PSYCHOLOGY

Animals Compete With Humans

Workers of the future will include pigeons, chimpanzees, dogs, perhaps even porpoises. Inexpensive to train, animals can do numerous industrial jobs, Marilyn B. Ferster reports.

➤ PSYCHOLOGISTS can now train animals to do some kinds of work in industry that men and women must do now. Competing with automated machines was a hard blow to human pride. But now it appears that man must contend with lower animals—pigeons, chimpanzees and even other creatures that can take over some of his jobs.

The notion of using animals as workers is not new. Certain breeds of dogs have been trained to perform many valuable services. The blind man, for example, depends on the seeing-eye dog to guide his way. Even the amateur dog owner likes to train his dog as his personal valet, teaching him to fetch his newspaper, mail and slippers.

Reinforcement Theory

The new animal training technology is known as reinforcement theory, or operant conditioning. It allows the behavior of animal subjects to be scientifically controlled so that animals can do more demanding tasks.

Here is how the psychologist uses reinforcement theory to acquire control over his subject. The animal is deprived of something he wants, usually food. When he is sufficiently hungry, he is placed in a chamber and given small amounts of food as a reward or reinforcement, every time he presses a lever. The animal soon learns to press the lever whenever he wants food.

The experimenter next sets up certain conditions for obtaining reinforcement. The animal no longer receives food each time it presses the lever. Perhaps it has to press it 10 times, or 20. The behavior of the animal changes in an orderly way as a function of the conditions imposed. In this way, it soon comes under the control of the experimenter.

With such techniques, the psychologist has at last achieved the same kind of control over behavioral data that physicists and biologists achieve over things in their fields. Mostly, the psychologists have used this control to learn more about behavior itself. Or they have used it to treat certain clinical disorders and solve various human learning problems. But the whole area of training animal subjects to do a man's job has largely been untapped.

It is not surprising that Harvard University's Prof. B. F. Skinner, the so-called father of reinforcement theory, was one of the first to attempt putting an animal to work. During World War II, he trained pigeons to guide a missile toward a battleship.

Although his operation was never put into practice, Dr. Skinner clearly demonstrated its potential use. There are many jobs that an animal could be trained to do. The decision of whether to use an animal or a machine is one of economics: if the animal's labor is cheaper, the animal should be used; if the automatic device is cheaper, then the machine is the better choice.

Dr. Thom Verhave of San Francisco, Calif., devised one of the first training procedures for animals to do a purely industrial task. Dr. Verhave trained a group of pigeons to be reliable inspectors of drug capsules.

Normally, drug companies employ a staff of people who view each capsule as it passes on an assembly line, and judge whether or not it is acceptable. Dr. Verhave believed that this kind of inspection problem was within the repertory of a pigeon because the bird has excellent visual acuity, as well as color vision.

The task was, essentially, to reject any capsule that deviated from a standard, perfect capsule by a certain amount. The pigeon was trained to recognize pills with dents in all their varieties—small dents, large dents, and dents wherever they appeared on the pill. He could also detect discolored pills, and pills that were either too big, too small, too flat, or misshapen in any way. Whenever a pill did not match the perfect pill, the pigeon learned to reject it.

The primary advantage of the pigeon's labor here is that it is free. Training the animal is a relatively minor expense, compared with salary checks for human inspectors.

The pigeon's labor is also much cheaper than that of the machine. Furthermore, the nature of the defective pill shifts from time to time. One pill is dented, and another is discolored. A mechanical device would be incapable of adjusting to the many varieties of defects.

Unfortunately, Dr. Verhave's experiment was never used industrially. Perhaps one reason for this was the possibility of public disapproval if a bird were to select items that people would eventually consume.

Pigeons Inspect Transistors

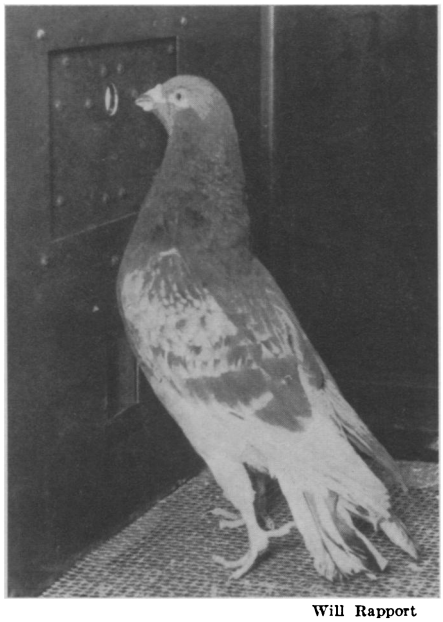
Another psychologist, Dr. William Cumming of Columbia University, trained pigeons to inspect transistors, and to reject any that deviated from a given acceptable standard. Although Dr. Cumming clearly demonstrated that this was a feasible application, industry has not yet adopted his technique either.

Carl Sontheimer of THOR Education, Inc., Stamford, Conn., has suggested that a pigeon could also be trained to read the handwriting on bank checks, thus replacing an optical scanning device. Twenty-six pigeons would be taught the alphabet, each one learning a different letter in all its varieties. As in Dr. Verhave's experiment, the problem here is visual discrimination.

Once every bird has learned its letter, an actual check signature would be presented,

Joern Gerdts

PIGEONS SPOT TROUBLE—The pigeons peck a warning that discards the defective article in a production line. Thousands of visitors to the Seattle World's Fair saw the pigeons there perform.



Will Rapport

INSPECTOR—The pigeon's visual acuity and color vision enables it to detect discolored and defective pills accurately as they pass along an assembly line.

character by character. The pigeon trained to recognize a particular character would peck a key, that would then record this letter on a typewriter. When each letter of the signature had been identified, the check could be processed mechanically.

Chimpanzees appear to be the best candidates for animal laborers. One of their obvious advantages is that they are long-lived, living about two-thirds as long as a man. Another is their high order in the animal kingdom.

Chimpanzees could not be trained to make actual constructions, since they cannot use thumb and forefinger with sufficient dexterity. However, they could learn to pick fruit, operate a switchboard or punch a press. They could also pilot space vehicles, and bombs or other missiles. A chimpanzee or monkey could easily be trained to adjust a value mechanically, so it will conform with a given criterion value. This kind of performance is especially suitable for the animal because there is an explicit criterion for defining when an adjusted knob or dial has produced a required condition.

Dr. Marvin Grunzke of Holloman Air Force Base, New Mexico, has conducted a prototype experiment using a chimpanzee. With a lever that moves up, down, left and right, the animal must position one dot of light in a vertical row and another dot in a horizontal row to correspond with a sample dot somewhere in these rows. Each time the animal displaces the lever, the light advances one step in the appropriate direction.

The chimp performs admirably, always placing the movable light in the position of the fixed light. This kind of performance could be applied in production systems when the pressure between two rollers must be adjusted.

Another application of this performance is in the control of the influx of a chemical into a processing vat according to the rate at which the reaction proceeds. In chemical reactions, there usually is an optimal amount of chemical required so that the reaction can proceed at a maximum rate. Using too much chemical is wasteful and using an insufficient amount slows up the equipment.

Analog computers are customarily used to solve such problems in industry. However, these are very expensive. Animal labor would certainly be cheaper here.

Many psychologists have also been intrigued by notions of using reinforcement theory to train animals as entertainers. Several years ago, a graduate student in psychology, Keller Breland, left academic psychology to set up animal demonstrations for state fairs and other public functions. Mr. Breland has also acted as a consultant on the training of porpoises at Marineland, Fla., a popular tourist attraction.

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RADIOLOGY

Leukemia From Radiation

➤ AN INCREASE in the incidence of leukemia (cancer of the blood) would definitely result from the exposure of populations to 100 roentgens of radiation, Dr. Eugene P. Cronkite, Medical Research Center, Brookhaven National Laboratory, Upton, N. Y., reported in New York. This level of exposure is well below the 400 to 600 roentgens that may result in 50 percent fatality in man.

Such exposure in peacetime can occur from accidents in handling fissionable materials and from reactor accidents.

There is at present no way to determine which members of a group exposed to 100 roentgens would develop leukemia. Age, general health, and a host of other variables that influence degree of susceptibility to the effects of radiation make such pinpointing difficult, Dr. Cronkite said.

In handling groups which may have suffered exposures of 100 roentgens or below, hospitalization for a period of observation would be advised. Those persons in which no detectable physiological injury can be observed would require largely psychotherapy, he said. The psychotherapy would primarily be assurances by medical experts that the exposed person was in good health and very likely to remain in good health.

In the sublethal ranges of exposure, therapy is largely observation. Within the lethal range, the administration of antibiotics and fresh blood transfusions are among the treatments clinically indicated. In the supralethal range, the possibility of bone marrow transplantation should be considered. Homotransplants of marrow in humans have not proved successful. Autologous marrow is effective. This would require storage of bone marrow of persons working in atomic industries or anywhere such exposure could occur.

Autologous marrow banking and storage is under serious study, but thus far it has not been possible to maintain storage for long periods of time.

Dr. Cronkite reported on the diagnosis, treatment and prognosis of radiation injury from whole body exposures to the biological and medical sciences section of the New York Academy of Sciences meeting in joint session with the Conference on Modification of Radiation Injury by Bone Marrow Transplantation and Chemical Protection.

At the same meeting Drs. D. Grahn and G. A. Sacher of the Argonne National Laboratory, Argonne, Ill., reported on the physical factors which affect responses to radiation. The same dose of radiation, they pointed out, will result in different reactions from different species of animals. Reaction also will change with type of radiation, age of animal, the rate of exposure and the time of exposures.

If a dose of radiation is given in two parts, the longer the time difference between the exposures the greater the amount of recovery.

Research by Dr. George F. Leong of the U.S. Naval Radiological Defense Laboratory in San Francisco has demonstrated that larger animals such as burros, sheep and goats will recover from radiation exposure much more slowly than will small animals such as rodents.

Dr. O. Hug of the University of Munich, Germany, reported that some insects will scurry about madly when in a field of radiation. An increased excitability of nerves and muscles results in higher animals exposed to radiation. There are indications of disturbances and possibly damage to the central nervous system. Effects of exposure to nervous system in man and animals increase with the level of dose.

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PSYCHOLOGY

Memory Linked to Enzyme Concentration

➤ MEMORY, one of the major mysteries of the way that brain cells operate, is attributed to an increase in chemicals called enzymes which are induced to form in the living organism.

Dr. C. E. Smith of the San Jose State College, Calif., reported in Science, 138:889, 1962, that experimental evidence suggests that the basis of memory lies in an increase in enzymes.

It would work something like this: The neurons under the influence of an experience would be stimulated to release more of such substances as acetylcholinesterase and RNA, substances that have been shown to be produced in larger quantity by active cells, such as occur during learning. RNA is the substance that carries the genetic code that allows an organism to reproduce itself. Esterase is a substance that transmits a long-lasting effect that produces more enzyme.

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