TECHNICAL NOTE

A HARNESS AND ELECTRODE CONNECTOR FOR RATS¹

Several methods have been used to make electrical or physical connection with rats in behavioral studies. Although electrified grids with a scrambling circuit have been most commonly used to deliver electric shock, they are generally considered to be less than perfect for studies where the intensity of the shock is an important factor (see Bolles, 1966; or Azrin, Hopwood, and Powell, 1967), and not applicable when one of two subjects is to be selectively stimulated. Other methods also have disadvantages. Restraint devices, such as that developed by Azrin *et al.* (1967), provide considerably more control over shock intensity, but have the obvious disadvantage of restricting movement of the subject and preventing interaction with other animals or objects in the environment. Weiss (1967) developed a tail electrode that circumvents these difficulties, but rats shocked at the base of their tails direct much of their effort to attacking the area of stimulation, thus reducing the time they can engage in other behaviors. In addition, these attacks frequently sever the connecting wires unless they are protected by cumbersome shields or an electrically charged outer surface. The latter solution could confound data by introducing uncontrolled electric shock in a study where shock is a variable. Connectors using a belt or strap (Ferraro, Silver, and Snapper, 1965) to hold surface electrodes in place require delicate application to assure that the belt is neither too loose nor too tight, and to avoid short circuits by way of smeared or squeezed electrode paste.

A simple, efficient, and inexpensive apparatus for making electrical and physical contact with rats has been in use in this laboratory for more than 2 yr. The apparatus consists of a harness with connectors on both sides, one on the inner surface to connect to electrodes subcutaneously implanted in the nape of the subject's back, the other on the outer surface to connect to sensing or stimulating equipment via a mercury swivel commutator.

The harness, pictured in Figure 1, is literally a vest worn over the back of a rat. Two rubber "O" rings having an inside diameter of 1 in. (2.5 cm) and a thickness of $\frac{3}{32}$ in. (0.2 cm) form the arm loops at the end of a 2-in. (5 cm) length of a 1.25 in. (3.2 cm) wide heat-resistant waistband elastic that covers the upper portion of the animal's back. A $\frac{1}{8}$ in. by 1.25 in. by 0.25

in. (1.4 by 3.2 by 0.64 cm) thick block of Plexiglas, affixed to the center of the elastic band, provides a mounting base for the connectors leading up to the commutator and down to the electrodes.

The harness is constructed by making a 1.5 in. (3.8 cm) fold on each end of a 5 in. (12.7 cm) length of the elastic band, placing an "O" ring in each fold, and sewing the resulting tabs through each other, and to the unfolded portion. The completed harness is approximately 2 in. (5 cm) long (excluding the "O" rings) and has a 1 in. (2.5 cm) center section with three thicknesses of the band. The Plexiglas block is drilled and tapped to receive the $\frac{1}{4} \times 28$ thread of a Winchester SM2P plug (available from Pace/Avnet Electronics, 3901 Pace Court, Schiller Park, Illinois 60176), then riveted to the center of the elastic band. A $\frac{1}{8}$ in. (1.4 cm) Plexiglas rod, bored to fit over the $\frac{5}{16}$ in. (0.8 cm) outside diameter of the plug that extends above the block, is threaded with a $\frac{1}{8}$ by 12 die, cut to a 0.25 in. (0.6 cm) length, and cemented (with ethylene dichloride) to the block so that it completely surrounds the plug. The receptacle for the plug (Winchester SM2S socket, available from Pace/Avnet Electronics) is soldered to wires leading to a mercury commutator and covered by a threaded Plexiglas cap. Thus, after the plug is inserted in the receptacle, the cap can be screwed to the threaded Plexiglas that surrounds the plug to produce a securely locked connection.

One end of each of two insulated wires is soldered to the terminals at the back of the plug, the wires inserted through a small hole in the center of the elastic band, and the other ends soldered to the terminals of a miniature two-contact plug (#92 hearing aid plug, available from Plastic Products, Box 1204, Roanoke, Va. 24006). The miniature plug connects with a receptacle (MS 62 Socket, available from Plastic Products) that has been attached, via solderless connectors, to gold electrode wires (0.025 in. diameter) implanted in the upper back of the subject. The connectors are a crimp type (Waldon Electronics #S-1019 available from Newark Electronics) that have been cut in half to reduce length and weight. Electrode implantation is accomplished while the animal is under light, general anesthesia (30 mg sodium pentobarbital per Kg body weight) using the method described for rabbits by Rubin and Azrin (1967). Basically, the electrode implantation procedure consists of raising a loose fold of skin in the nape of the back and taking a single, small stitch with a surgical needle threaded with about 1.25 in. (3 cm) of gold wire. The two electrodes are implanted approximately 0.5 in. (1.2 cm) apart and are completely covered when the harness is attached.

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Fig. 1. Photograph of assembled harness. A. Rubber "O" rings, 2.5 by 3 by 0.2 cm. B. Waistband elastic, 3.2 cm wide. C. Plexiglas block, 1.4 by 3.2 by 0.6 cm. D. Winchester SM2P plug. E. Plexiglas rod, threaded $\frac{9}{16} \times 12$. F. Rivets, fixing Plexiglas block to elastic band. G. Plastic Products #92 hearing aid plug. H. Winchester SM2S socket. I. Plexiglas cap, threaded $\frac{9}{16} \times 12$. See text for construction procedures.

The inset in Figure 1 shows a rat wearing a harness. To attach the harness, the electrode receptacle is connected to the miniature plug on the harness. Then, one forepaw of the subject is placed through an "O" ring, the elastic band laid over its back and the other forepaw inserted in the second "O" ring. Finally, the commutator leads are plugged into the harness and the threaded Plexiglas cap tightened. The whole process takes less than 30 sec.

When the harness is in place, a rat cannot reach the area of electrode placement with either its mouth or its paws. Even rats receiving intense electric shock through the harness do not attempt to reach the electrodes, and they have never been observed biting or gnawing on any component of the harness.

Over the past 2 yr, this apparatus has been used with rats to deliver electric shock, record copulations (using the method of Rubin and Azrin, 1967), and measure activity (see Hake, Enoch, and Kelly, 1971), with no difficulty. Figure 2 is a cumulative record of a rat avoiding a 3-mA, 100-msec shock on a signalled escape/avoidance procedure with a response-shock interval of 40 sec and a shock-shock interval of 10 sec. Signal onset occurred 10 sec before a shock and was terminated by a response, but responses in the absence of the signal had no effect.

The total cost of the components of the apparatus is less than \$10.00. The entire apparatus, with the exception of the Plexiglas locking screw and cap (which require a lathe for construction), can be made with hand tools. Substituting a locking connector for the Winchester plug and socket would eliminate the need for a lathe.

The implanted electrodes, of course, have a tendency to "grow out" and must be replaced every four to six weeks. If the subjects are to be studied five days a week, it is suggested that the electrodes be removed following the last session of a week and replaced 18 to 24 hr before the first session of the next week.

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REFERENCES

- Azrin, N. H., Hopwood, J., and Powell, J. A rat chamber and electrode procedure for avoidance conditioning. *Journal of the Experimental Analysis of Behavior*, 1967, 10, 291-298.
- Bolles, R. C. Shock density and effective shock intensity: A comparison of different shock scramblers. *Journal of the Experimental Analysis of Behavior*, 1966, 9, 553-556.
- Ferraro, D. P., Silver, M. P., and Snapper, A.G. A method for cardiac recording from surface electrodes in the rat during free-operant procedures. *Journal of the Experimental Analysis of Behavior*, 1965, 8, 17-18.

Fig. 2. Cumulative record of signalled escape-avoidance responding by a rat receiving electric shock via the harness and implanted electrodes. The shock had an intensity of 3 mA and a duration of 100 msec. The response-shock interval was 40 sec, the shock-shock interval 10 sec, signal onset occurred 10 sec before shock and was terminated by a response, but responses in the absence of the signal had no effect. Signals are indicated by a downward deflection of the stepping pen and shocks are indicated by a pip on the base pen.

- Hake, D. F., Enoch, V., and Kelly, J. F. A simple method for measuring the general activity of rats in brain stimulation and other studies. *Journal of the Experimental Analysis of Behavior*, 1971, **16**, 63-65.
- Rubin, H. B. and Azrin, N. H. Temporal patterns of sexual behavior in rabbits as determined by an automatic recording technique. *Journal of the Experimental Analysis of Behavior*, 1967, **10**, 219-231.
- Weiss, Jay. A tail electrode for unrestrained rats. *Journal of the Experimental Analysis of Behavior*, 1967, **10**, 85-86.