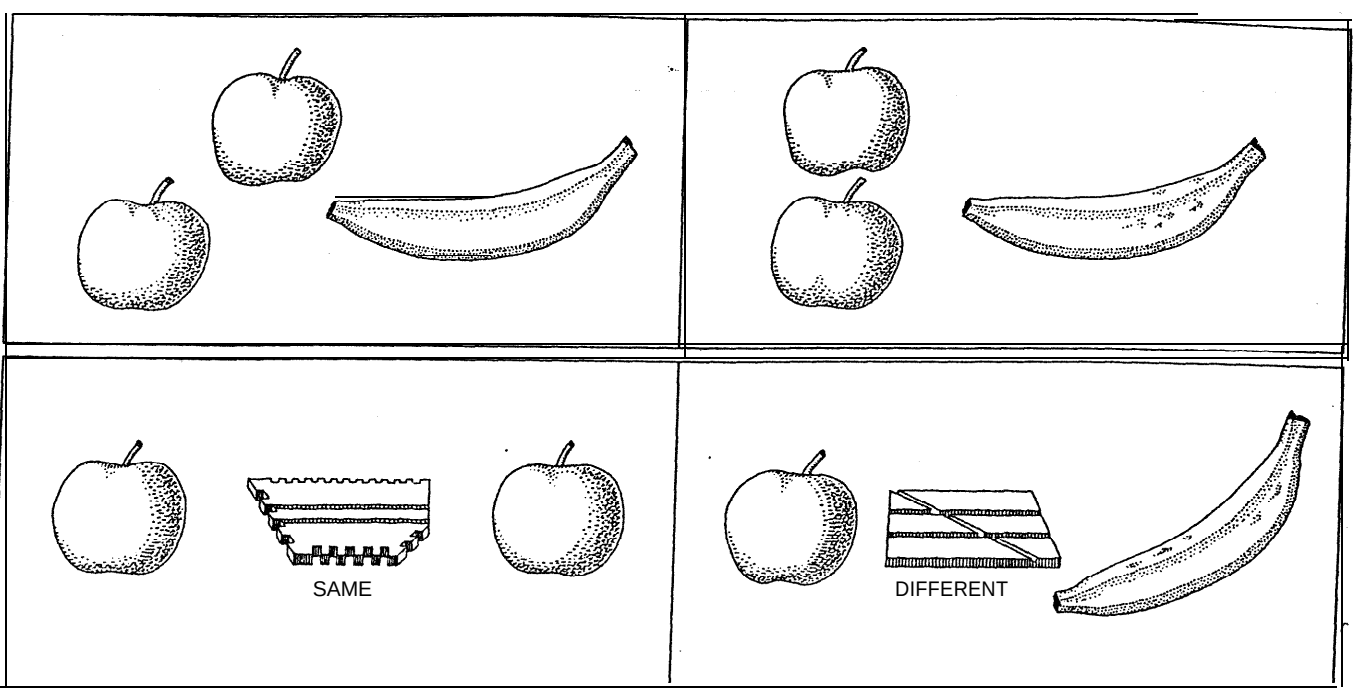
BROWN



GREEN

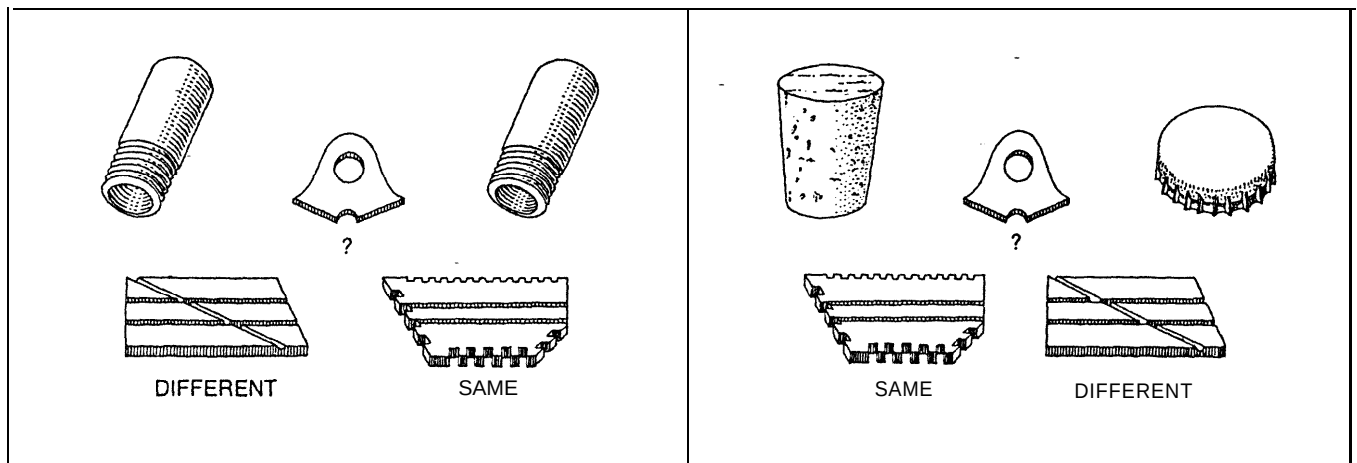
PLASTIC **SYMBOLS** that varied in color, shape and size were chosen as the language units to be taught to Sarah. The plastic pieces were backed with metal so that they would adhere to a magnetic board. Each plastic symbol stood for a specific word or con-

cept. A "Chinese" convention of writing sentences vertically from top to bottom was adopted because at the beginning of her training Sarah seemed to prefer it. Sarah had to put the words in proper sequence but the orientation of the word symbols was not important.



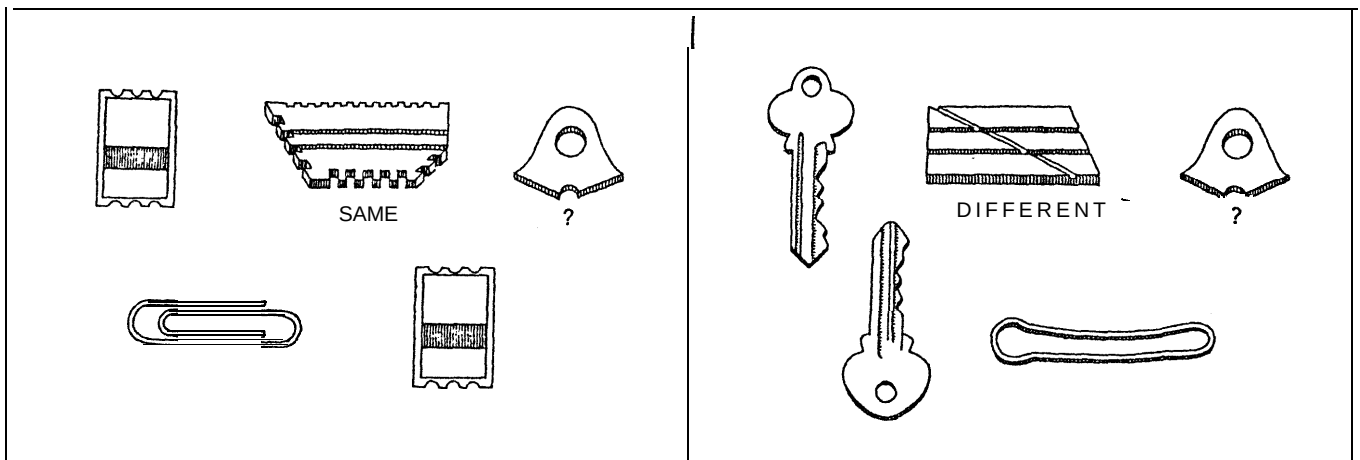
CONCEPTS “SAME” AND “DIFFERENT” were introduced into Sarah’s vocabulary by teaching her to pair objects that were alike (*top illustration*). Then two identical objects, for example apples,

were placed before her and she was given plastic word for “same” and induced to place word between the two objects. She was also taught to place the word for “different” between unlike objects.



THE INTERROGATIVE was introduced with the help of the concepts “same” and “different.” A plastic piece that meant “ques-

tion mark” was placed between two objects and Sarah had to replace it with either the word for “same” or the word for “different.”



NEW VERSION OF THE INTERROGATIVE was taught by arranging an object and plastic symbols to form questions: “What is

[Object A] the same as?” or “What is [Object A] different from?” Sarah had to replace question marker with the appropriate object.

on the alternatives offered. Watermelon is classified as fruit in one Set of alternatives, as food in another set and as big in a third set. On the basis of these demonstrated conceptual abilities we made the assumption that the chimpanzee could be taught not only the names of specific members of a class but also the names for the classes themselves.

It is not necessary for the names to be vocal. They can just as well be based on gestures, written letters or colored stones. The important thing is to shape the language to fit the information-processing capacities of the chimpanzee. To a large extent teaching language to an animal is simply mapping out the conceptual structures the animal already possesses. By using a system of naming that suits the chimpanzee we hope to find out more about its conceptual world. Ultimately the benefit of language experiments with animals will be realized in an understanding of intelligence in terms not of scores on tests but of the underlying brain mechanisms. Only then can cognitive mechanisms for classifying stimuli, for storing and retrieving information and for problem-solving be studied in a comparative way.

The first step in teaching language is to exploit knowledge that is already present. In teaching Sarah we first mapped the simple social transaction of giving, which is something the chimpanzee does both in nature and in the laboratory. Considered in terms of cognitive and perceptual elements, the verb "give" involves a relation between two individuals and one object, that is, between the donor, the recipient and the object being transferred. In order to carry out the act of giving an animal must recognize the difference between individuals (between "Mary" and "Randy") and must perceive the difference between donors and recipients (between "Mary gives Randy" and "Randy gives Mary"). In order to be able to map out the entire transaction of giving the animal has to distinguish agents from objects, agents from one another, objects from one another and itself from others.

The trainer began the process of mapping the social transaction by placing a slice of banana between himself and Sarah. The chimpanzee, which was then about five years old, was allowed to eat the tasty morsel while the trainer looked on affectionately. After the transaction had become routine, a language element consisting of a pink plastic square was placed close to Sarah while the slice of banana was moved beyond

her reach. To obtain the fruit Sarah now had to put the plastic piece on a "language board" on the side of her cage. (The board was magnetic and the plastic square was backed with a thin piece of steel so that it would stick.) After Sarah had learned this routine the fruit was changed to an apple and she had to place a blue plastic word for apple on the board. Later several other fruits, the verb "give" and the plastic words that named each of them were introduced.

To be certain that Sarah knew the meaning of "give" it was necessary to contrast "give" with other verbs, such as "wash," "cut" and "insert." When Sarah indicated "Give apple," she was given a piece of apple. When she put "Wash apple" on the board, the apple was placed in a bowl of water and washed. In that way Sarah learned what action went with what verb.

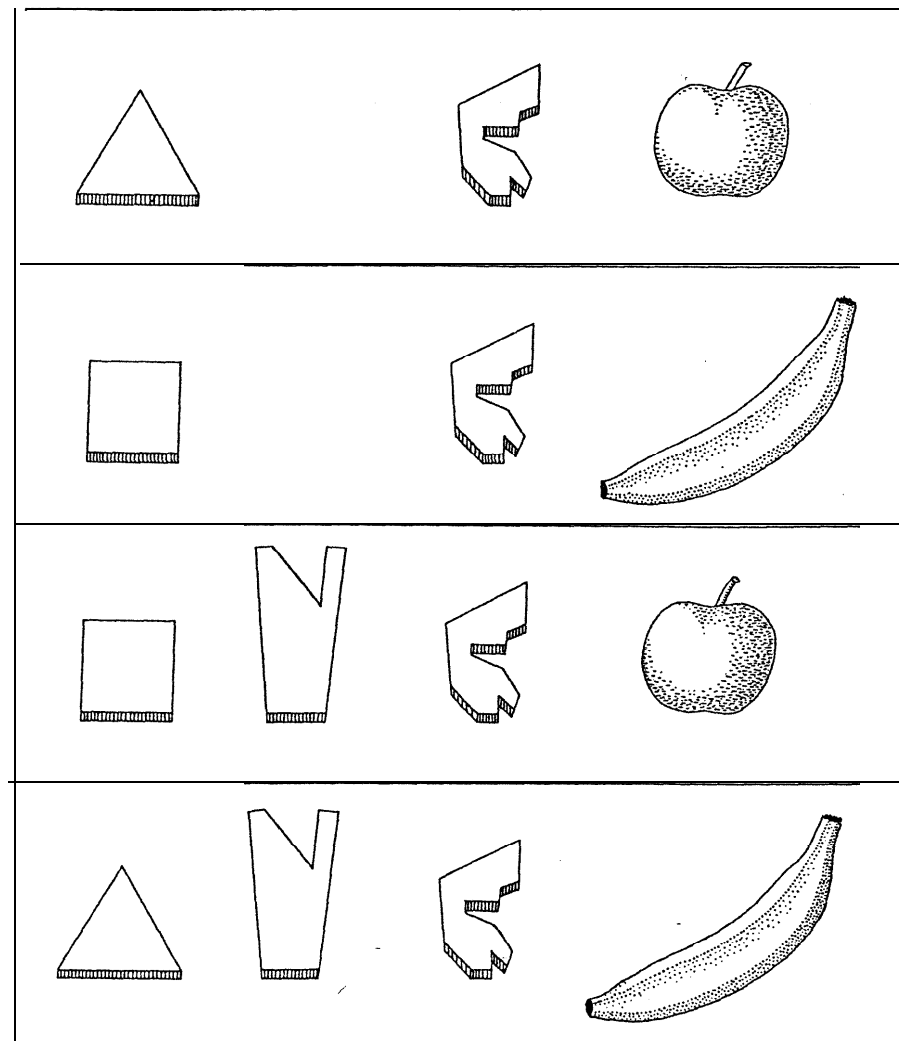
In the first stage Sarah was required to put only one word on the board; the name of the fruit was a sufficient indicator of the social transaction. When names for different actions-verbs were introduced, Sarah had to place two words on the board in vertical sequence. In order to be given an apple she had to write "Give apple." When recipients were named, two-word sentences were not accepted by the trainer; Sarah had to use three words. There were several trainers, and Sarah had to learn the name of each one. To facilitate the teaching of personal names, both the chimpanzees and the trainers wore their plastic-word names on a string necklace. Sarah learned the names of some of the recipients the hard way. Once she wrote "Give apple Gussie," and the trainer promptly gave the apple to another chimpanzee named Gussie. Sarah never repeated the sentence. At every stage she was required to observe the proper word sequence. "Give apple" was accepted but "Apple give" was not. When donors were to be named, Sarah had to identify all the members of the social transaction: "Mary give apple Sarah."

The interrogative was introduced with the help of the concepts "same" and "different." Sarah was given a cup and a spoon. When another cup was added, she was taught to put the two cups together. Other sets of three objects were given to her, and she had to pair the two objects that were alike. Then she was taught to place the plastic word for "same" between any two similar objects and the plastic word for "different" between unlike objects. Next what amounted to a question mark was placed

between pairs of objects. This plastic shape (which bore no resemblance to the usual kind of question mark) made the question explicit rather than implicit, as it had been in the simple matching tests. When the interrogative element was placed between a pair of cups, it meant: "What is the relation between cup A and cup B?" The choices provided Sarah were the plastic words "same" and "different." She learned to remove the interrogative particle and substitute the correct word [see top illustration on opposite page]. Sarah was able to transfer what she had learned and apply the word "same" or "different" to numerous pairs of objects that had not been used in her training.

Any construction is potentially a question. From the viewpoint of structural linguistics any construction where one or more elements are deleted becomes a question. The constructions we used with Sarah were "A same A" and "A different B." Elements in these constructions were removed and the deletion was marked with the interrogative symbol; Sarah was then supplied with a choice of missing elements with which she could restore the construction to its familiar form. In principle interrogation can be taught either by removing an element from a familiar situation in the animal's world or by removing the element from a language that maps the animal's world. It is probable that one can induce questions by purposively removing key elements from a familiar situation. Suppose a chimpanzee received its daily ration of food at a specific time and place, and then one day the food was not there, A chimpanzee trained in the interrogative might inquire "Where is my food?" or, in Sarah's case, "My food is?" Sarah was never put in a situation that might induce such interrogation because for our purposes it was easier to teach Sarah to answer questions.

At first Sarah learned all her words in the context of social exchange. Later, when she had learned the concepts "name of" and "not name of," it was possible to introduce new words in a more direct way. To teach her that objects had names, the plastic word for "apple" and a real apple were placed on the table and Sarah was required to put the plastic word for "name of" between them. The same procedure was repeated for banana. After she had responded correctly several times, the symbol for "apple" and a real banana were placed on the table and Sarah had to put "not



TEACHING LANGUAGE WITH LANGUAGE was the next step. Sarah was taught to put the symbol for "name of" between **the** word for "apple" and an apple and **also** between the word for "banana" and a banana. She learned the concept "not name of" in the same way. Thereafter Sarah could be taught new nouns by introducing them with "name of."

name of" between them, After she was able to perform both operations correctly new nouns could be taught quickly and explicitly, The plastic words for "raisin" and "name of" could be placed next to a real raisin and Sarah would learn the noun. Evidence of such learning came when Sarah subsequently requested "Mary give raisin Sarah" or set down "Raisin different apple."

An equally interesting linguistic leap occurred when Sarah learned the predicate adjective and could write such sentences as "Red color of apple," "Round shape of apple" and "Large size of apple." When asked for the relation between "Apple is red ? Red color of apple" and given "same" and "different" as choices, she judged the sentences to be the same. When given "Apple is red ? Apple is round," she judged the sentences to be different. The distinctions between similar and different, first learned with actual objects, was later

applied by Sarah in linguistic constructions.

In English the conditional consists of the discontinuous elements "if-then," which are inconvenient and conceptually unnecessary. In symbolic logic the conditional consists of the single sign $\supset$, and we taught Sarah the conditional relation with the use of a single plastic word. Before being given language training in the conditional, she was given contingency training in which she was rewarded for doing one thing but not another. For example, she was given a choice between an apple and a banana, and only when she chose the apple was she given chocolate (which she dearly loved). "If apple, then chocolate, if banana, then no chocolate" were the relations she learned; the same relations were subsequently used in sentences to teach her the name for the conditional relation.

The subject was introduced with the

written construction: "Sarah take apple ? Mary give chocolate Sarah." Sarah was provided with only one plastic word; the conditional particle. She had to remove the question mark and substitute the conditional in its place to earn the apple and the chocolate. Now she was presented with: "Sarah take banana ? Mary no give chocolate Sarah." Again only the conditional symbol was provided. When Sarah replaced the question mark with the conditional symbol, she received a banana but no chocolate. After several such tests she was given a series of trials on each of the following pairs of sentences: "Sarah take apple if-then Mary give chocolate Sarah" coupled with "Sarah take banana if-then Mary no give chocolate Sarah," or "Sarah take apple if-then Mary no give chocolate Sarah" coupled with "Sarah take banana if-then Mary give chocolate Sarah."

At first Sarah made many errors, taking the wrong fruit and failing to get her beloved chocolate. After several of her strategies had failed she paid closer attention to the sentences and began choosing the fruit that gave her the chocolate. Once the conditional relation had been learned she was able to apply it to other types of sentence, for example "Mary take red if-then Sarah take apple" and "Mary take green if-then Sarah take banana." Here Sarah had to watch Mary's choice closely in order to take the correct action. With the paired sentences "Red is on green if-then Sarah take apple" and "Green is on red if-then Sarah take banana," which involved a change in the position of two colored cards, Sarah was not confused and performed well.

As a preliminary to learning the class concepts of color, shape and size Sarah was taught to identify members of the classes red and yellow, round and square and large and small. Objects that varied in most dimensions but had a particular property in common were used. Thus for teaching the word "red" a set of dissimilar, unnamed objects (a ball, a toy car, a Life Saver and so on) that had no property in common except redness were put before the chimpanzee. The only plastic word available to her was "red." After several trials on identifying red with a set of red objects and yellow with a set of yellow objects, Sarah was shifted to trials where she had to choose between "red" and "yellow" when she was shown a colored object. Finally completely new red and yellow objects were presented to her, including small cards that were identical except for their color.

Again she performed at her usual level of accuracy.

Sarah was subsequently taught the names of shapes, "round" and "square," as well as the size names "large" and "small." These words formed the basis for teaching her the names of the class concepts "color of," "shape of" and "size of." Given the interrogative "Red ? apple" or "Yellow ? banana," Sarah was required to substitute the plastic word for "color of" for the question mark. In teaching class names a good many sentences were not written on the board but were presented as hybrids. The hybrid sentences consisted of a combination of plastic words and real objects arranged in the proper sentence sequence on Sarah's worktable. Typical sentences were "Yellow ?" beside a real yellow balloon or "Red ?" beside a red wood block.

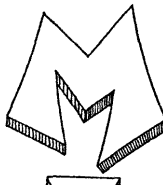
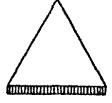
The hybrid sentences did not deter Sarah in the least. Her good performance showed that she was able to move with facility from symbols for objects to actual objects. Her behavior with hybrid constructions recalls the activity of young children, who sometimes combine spoken words with real objects they are unable to name by pointing at the objects.

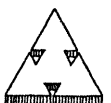
Was Sarah able to think in the plastic-word language? Could she store information using the plastic words or use them to solve certain kinds of problem that she could not solve otherwise? Additional research is needed before we shall have definitive answers, but Sarah's performance suggests that the answers to both questions may be a qualified yes. To think with language requires being able to generate the meaning of words in the absence of their external representation. For Sarah to be able to match "apple" to an actual apple or "Mary" to a picture of Mary indicates that she knows the meaning of these words. It does not prove, however, that when she is given the word "apple" and no apple is present, she can think "apple," that is, mentally represent the meaning of the word to herself. The ability to achieve such mental representation is of major importance because it frees language from simple dependence on the outside world. It involves displacement: the ability to talk about things that are not actually there. That is a critical feature of language.

a piece of fruit and two plastic words, she was required to put the correct word for the fruit on the board before she was allowed to eat it. Surprisingly often, however, she chose the wrong word. It then dawned on us that her poor performance might be due not to errors but to her trying to express her preferences in fruit. We conducted a series of tests to determine her fruit preferences,

using actual fruits in one test and only fruit names in the other. Sarah's choices between the words were much the same as her choices between the actual fruits. This result strongly suggests that she could generate the meaning of the fruit names from the plastic symbols alone.

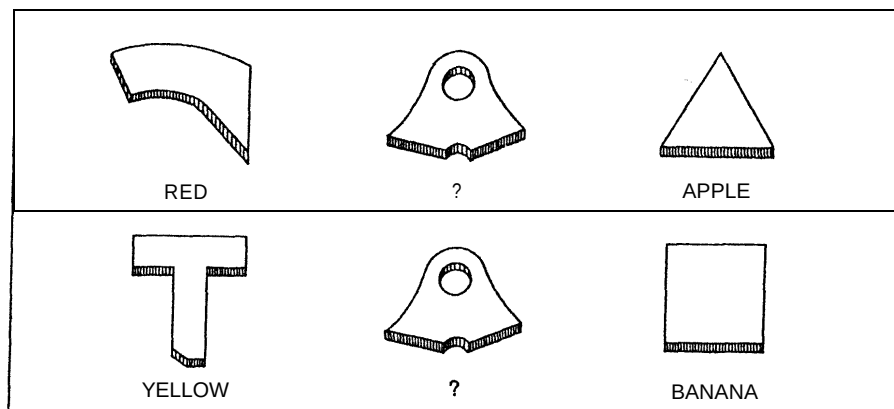
We obtained clearer evidence at a later stage of Sarah's language training. In the same way that she could use

	SARAH		MARY
	TAKE		GIVE
	APPLE		CHOCOLATE
	IF THEN		SARAH

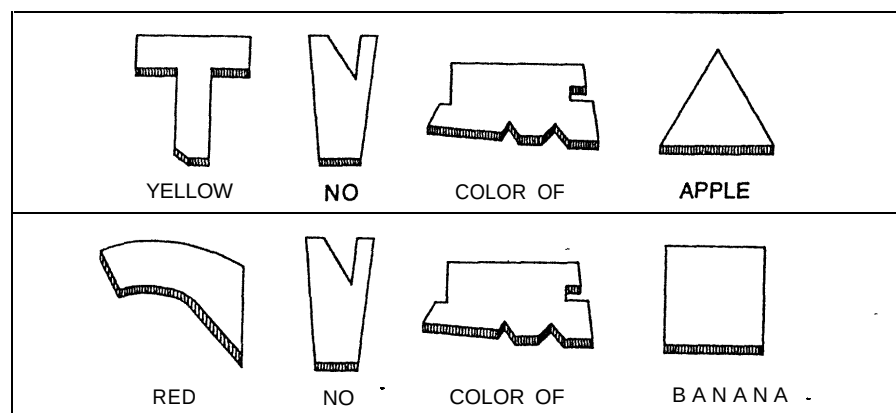
	SARAH		MARY
	TAKE		NO
	BANANA		GIVE
	IF THEN		CHOCOLATE
			SARAH

The hint that Sarah was able to understand words in the absence of their external referents came early in her language training. When she was given

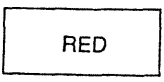
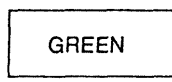
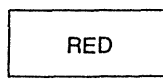
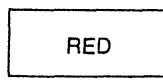
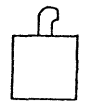
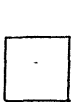
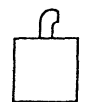
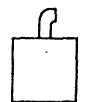
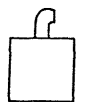
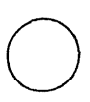
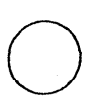
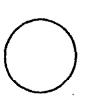
CONDITIONAL RELATION, which in English is expressed "if... then," was taught to Sarah as a single word. The plastic symbol for the conditional relation was placed between two sentences. Sarah had to pay attention to the meaning of both sentences very closely in order to make the choice that would give her a reward. Once the conditional relation was learned by means of this procedure, the chimpanzee was able to apply it to other situations.



CLASS CONCEPT OF COLOR was taught with the aid of sentences such as "Red ? apple" and "Yellow ? banana." Sarah had to replace the interrogative symbol with "color of."



NEGATIVE CONCEPT was introduced with "no-not." When asked "Yellow ? apple" or "Red ? banana," Sarah had to replace interrogative symbol with "color of" or "not color of."

ALTERNATIVE FEATURES			
			
			
			
			

FEATURE ANALYSIS of an actual apple and the plastic word for "apple" was conducted. Sarah was shown an apple or the word and made to choose from alternative features: red or green, round or square, square with stem or plain square and square with stem or round. Sarah gave plastic word for "apple" same attributes she had earlier assigned to apple.

"name of" to learn new nouns, she was able to use "color" to learn the names of new colors. For instance, the names "brown" and "green" were introduced in the sentences "Brown color of chocolate" and "Green color of grape." The only new words at this point were "brown" and "green." Later Sarah was confronted with four disks, only one of which was brown, and when she was instructed with the plastic symbols "Take brown," she took the brown disk. Since chocolate was not present at any time during the introduction of the color name "brown," the word "chocolate" in the definition must have been sufficient to have Sarah generate or picture the property brown.

What form does Sarah's supposed internal representation take? Some indication is provided by the results of a test of ability to analyze the features of an object. First Sarah was shown an actual apple and was given a series of paired comparisons that described the features of the apple, such as red v. green, round v. square and so on. She had to pick the descriptive feature that belonged to the apple. Her feature analysis of a real apple agreed nicely with our own, which is evidence of the interesting fact that a chimpanzee is capable of decomposing a complex object into features. Next the apple was removed and the blue plastic triangle that was the word for "apple" was placed before her and again she was given a paired-comparison test. She assigned the same features to the word that she had earlier assigned to the object. Her feature analysis revealed that it was not the physical properties of the word (blue and triangle) that she was describing but rather the object that was represented by the word [see bottom illustration at left],

To test Sarah's sentence comprehension she was taught to correctly follow these written instructions: "Sarah insert apple pail," "Sarah insert banana pail," "Sarah insert apple dish" and "Sarah insert banana dish." Next instructions were combined in a one-line vertical sequence ("Sarah insert apple pail Sarah insert banana dish"). The chimpanzee responded appropriately. Then the second "Sarah" and the second verb "insert" were deleted to yield the compound sentence: "Sarah insert apple pail banana dish." Sarah followed the complicated instructions at her usual level of accuracy.

The test with the compound sentence is of considerable importance, because it provides the answer to whether or not

Sarah could understand the notion of constituent structure: the hierarchical organization of a sentence. The correct interpretation of the compound sentence was "Sarah put the apple in the pail and the banana in the dish." To take the correct actions Sarah must understand that "apple" and "pail" go together but not "pail" and "banana," even though the terms appear side by side. Moreover, she must understand that the verb "insert" is at a higher level of organization and refers to both "apple" and "banana." Finally, Sarah must understand that she, as the head noun, must carry out all the actions. If Sarah were capable only of linking words in a simple chain, she would never be able to interpret the compound sentence with its deletions. The fact is that she interprets them correctly. If a child were to carry out the instructions in the same way, we would not hesitate

to say that he recognizes the various levels of sentence organization: that the subject dominates the predicate and the verb in the predicate dominates the objects.

Sarah had managed to learn a code, a simple language that nevertheless included some of the characteristic features of natural language. Each step of the training program was made as simple as possible. The objective was to reduce complex notions to a series of simple and highly learnable steps. The same program that was used to teach Sarah to communicate has been successfully applied with people who have language difficulties caused by brain damage. It may also be of benefit to the autistic child.

In assessing the results of the experiment with Sarah one must be careful not

to require of Sarah what one would require of a human adult. Compared with a two-year-old child, however, Sarah holds her own in language ability. In fact, language demands were made of Sarah that would never be made of a child. Man is understandably prejudiced in favor of his own species, and members of other species must perform Herculean feats before they are recognized as having similar abilities, particularly language abilities. Linguists and others who study the development of language tend to exaggerate the child's understanding of language and to be extremely skeptical of the experimentally demonstrated language abilities of the chimpanzee. It is our hope that our findings will dispel such prejudices and lead to new attempts to teach suitable languages to animals other than man.

The Authors

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theory. More exotic birthplace than Shanghai, namely Aberdeen, S.D."

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TEACHING LANGUAGE TO AN APE

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I. SUMMARY

The authors have taught a chimpanzee named Sarah to read and write with variously shaped and colored pieces of plastic, each representing a word. Why try to teach human language to an ape? The motive in this case was to better define the fundamental nature of language. Language is a general system of which human language is a particular, albeit remarkably refined, form. By teaching language to a chimpanzee it may be possible to identify those aspects of language that are uniquely human. Moreover, such experiments may reveal the nature of the chimpanzee's conceptual world and facilitate the comparative study of cognitive processes.

The first step was to exploit knowledge that Sarah already had; they mapped out the social transaction of giving, which is something that the chimpanzee does both in nature and in the laboratory. In order to map out the entire transaction of giving, the animal had to distinguish agents from objects, agents from one another, and objects from one another. Sarah initially had to put a pink plastic square on a "language board" mounted on the side of her cage in order to receive a slice of banana. Later several other fruits, the verb "give," and the plastic words that named each of them were introduced. To be certain that Sarah knew the meaning of "give" it was necessary to contrast "give" with other verbs. When she put "wash apple" on the board, she did not receive the apple; it was placed in a bowl and washed. At this stage Sarah had to place two words, "give apple," on the board to receive the apple. When recipients were named, three words were required; identification of the donor required yet another word. At every stage she had to observe the proper word sequence.

At first Sarah learned all her words in the context of social exchange, but later, when she had learned the concepts of "name of" and "not name of," it was possible to introduce new

words in a more direct way. Subsequently, Sarah was trained in the uses of adjectives and conditional and interrogative statements. In order to teach her the concepts of color, shape, and size she was taught to identify members of the classes red and yellow, round and square, and large and small. Objects which varied in most dimensions but had one of the above properties in common were used for this purpose. In teaching class names many of the sentences were not "written" on the board but were presented as hybrids consisting of a combination of plastic words and real objects. For example, a typical hybrid sentence was "Yellow?" beside a banana. Her performance showed that she was able to move with facility from symbols for objects to the real objects.

Was Sarah able to think in her new language? Could she store information using the plastic words and use it to solve problems that she could not have otherwise solved? Additional research is required for unequivocal answers to these questions, but several aspects of Sarah's performance indicate that the answers may be a qualified yes. For Sarah to match the word "apple" with an actual apple indicates that she knows the meaning of the word, but it does not mean that she can think apple when she is presented with the word alone. The ability to achieve such mental representation is important because it frees language from direct dependence on the external world. The hint that Sarah could use words in the absence of their external referents came in a test where she was given a piece of fruit and two plastic words. While the task was to put the correct word for the fruit on the board, she frequently put up the wrong word. Subsequent tests indicated that she was trying to communicate her preference in fruit. This strongly suggests that Sarah could generate meanings of fruit from the symbols alone.

II. GLOSSARY

autistic — individuals who indulge in wishful thinking or phantasy to a pathological degree.

call system — a series of vocalizations used by some animals for intraspecific communication.

constituent structure — the hierarchical organization of a sentence.

displacement — the ability to talk about things that are not currently present.

language board — a sheet of steel on which Sarah placed her magnetized words.

III. ESSAY STUDY QUESTIONS

1. What was the objective of the authors' work and to what extent did they accomplish it?
2. Why did the authors teach Sarah to communicate with plastic chips rather than vocal patterns? Is this really language?
3. Until animals are taught language it will not be possible to study their cognitive processes for classifying stimuli, for storing and retrieving information, and for problem solving. Discuss.
4. In most psychological experiments many subjects are tested but the Premacks' conclusions are based on data from only a single organism. Discuss.
5. The test with the compound sentence was of considerable importance. Explain.
6. A chimpanzee is capable of decomposing a complex object into features. Explain.
7. What evidence is there that Sarah could think and solve problems in plastic word language?
8. How was Sarah trained to understand conditional statements?
9. What procedures were used to train Sarah to form concepts of color, shape, and size?
10. How was Sarah trained to understand questions?
11. Sarah could have learned more words if the symbols were similar to the objects they represented. Why did the authors not use this strategy?