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NOTE

1. Supported by Grant FR-00167 from the National Institutes of Health. I am grateful to Robert Woodworth, William Hagquist, and Diane Eich for their assistance.

The placement of shocking electrodes for escape and avoidance learning in fish

FRANK T. SEVERIN, Saint Louis University, St. Louis, Mo. 63103

Measurements were made to determine whether the voltage gradient in the body of a fish swimming between two vertical electrically charged plates would vary with the animal's orientation. The voltage gradient in anesthetized goldfish positioned perpendicular to the electrodes was found to be five times greater than when oriented parallel to them. A suggestion is made for minimizing this differential in avoidance-learning apparatus.

An experimental situation for small aquatic animals described by Horner, Longo, & Bitterman (1961) and Bitterman (1966) has stimulated interest in the use of fish in psychological laboratories for the study of escape and avoidance learning. One feature of this apparatus which has been widely imitated is to place the shocking plates in the walls of the training tank.

Judging from the voltage gradient between electrodes set either at the sides or

the ends of a tank, the shock delivered to a fish should vary in intensity depending upon its orientation at the moment. When positioned perpendicular to the electrodes, the voltage drop along the length of its body should be greater than across its narrow dimension when swimming parallel to them. The present investigation was undertaken to verify this differential.

METHOD

Three goldfish of 5.5 cm standard length served as Ss. The apparatus consisted of two vertical stainless steel plates, 15 cm square, placed parallel to each other, 15 cm apart, in a plastic container of water. A potential of 8 V was applied across these plates by means of a battery in series with a variable resistor. Two sets of needle electrodes, 10 cm in length, were fashioned from 20-gauge silver wire and fixed rigidly in 3 x 3 x 14 cm holders. The 5-cm distance between one pair of electrodes corresponded to the length of a goldfish. The 1.1-cm spacing of the other pair represented the narrow dimension of the fish. The ends of the electrodes to be immersed in water were sharpened to a point and bent into small hooks parallel to each other. To inhibit polarization, the silver wires were chlorided by connecting them through a battery to a sheet of silver in a 5% sodium chloride solution (Hill, 1950). Voltage measurements were made with a Sylvania vacuum tube polymeter, Model 303.

Each set of needle electrodes was immersed 4 to 5 cm in the water, midway between the metal plates, with its holder

perpendicular to them. The voltage drop across the electrodes was then determined. Throughout the experiment, 10 readings were taken for each measurement and the average value accepted. The electrodes were tested for polarization before and after each set of 10 readings by placing them in a sodium chloride solution while attached to a battery to see whether they would support a steady current of a fraction of a milliamperere for 60 sec (Hill, 1950). A goldfish, anesthetized with MS 222 (Tricainmethanesulfonate), was attached by the snout and region of the caudal peduncle to the first pair of needle electrodes and placed perpendicular to the plates midway between them. Readings were taken of the voltage gradient along the length of the fish. The second pair of electrodes was then hooked skin deep across the narrow dimension of the fish and similar readings taken, with the fish positioned parallel to the plates. These measurements were repeated with two additional goldfish.

RESULTS AND CONCLUSION

Since the shocking plates used in this experiment replicate the condition of electrodes placed either in the walls or the ends of an avoidance training tank, it can be seen that the voltage gradient in the body of a fish will depend upon its own alignment. Positioned perpendicularly to the shocking plate, the voltage drop measured along the length of a fish was five times greater than across its narrow dimension when oriented parallel to them. These findings confirm a subjective experience which served as the starting point for this investigation. While experimenting with electrodes set in the sides of a smaller tank, the author placed his hand in the water between them. When held with the axis between the thumb and middle finger perpendicular to the electrically charged plates, a stinging sensation was felt in abrasions on the joints of these two fingers. The pain ceased whenever the hand was rotated 90 deg. A fish generally maintains a level position in the water and, in diving or surfacing, describes a small angle compared with the 360 deg it is free to turn in the horizontal plane. Electrodes placed at the bottom of the tank and near the surface of the water should minimize differences in voltage gradient due to the animal's orientation.

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Table 1
Gradient in Volts Measured in the Bodies of Goldfish Oriented Perpendicular with and Horizontal to Two Vertical Electrodes

	Orientation of Fish	
	Perpendicular	Horizontal
Fish A	1.6	0.3
Fish B	1.6	0.3
Fish C	1.6	0.3
Electrodes without Fish	1.7	0.3

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