A SIMPLE SYSTEM FOR THE RECORDING OF SINGLE UNIT ACTIVITY IN UNRESTRAINED CATS

R. TARNECKI, A. SOBIESZEK, Z. KARTASIŃSKI and J. RAJKOWSKI

Department of Neurophysiology, Nencki Institute of Experimental Biology
Warsaw, Poland

For recording the activity of single neurons in unanesthetized animals two techniques can be used: permanently implanted microwires (7) or movable microelectrodes (1, 2, 4–6, 8). The latter method permits to make a selection of cells in the course of the experiment. However, cells cannot be kept for a long time and are easily lost during violent head movements. Besides, successive penetrations cause some damage to the brain tissue and increase the risk of infection.

Several requirements should be met by any system to be really effective during behavioral experiments. The system should be precise, solid and easy to operate. Obviously the device should be small and light so that it does not cause too much discomfort to the animal. This is especially important when we try to relate some forms of spontaneous or acquired behavior to altered patterns of neuronal activity. Probably no single technique will solve all the problems involved in that type of research on unrestrained animals.

Some systems successfully used are very complicated and expensive (1, 3, 4). Evart's hydraulic microelectrode positioner requires many specially machined parts. Other systems also required many small precise details, which need sophisticated shaping (4).

The system described here is simple and easy to manufacture, yet enables a precise localization of the recording electrode. The micro-manipulator consists of a U-shaped, light-metal frame and of a fine-thread screw, rotating between its arms (Fig. 1). The microelectrode can be advanced to the target by turning the knob A. The depth of penetra-
tion is limited by the length of the U-shaped frame. Subcortical penetrations require longer screws, whereas for a cortical recording the system can be made small in size. Because of the construction of the supporting base there may be no dead space and the effective depth of electrode penetration may be equal to the length of the screw. The length of the micromanipulator described in this paper, complete with the supporting screw (Fig. 1 and 2), is 60 mm. It could be reduced by 30% for cortical recording. Fine adjustments at the recording site can be done by knob A, connected with the turning disc of knob A by a rubber transmission ring (Fig. 2A-A). Rotation of the rubber transmission ring during rotation of knob A is prevented by a clutch. A microelectrode holder (Fig. 2B) is fixed to the screw. Side movements of the electrode during penetration are eliminated by special construction of the holder. The holder has a guide shoe which moves along the keyway cut in the frame. The shoe is rigidly adjusted in the keyway by a ball. The ball is pressed by a spring towards the keyway side (Fig. 2B-B). This system also considerably reduces friction. The micromanipulator attached to the adapter (Fig. 1, 2) can be easily coupled to the steel cylinder (Fig. 1C, 3) supporting the micromanipulator during recording. Besides, the whole system may be protected and screened by a metal shield. Details of construction of the micromanipulator are shown on Fig. 2.
Using a simple calibration system (Fig. 3) the supporting cylinder can be easily implanted in any place on the skull in a vertical plane of the Horsley–Clarke coordinate system. This is achieved by providing the cylinder with a sloping base. Since the slope of the skull varies with the lateral Horsley–Clarke coordinate it is necessary to have a series of cylinders with differently tilted bases.

As the first step during implanation of the cylinder, a round 1 cm diameter opening is made in the skull, centered above the target. When the hole is made and the cylinder with a properly tilted base is selected, four bolts are screwed around the skull opening and the cylinder, which had been positioned in a calibrated vertical plane by the calibrator.
Fig. 3. Details of the calibration system.
1, cylindrical adapter attached to the electrode holder of the stereotactic apparatus; 2, removable conical element for calibration of the center of the supporting cylinder in the Horsley-Clarke coordinates; C, the position of the supporting base attached to the cylindrical adapter in place of the conical element, after calibration.

holder, is cemented to the skull. The ring in the lower part of the cylinder and the four bolts serve to fix the steel cylinder rigidly to the skull. After completion of the recording, the cylinder is covered with a nylon cap.

The advantage of the system described here is that it may be easily mounted on the skull for recording. Besides, after the completion of one penetration, it may be quickly reset for the next recording from another region of the brain. The adapter by which the micromanipulator is coupled to the previously implanted steel cylinder is eccentric to the axis of the cylinder (Fig. 2SB2) The steel cylinder receives adapters with different eccentricity. As a result of such a construction, the microelectrode can be made to enter the cylinder at eccentricities varying between 0 and 5 mm. The micromanipulator fixed on the cat’s head ready for recording, is shown on Fig. 4. Location of the FET circuit
directly on the micromanipulator (Fig. 1D) makes recording easier because it minimizes the movement artifact.

The system has been tested in cats where single cells can be held for over an hour. Cells were recorded for several months from the same animal.

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R. TARNECKI, A. SOBIESZEK, Z. KARTASIŃSKI and J. RAJKOWSKI, Nencki Institute of Experimental Biology, Pasteura 3, 02-093 Warsaw, Poland.