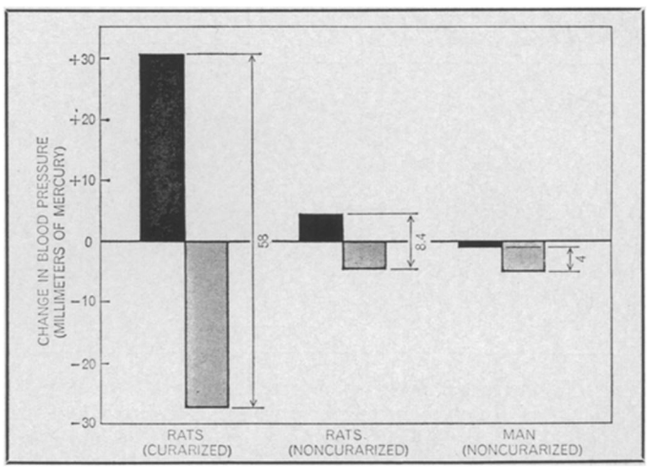
VISCERAL LEARNING

Learning to control the uncontrollable

Experiments in controlling involuntary visceral responses are building a bridge between operant and classical conditioning

by Lawrence Massett



Comparison of blood-pressure learning in rats and humans and experimental set-up used in measurements of visceral responses of animals.

Scientific American

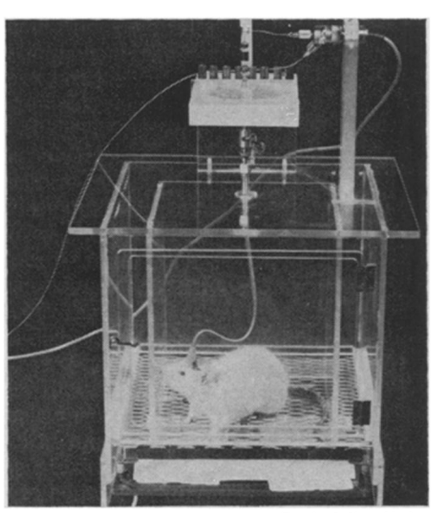
About 10 years ago, researchers under the direction of Dr. Neal Miller, a psychologist at Rockefeller University, performed an apparently simple experiment on two groups of dogs. One group of animals was rewarded with water for increasing its salivation. The other group was similarly rewarded for decreasing its salivation. At the end of 40 days, the dogs had learned to change their normal patterns of salivation in the reward-producing direction.

The experiment sounds unspectacular. Yet its implications have overthrown some of the fundamental theories psychologists have held about the way behavior is learned. More recent work by Dr. Miller and others has built upon the original experiment and suggests as a result the possibility of controlling the autonomic nervous system as an approach to a great range of disorders, including human cardiac arrhythmias, ulcers, asthma, epileptic seizures and abnormal blood pressure. "Right now," says Dr. Jim Matthews, a psychologist at Brown University, "Neal Miller is perhaps the best-known experimental psychologist in the country."

The importance of the experiment with dogs was that it seemed to be an example of operant learning mediated by the autonomic nervous system rather than by the cerebrospinal nervous system. According to traditional doctrine, operant learning could involve only voluntary skeletal responses via the cerebrospinal system. The autonomic nervous system, which mediates involuntary visceral and glandular responses, was considered suitable only for classical conditioning as demonstrated by Pavlov.

Clearly, what Dr. Miller's dogs had learned to do was not an instance of classical conditioning: Had it been classical conditioning, the water used for reward might have induced either an increase or a decrease in salivation as a reflex response, but not both. The experiment looked much more like a typical case of operant learning, in which the presentation of a reward reinforces any response that happens immediately to precede the reward. Operant conditioning has been considered superior to classical, since it can be used to shape a greater variety of responses.

It was not easy for Dr. Miller to convince others of the significance of his findings, however. He had a hard time even finding someone to help with the experiments. "For years," Dr. Miller recalls, "students and research assistants who were supposed to be working on the problem kept finding excuses to do something else instead. The prejudice against visceral learning was just too strong." He attributes the prejudice partly to the textbook dogma that automatically regulated behavior can be modified only by classical conditioning, and partly to cultural factors. "The autonomic nervous system was just not held in high esteem, at least in this country," he declares. "It's a cultural matter. Someone has said, for instance, that North Americans think with their skeletal muscles, while people in South America think with their glands."



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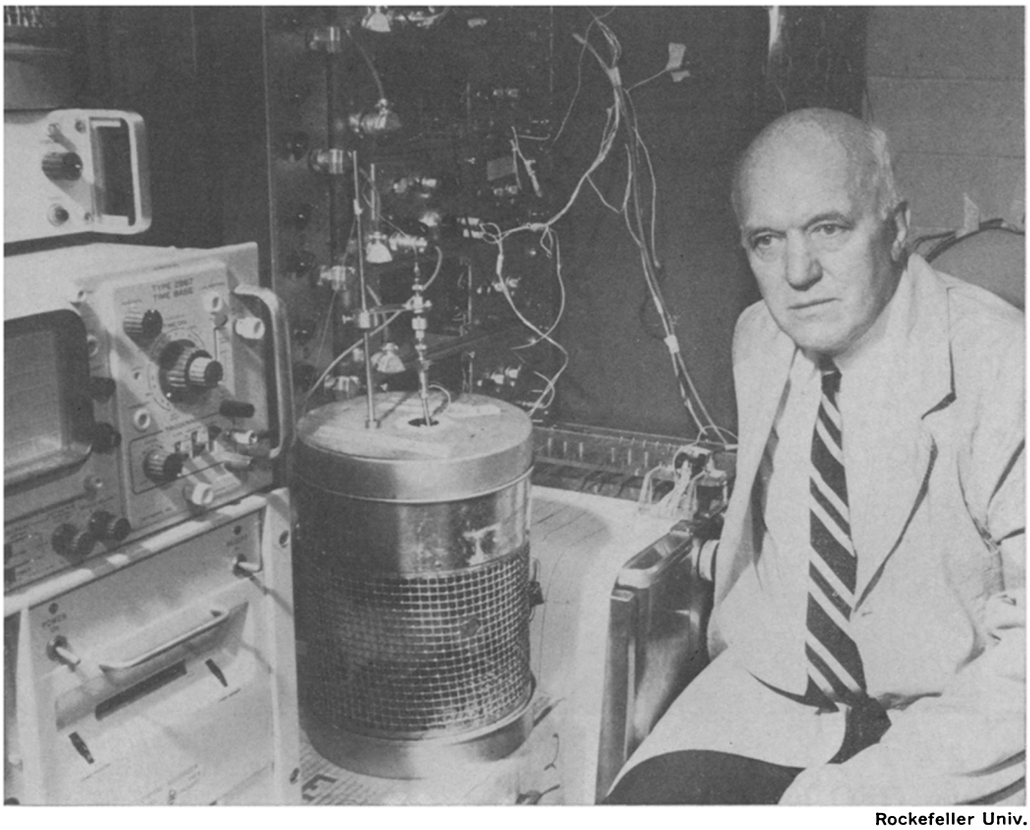
The problem of finding assistants was gradually overcome as Dr. Miller and his few colleagues devised experimental techniques that showed more and more clearly that operant conditioning could indeed be applied to visceral responses. The dog experiment was not sufficient proof because, though salivation normally is called a visceral response, the possibility remained that the dogs had somehow learned to regulate their salivation by means of their skeletal nervous system. "A person experienced in yoga," Dr. Miller points out, "is supposed to be able to slow down his heart. That sounds like visceral learning, but it is said that yogi accomplish the feat by using their skeletal muscles to alter the pressure inside their chest."

To eliminate any possible influence



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Miller and apparatus to record and reward changes in a rat's blood pressure.

from the cerebrospinal nervous system in his laboratory animals, Dr. Miller began working with rats paralyzed by curare. A drug used as a poison by South American Indians, curare blocks the transmission of cerebrospinal nerve impulses but does not inhibit the autonomic nervous system.

Rats under the influence of curare cannot be rewarded for their responses with the usual reinforcements of food and water. Dr. Miller's rats were rewarded instead by direct electrical stimulation of a pleasure center in the hypothalamus. To make sure that brain stimulation was not, for some peculiar reason, the only kind of reward that would reinforce visceral learning, Dr. Miller also rewarded some of the rats by allowing them to escape from a mild electric shock whenever they produced the desired response.

Under these circumstances Dr. Miller has demonstrated a variety of visceral learning in animals. The rats have learned to raise or lower their heartbeat rates, to regulate their intestinal contractions, to alter the rate of urine formation in their kidneys, to increase or decrease the amount of blood flowing through their stomach walls and to change their systolic blood pressure.

Much of Dr. Miller's recent work has been devoted to showing that the responses the rats learn are not merely a reflection of an over-all increase or decrease in the activity of their autonomic nervous system. According to standard physiological theory, the sympathetic branch of the autonomic nervous system is capable only of general activity and always fires nonspecifically, as a unit. But the rats have been able to alter one visceral function without affecting the others. Some of the responses the animals learned were, in fact, startlingly specific; they learned, for example, to dilate the blood vessels in one ear only.

From a theoretical point of view, it is more difficult to demonstrate the existence of visceral learning in human beings than in animals, largely because curare cannot be administered to human subjects. Even in animals, visceral learning is harder to produce without curare; by paralyzing the skeletal nervous system, Dr. Miller speculates, the curare reduces external distractions and enables the animal to concentrate on modifying its visceral responses more efficiently.

From a practical point of view, the theoretical difficulties are inconsequential so long as people can actually learn, one way or another, to control their autonomic responses. Researchers at a number of institutions, including Harvard University Medical School, Cornell University Medical College and the Gerontology Research Center in Baltimore, have already reported some success in training human subjects to control such functions as heart beat rate and blood pressure. Last month Dr. Miller and his colleagues began a large-scale project at New York City's Bellvue Hospital, designed to teach people to control their blood pressure.

The apparatus needed to train humans is, fortunately, much simpler than the equipment used in animal experiments. The only unusual equipment necessary is an instrument capable of measuring minute changes in whatever visceral function is to be regulated. If, for instance, a person is being taught to lower his blood pressure, then his blood pressure is carefully monitored; each time it fluctuates even slightly in the desired direction the subject receives a signal such as a tone or a light. His only instructions are to maintain the signal for as long as possible, as often as he can; how he does so is up to him.

Some researchers believe that, for humans, hypnosis may serve as a substitute for curare in blocking out distractions. Recently Dr. Philip G. Zimbardo of Stanford University trained several subjects under hypnosis to vary the temperature of their hands. Dr. Zimbardo merely told his subjects to relax and to make one hand hotter than normal and the other colder. Although other experimenters have thought it important to supply their subjects with feedback on their performance, Dr. Zimbardo found that informing his hypnotized subjects about their progress merely distracted them.

The therapeutic possibilities of visceral learning have only begun to be explored. Further research, Dr. Zimbardo says, "will enable us to understand and hopefully to modify the behavior of human beings who somehow 'naturally' induce such disorders as rapid heart action, ulcers, asthma, excessive sweating and similar problems." Dr. Miller agrees that visceral learning may offer an explanation of the ways in which psychosomatic disorders are developed, and has planned a further series of animal experiments to explore the ways in which such disorders might be produced.

"If a child is afraid of going to school," Dr. Miller explains, "he might display a variety of autonomic symptoms. If one of the symptoms, say an upset stomach or a change in heart rate or blood pressure, is particularly disturbing to the child's mother," he says, "she might reinforce the symptom by demonstrating her concern or by keeping the child at home." Eventually, the child might develop a habit of responding to stressful situations with a visceral symptom.

Presently Dr. Miller and his colleagues are experimenting to see whether non-curarized animals can learn harmful visceral responses. They are also trying to determine whether there is a critical period during the animal's infancy when visceral learning is particularly intense and long-lasting.

"It's too early to promise any cures," says Dr. Miller, "but there's no doubt that we have developed a powerful new learning technique." □