TECHNICAL NOTE

*A TECHNIQUE FOR RECORDING ELECTROMYOGRAPHIC
ACTIVITY IN FREELY-MOVING RATS USING AN
ALL-PURPOSE SLIP RING COMMUTATOR¹*

The method described permits the stable recording of electromyographic (EMG) activity from freely moving rats. The technique practically eliminates movement artifact and is especially useful for recording chronically in experimental situations of long duration.

EMG was recorded from two electrodes sutured to the surface of the clavotrapezius and acromiotrapezius muscles of the neck while the rat was under Nembutal anaesthesia. The muscles were exposed by extending a sagittal incision made on the scalp posteriorly along the skin for about 2 in. Care was taken to clear the connective tissue attached to the muscles. The electrodes consisted of flexible, braided stainless steel wire covered with plastic insulation (Electrodyne, # 201);² they were approximately 3.5-cm long. The insulation was removed from one end of each electrode to expose an area approximately 7-mm long. The exposed end was then twisted into a loop and covered with "insulex" so that only a 1-mm area was bare. The insulex also helped retain the shape of the loop over a considerable period of time. The construction of the electrode loop is schematized in Fig. 1. The electrodes were secured to the surface of the muscles by three sutures around each loop and one suture along the stem of each wire, to prevent them from moving excessively when the muscles were flexed or relaxed. This precaution reduced recording artifact produced by movement. Unabsorbable silk thread was employed for the sutures. An area of about 2 to 3 mm was left between the bare ends of the two electrodes to minimize the amplitude of heart rate signals that might be picked up. Both electrodes were attached to an Amphenol 223-21-05 connector (with Amphenol 220-P01 pins) firmly cemented to the skull. The incision along the skin was then sutured with catgut (#4/0). During recording, the connector was attached to a lead-in cable by an Amphenol 223-22-05 connector (with Amphenol 220-S01 pins) which led to the commutator described below and then to a Grass Model 7 polygraph.

Figure 2 contains samples of EMG records obtained with this technique while rats were pressing a lever

for food reinforcement. The records are free of movement artifact, and heart-rate signals superimposed on EMG at settings of 50 microvolts per centimeter are minimal even when EMG activity is low. The preparation has been used for at least two months.

The heart rate signals seen on the fifth channel of Fig. 2 were recorded from one Grass disc electrode chronically implanted under the skin and from one of the EMG electrodes. It is worth noting that this method permitted the recording of heart-rate signals of greater amplitude than was possible with our original technique (de Toledo and Black, 1965).

A few years ago, Sutton and Miller (1965) described a mercury swivel designed to provide electrical recordings without movement artifact from freely moving animals; we found the mercury swivel unsatisfactory for noise-free recordings. The main objections were interference due to movement artifact caused when the swivel rotated rapidly and the frequent oxidation of the mercury. The following slip ring swivel with brass and carbon contacts has proved better than the mercury swivel and has provided noise-free recordings of heart rate, EMG, EEG, and respiration even at high sensitivity levels (*cf* the EMG and heart-rate tracings in Fig. 2).

The swivel consists of a Plexiglas rod, 3-in. long and 0.5 in. in diameter, drilled longitudinally with a $\frac{1}{32}$ in. hole. The rod is fitted with 0.25-in. brass rings sep-

Fig. 1. Diagram of the electrode loop.

¹Supported by Research Grant No. 81 from the Ontario Mental Health Foundation and by Research Grant APY 42 from the National Research Council of Canada to A. H. Black. Reprints may be obtained from A. H. Black, Dept. of Psychology, McMaster University, Hamilton, Ontario, Canada.

²Purchased from Electrodyne Inc., 15 Southwest Part, Westwood, Mass.

Fig. 2. Samples of electromyographic activity (EMG) and heart rate (HR) records from two subjects. Gain on EMG = 50 mv/cm; time constant for integration = 0.02. BP—bar presses; INT EMG—integrated EMG. Channel 3 is a code used to describe the behavior of the subject.

Fig. 3. Diagram of swivel.

arated by insulating washers, $\frac{1}{16}$ in. thick and 0.5 in. in diameter. The brass rings are carefully polished to provide a smooth surface. Insulated wires (# 28) are soldered to the inside surface of the rings and are brought out to the upper end of the assembly through grooves cut into the central shaft; the wires are secured at the upper end by means of 0-80 RH screws tapped

radially into the shaft. The lower end of this ring assembly is fitted to a ball race contained in a housing machined from a 3.5 in. by 2.25 in. by 1 in. block of Plexiglas. The top section of the housing is drilled so that the upper end of the ring assembly protrudes through and rotates freely. Brush holders made from 1-in. lengths of brass tubing with an inside diameter of $\frac{1}{8}$ in. and an outside diameter of $\frac{3}{16}$ in. are mounted horizontally in the housing. Carbon brushes (Meccano # 1500, 0.25-in. long and $\frac{1}{8}$ in. in diameter), fitted into these holders, are pushed by springs (Meccano # 1505)^a and make contact with the brass rings on the rotor. The brushes are bedded in by means of sand paper to ensure good contact with the rings. Outputs leading to a recording unit, such as a polygraph, are taken from the body of the brush holders. Whenever necessary, the brass rings can be easily cleaned with a regular pencil eraser. The different parts of the swivel are schematized in Fig. 3.

REFERENCES

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- Sutton, D. and Miller, J. M. Implanted electrodes: cable coupler for elimination of movement artifact. *Science*, 1963, 140, 988-989.

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^aThese carbon brushes and springs are similar to those used in Grason-Stadler shock generator scramblers.

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