29. *Object and Color Naming in Chimpanzees (Pan troglodytes)*

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Ever since the Gardners' attempt, the American sign language and other artificial visual languages were taught to chimpanzees and a gorilla.[1)-6)] Controversies emerged among experimental psychologists, linguists and others, but currently there is no consensus on what apes really learn and how.[7)] Savage-Rumbaugh *et al.*[8),9)] investigated the initial acquisition of symbolic skills. They failed to train chimpanzees to name colors or objects by depressing keys with geometric symbols. The chimpanzees learned competently when they asked for food or tools by pressing symbol keys, and the importance of request training in developing symbolic use of lexigrams was emphasized.

Up to now, to our knowledge, experimental evidence has not been available demonstrating that a chimpanzee can name items without previous training to request the items. Our chimpanzees learned lexigram names of objects and/or their colors through training for which naming responses were reinforced with a common food reward rather than by giving the named item.

Three nondeprived young wild-born chimpanzees, Ai (female), Akira (male), and Mari (female), were the subjects. When training started in April, 1978, their ages were estimated to be about two years. They were carried into the training room (190×220×180 cm) from their home cage and left alone there for daily sessions of about one hour to earn food rewards. A piece of apple or raisin was delivered after 1–5 consecutive correct responses. Sessions were controlled by a mini-computer, PDP11/V03.

After an initial 3–4 month adaptation period to laboratory conditions, 8–9 months were spent in extensive training in matching-to-sample tasks, first with colors and then with geometric figures. In the initial task, the color sample (53×38 mm) was displayed on a panel, and pressing a key of the same color was rewarded. The three chimpanzees learned five-color matching in 29–34 sessions. Then the color stimuli were replaced by the geometric figures. Each

figure was composed of two or three design elements out of 9 arbitrary elements (Fig. 1). The chimpanzee faced a keyboard of seven rows of five keys among which the upper five rows were used throughout the present study (Fig. 2). Each row displayed the same

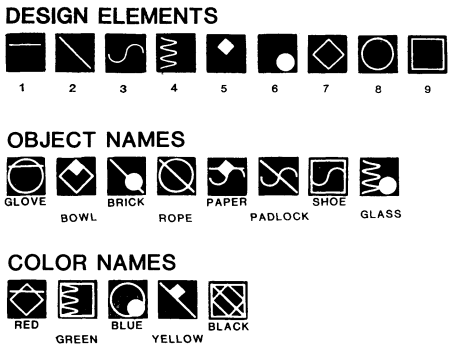

Fig. 1. Nine design elements, eight object names (lexigrams) and five color names (lexigrams). Lexigrams were composed of two or three elements. All are white figures with dark backgrounds.

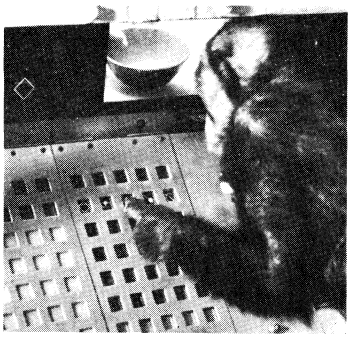

Fig. 2. A view of the chimpanzee's console. Subject Ai had just pressed the color name (red) and was about to press the key for the object name (bowl). On the front panel, the lexigram for "red" is shown. The single blank key is partly masked by the chimpanzee's left upper arm. The outlet of the food dispenser is hidden by the chimpenzee's body.

five figures, but in different key positions. On each trial, a sample figure was displayed with similar method used by Rumbaugh *et al.*[10] Simultaneously one row of keys was randomly lit. The chimpanzee pressed the lit key with the matching figure to produce a facsimile of that figure on another panel located just below the sample panel. The chimpanzee then pressed a single blank key to conclude its response. If the matching key symbol was chosen, the chimpanzee was rewarded. The positions of all key symbols were randomized from session to session to prevent chimpanzees from using positional cues. By the end of the first year, the three chimpanzees had accomplished these tasks, exceeding a criterion of 90% accuracy for two consecutive sessions.

For the naming task a display window (24×17×24 cm) was mounted above and to the right of the keyboard, into which the experimenter could place stimulus objects (Fig. 2). Eight objects were selected and eight different lexigrams were arbitrarily assigned to these objects (Fig. 1).

In the initial object-naming task, the computer informed the experimenter of the randomly-chosen object to be placed in the window to begin a trial. The experimenter then pressed a start switch to light one of the five rows of the keyboard, whereupon the chimpanzee had to press the key with the correct lexigram name and then the blank key. Correct responses were followed by a buzzer and intermittently by food. Training on this task began with two objects, a glove and a padlock. The remaining six objects were added one by one when performance reached the previously-established criterion. Since each row carried five lexigrams at most, the sixth and later lexigrams replaced the previously learned lexigrams

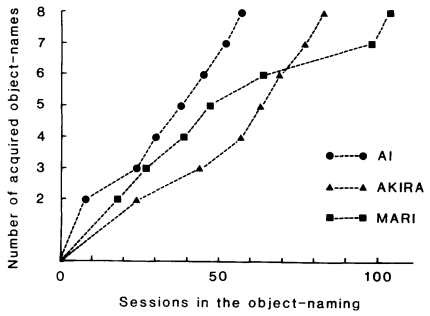

Fig. 3. Cumulative curves for object name learning. The number of acquired object names is shown as a function of the cumulative number of daily sessions for each of the three chimpanzees.

one by one. Fig. 3 shows the cumulative number of sessions to reach criterion for each set of object names. Despite the increasing size of the vocabulary the three chimpanzees learned new names steadily.

We further taught the chimpanzees the names of the colors of the objects (Fig. 1). Five objects (glove, bowl, brick, rope, and paper) were chosen for this task. Each was painted in one of five colors (red, green, blue, yellow, and black), to yield 25 objects. The lexigrams for colors were mounted on the keys in the upper three rows of the keyboard and those for objects were in the lower two rows. Each trial began by presenting a colored object in the display window and illuminating one of the two rows of the object names. Pressing the key with the correct name illuminated one of the three

rows of the color names. Pressing a color-name key was followed by pressing the blank-key. When the chimpanzee named both object and color correctly, the "correct" buzzer sounded and the chimpanzee was rewarded.

Training on the object-color naming task began with one object (red or green brick). Other objects and/or colors were added to the stimulus set one by one. Ai and Mari quickly learned one object and two color names in three and eight sessions respectively, and showed strong transfer effects in the color naming of the untrained objects in the later sessions. For example, Ai always kept more than 90% correct naming of the two colors, even after 3–5 object names were added. On the other hand, Akira failed to reach the criterion for one object and two color names in 18 sessions, so we simplified the task to the color response alone until Akira had learned five color names. Then, the object phase was restored. Eventually, Ai and Akira reached the final stage of naming five objects in five colors after 65 and 172 sessions, respectively, and Mari reached the stage of naming three objects in three colors after 72 sessions.

The total number of trials required to learn object and color names and the number of correct trials during the last two sessions of the object-color naming task are in Table I. The chimpanzees' overall accuracy was more than 92%. Ai gave the correct object name in 94% of 227 trials and the correct color name in 93% of 214 trials. Akira pressed the correct object lexigram in 93% of 589 trials and the correct color lexigram in 94% of 548 trials. Mari pressed the correct object lexigram in 99% of 357 trials and the correct color lexigram in 92% of 356 trials. The difference in the total number of trials among the three chimpanzees was due to a difference in the number of consecutive correct trials required. Except for Ai's trials with the color green, accuracy for each object and color was more than 80%. Thus, the three chimpanzees were able not only to name the objects regardless of color but also to name the colors regardless of objects.

Since the symbols were never used for any other purpose, we infer that our chimpanzees developed a naming skill without having had any opportunity to request objects with the same symbols. Pretraining on color- and figure-matching provided a new approach to the initial training of naming skill. Chimpanzees used in previous studies were trained initially by reinforcing individual symbol responses using their appropriate incentives (such as food, tool, play, etc.). In our study, symbol responses were associated with objects that were independent of the rewards, the raisins or pieces of apples

Table I. The number of correct trials and total trials for each name during the last two sessions of the object-color naming experiment

Subjects	Ai	Akira	Mari*
	Trials	Trials	Trials
Object-names	214/227	548/589	356/357
Glove	43/46	103/122	—
Bowl	43/43	104/114	—
Brick	43/49	110/112	118/118
Rope	41/45	123/127	121/121
Paper	44/44	108/114	117/118
Color-names	200/214	517/548	328/356
Red	35/35	104/129	109/119
Green	35/45	102/103	114/119
Blue	45/45	102/105	105/118
Yellow	41/41	103/104	—
Black	44/48	106/107	—

Entries stand for (correct trials)/(total trials). * Training for Mari terminated after three object-names and three color-names had been learned, not because of her inability but because she was needed in another experiment.

being the common rewards for all symbol responses. Although we have demonstrated that young chimpanzees can learn to name objects and colors by such match-to-sample training, it is not clear whether training which proceeds from matching or training which proceeds from requesting would be the more efficient.

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