be accelerated in and near bow shocks, namely at the earth (*8*) and at Jupiter (*9*). It is interesting, therefore, that perhaps only bow shocks in front of planets with magnetospheres can lead to high energy particle acceleration. This in turn reopens the question, Where do the particles gain most of their energy—that is, in the shock, behind the shock, or before escaping outward through the magnetospheric boundary? In view of the astrophysical importance for understanding shock acceleration of charged particles it is essential to resolve these alternatives.

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Seasonal Changes in Goldfish Learning?

Shashoua (*1*), using a "float training" technique, has recently confirmed reports by Agranoff and Davis (*2*), who used shuttle box avoidance procedures, that goldfish exhibit a cyclic annual change in ability to learn. A maximum was reported for the winter months, with a minimum occurring in the months of July and August. A possible cyclic change in hormonal levels was proposed as explanation for these findings (*1*).

For 4 years I have been training goldfish in shuttle boxes for use as "donors" in studies of the so-called chemical transfer of learning (*3*). Even though I used a schedule very similar to that employed by Agranoff's group (*2*), I did not observe any systematic seasonal change in learning ability. This was the case in work carried out both in the United States, where I obtained fish from the same supplier as Agranoff and Shashoua [Ozark Fisheries, Stoutland, Missouri (*4*)], and recently in Denmark, with fish supplied by Barilli and Biagi, Bologna, Italy. For example, the most recent groups of fish trained during the periods of Shashoua's maxima and minima, respectively, showed performances on the 10th and final day of training of 82.2 percent avoidance (mean of 18 fish trained in March) and 83.4 percent avoidance (mean of 12 fish trained in August).

It seems difficult to account for this discrepancy in results. An apparent difference in the way the fish are treated before training may be crucial, however. Both Agranoff and Shashoua use the fish 1 or 2 days after arrival, and do not report feeding the fish (*1*, *2*). In all of my work the fish were allowed an adaptation period of at least a week in the home tanks, and were fed twice a day, before being used in an experiment. Shipment during the hot summer months, when minimal learning ability was reported to occur, is probably highly stressful, even more so because the metabolic rate of the fish, which are poikilotherms, will be greatly increased. The effects found by Agranoff and Shashoua may be due to greater stress and starvation preceding training in the summer months. Therefore it would appear premature to propose any endogenous mechanisms for the observed effects.

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Fjerdingstad proposes that metabolic stress during shipment or the feeding schedules used may be responsible for my observations (*1*) and those of Agranoff and Davis (*2*). As I reported (*1*), animals obtained from local hatcheries and those obtained from Ozark Fisheries showed the same cyclic patterns of activity and learning behavior, so that the stress in transport could not be a factor. Also, all our animals are kept at a constant temperature (21°C), and they are fed once a day, so that starvation cannot be a determining factor.

Two features of Fjerdingstad's experiments (*3*) suggest that the goldfish he used had a low level of arousal in both summer and winter: (i) the animals required 10 days to learn a shock avoidance task to the 80 percent criterion and (ii) the experiments were done without aerating the water in the test aquariums. In my experience, winter goldfish can be trained to learn to avoid a shock in about 50 trials in a period of 3 hours to a criterion of 90 percent correct responses. This was achieved by vigorously aerating the water and not overfeeding the animals (that is, feeding once a day); the last feeding was 18 hours before the onset of the training. No such results could be obtained with summer animals. It seems possible that Fjerdingstad's results for training situations that require a period of several days are not influenced by the level of arousal of the animals, so that both his summer and winter animals correspond to my summer goldfish.

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