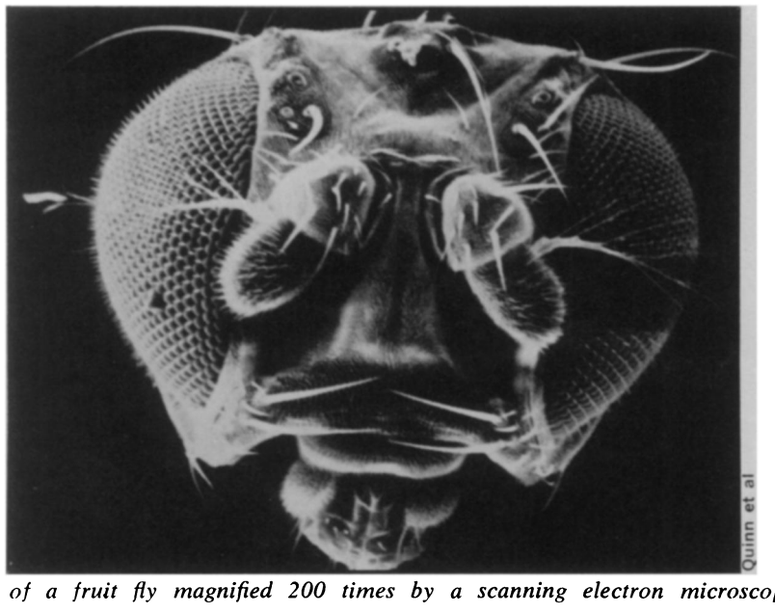
Flies That Learn

Fruit flies can respond to behavioral conditioning



Face of a fruit fly magnified 200 times by a scanning electron microscope.

by Joan Arehart-Treichel

There is a saying that "you can't teach old dogs new tricks." But there is no law that you can't teach new flies old tricks. That is more or less what geneticists at the California Institute of Technology and at the University of Freiburg in Germany have done—train fruit flies (*Drosophila melanogaster*) to avoid specific smells and visual cues. The flies' conditioned behavior is typical of learning in higher animals and people. It can persist—in the case of the flies for a day—but is rapidly extinguished or reversed by retraining.

Such training, or behavioral conditioning, has been tried on fruit flies before, but with questionable success. So these research reports appear to be the most convincing to date that fruit flies are able to learn. Actually, fruit flies' intelligence is not surprising when one considers that the flies stand halfway in complexity between the one-cell bacterium and humans. As Seymour Benzer of the Caltech group puts it, "One must not underestimate the little creatures, which are not an evolutionary antecedent of man, but are themselves high up on the invertebrate branch of the phylogenetic tree."

Past efforts to teach fruit flies have been fraught with pitfalls, such as pseudoconditioning, where a training schedule nonspecifically alters the state of a fly, producing changes in behavior that can be misinterpreted as associative learning. Another hazard is the possibility of flies providing odor cues that interfere with the cues designed by the researchers. Benzer, William G. Quinn and William A. Harris of Caltech set up experiments to avoid these complications.

During training, flies were exposed to two different stimuli—either two odors or two colors of light—one of which was associated with a negative reinforcement such as electric shock. The flies were then removed and tested in a new apparatus, similar to the training arrangement but without reinforcement, and their avoidance of each of the two stimuli was measured. The reciprocal experiment was then done on a second group of flies, but with shock coupled to the other stimulus. In both sets of experiments the flies selectively avoided the stimulus that had been associated with shock during their training, but not the other stimulus.

The Caltech biologists interpret these results as unequivocal evidence that fruit flies can learn. "The flies' selective avoidance behavior," they say, "has the properties expected of conventional learning. It is extinguished or reversed by later training and is an individual rather than collective property of the flies."

The Freiburg biologists—H. C. Spatz, A. Emanns and H. Reichert—also set up elaborate and carefully controlled experiments in order to show that fruit flies can learn to discriminate visually. "Our findings," they conclude, "are considered proof of associated learning in *Drosophila* with respect to optical stimuli."

The California and Freiburg scientists are not teaching flies for that purpose alone, though. They hope eventually to isolate mutant flies with altered learning abilities. Such a feat may be possible because more is known about the genetics of fruit flies than of any other organism of such complexity. In addition, if a mutant can be isolated from fruit flies, it is possible to find the cells in the mutant fly where the gene exerts its effect. Such a feat has been achieved for various existing behavioral mutations by producing "genetic mosaics," individuals in which only part of the fly is mutant.

All this is in the future, though. "We won't be there for years," Harris predicts. □