HOW MUCH CAN FISH LEARN? By Stephan Reebs, Ph.D. Department of Biology University of Moncton, NB, Canada

○ Learning, defined as the ability to change behavior with experience, is widespread among animals. Behavioral scientists have studied it for a long time. Much of that work, however, has been limited to the so-called "higher" vertebrates (birds and mammals). There is a widespread perception that fish are not as "intelligent" as birds and mammals, and that their learning capacity is somewhat impoverished. Is that really the case?

The answer, of course, is no. Fish do show some solid evidence of being able to learn from experience. For example, many fish will come to the surface when we approach their tank with the food container; obviously, they can learn to associate our approach with the imminent arrival of food.

But how much can a fish learn? Where is the limit? I think that aquarists could easily contribute answers to these questions, provided that they are curious and have some free time on their hands. Some of the techniques that scientists use in the study of learning behavior in fish are not particularly sophisticated and could easily be duplicated at home. Here are-some examples of experiments that could be done in the home aquarium.

We can put to good use the tendency that fish have to go in advance to the place where food is delivered. Try to always feed your fish in the same corner of the tank, and before each feeding session, present a neutral, non-frightening signal (such as turning off the air pump or the filter, moving an object slowly in front of the tank, or turning on a colored light bulb). Make sure no other stimuli are consistently associated with the arrival of food (such as the movement of your arm above the tank). After just a few feeding sessions, the fish should go



to the the right corner each time you present the signal, even though the food has not yet arrived. This would show first that the fish is capable of classical conditioning (linking the neutral signal with the very significant arrival of food), and second that they are capable of spatial learning (discriminating between different corners within the tank).

We can make the situation a bit more complex. Use a group of fish that does not mind splitting up once in a while, and after the signal, drop food in two corners. However, consistently drop twice as much food in corner A as you do in corner B. Pretty soon, you should see the fish splitting up after the signal, with twice as many fish going to corner A as to corner B (either that or the most dominant fish will monopolize corner A while the others will be relegated to corner B). The fish have learned to discriminate between different payoffs, and they have fine-tuned their spatial learning. The phenomenon by which fish will distribute themselves proportionally to the payoff of various food sources is called "ideal free distribution." and it has already been observed in threespine sticklebacks (Milinski 1984) and in the cichlid Aequidens curviceps (Godin and Keenleyside 1984).

Can fish learn not only about space but also about time? Recently, I kept individual convict cichlids in 50-gallon tanks and I fed each one twice everyday, always in corner A in the morning and always in corner B in the afternoon. As a signal, I turned off the filter one minute before dropping the food. During that minute, I watched where the fish went. My hope was that the fish would learn to go to corner A in the morning and corner B in the afternoon. But after 18 days, the fish still had not learned to go to the right corner at the right time. Instead, they swam quickly back and forth between the two corners until the food arrived. Either these fish cannot learn about time-place associations, or it takes them longer than I was willing to wait.

Another type of learning takes place through social transmission. Here we would ask: Can a fish learn a new task just by observing another fish do it? Install a clear partition in your aquarium and place one fish on each side. Then present a signal and feed one of the fish (the "model") in a given corner while the other fish (the "observer") looks on. Do not feed the observer. After a few days of this, remove the model and the partition, and present the signal. If the observer has learned from the model, it should go straight to the corner where the model used to be fed. Very few experiments of this kind have been reported in the scientific literature (for a rare example, see Anthouard 1987).

There are a number of other simple experiments that could be tried. For example, what would happen if we simultaneously presented two signals before the arrival of food? Would the fish learn faster or more slowly? Laboratory rats learn more slowly (a phenomenon called overshadowing) but what about fish? And what if we present two signals one after the other for awhile (without feeding the fish), and then present the second signal just before food arrival for awhile, and then present the first signal again? Would the fish realize the transition from signal A to signal B to food arrival and react to A by going to the corner where food is delivered? We know that rats and pigeons can do it (a phenomenon that goes by the beautiful name of sensory preconditioning). Yet, to my knowledge, questions like these have seldom been addressed in fish (for an example, see Amiro and Bitterman 1980).

One last aspect of learning is the use of memory for recognition. There is ample evidence in the scientific literature that fish can learn to recognize their neighbors, rivals, mate, young, territory, or home. They can also recognize other species: in one study (Csanyi et al. 1989), paradisefish (Macropodus opercularis) spent less time investigating a goldfish that was dropped in their tanks if they had already seen a goldfish three months before. This example shows that fish can remember for a long time. Perhaps the most celebrated example of long-term memory comes from salmon, which can, after several years at sea, find their natal streams based on the scent they learned there during the first few months of their existence (Hasler and Scholtz 1983).

I do not recommend moving salmon into the home tank just for the pleasure of studying their learning ability, but certainly any favorite species is amenable to a few simple manipulations and observations just for the sake of curiosity. For all practical purposes, the goldfish has been the only species seriously studied in the lab; observing any other species would give you the satisfaction of boldly going where no scientist has gone before.

For more information on animal learning theory, a complete introduction can be found in Dickinson (1980). One can also consult Gleitman and Rozin (1971) or Kieffer and Colgan (1992) for a review of learning in fish.

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