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BRIEF COMMUNICATION

The Contact Method: A Simple Technique for Electrical Self-stimulation without External Leads[1]

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WOLF, G., L. V. DICARA AND W. SIMPSON. *The contact method: a simple technique for electrical self-stimulation without external leads.* PHYSIOL. BEHAV. 11(5) 721–723, 1973.–Electrical currents to reward areas of the brain were administered without the use of external leads by utilizing a method conceptually similar to that of the electronic drinkometer. A wire brush connected to the intracranial electrode protudes above the rat's head. By lifting its head the rat can make contact between the brush and a stimulation plate mounted horizontally overhead. The stimulation circuit is completed through the contact of the rat's feet with a grounded metal floor. Current thresholds and stimulation rates obtained by this method were identical to those obtained by the conventional method of stimulation.

Self-stimulation Wireless contacts Chronic access Rats

THE PHENOMENON of electrical self-stimulation of the brain has been under intensive investigation during the past two decades, and a great deal of information has been gained concerning its neuroanatomical and physiological substrates and its relations to other kinds of motivated behavior [4, 6, 8]. On the other hand, little is known about the effects of positively reinforcing brain stimulation upon other behavioral and physiological processes. We are initiating a research program aimed at elucidating the effects of chronic unlimited access to rewarding intracranial stimulation as well as other positive reinforcements upon several behavioral and physiological variables such as social behavior, learning abilities, resistance to stress, and regulatory functions.

There are several technical problems involved in experimental paradigms requiring prolonged periods of access of the experimental animal to electrical brain stimulation. Electrical leads are cumbersome, restrict movement, and severely limit the variety of environmental situations under which self-stimulation behavior can be studied. If the animal is allowed to turn around freely a swivel or commutator is necessary to prevent twisting of the leads [1, 2, 5]. Wireless control via radio transmission to a miniature receiver and current source implanted into the animal circumvents the need for external leads but requires relatively complex electronic apparatus and is better suited for large laboratory animals such as monkeys [3, 7, 9].

In the present paper we describe a simple method for providing a source of stimulating current to rats with implanted electrodes without the use of external leads or radio transmission devices. The method is based upon the concept of the electronic drinkometer whereby the rat closes a circuit between a drinking spout and the floor of the cage whenever it contacts the spout. The study to be described indicates that current intensisty thresholds and self-stimulation rates for the present contact method and for the conventional method utilizing a bar press operant are highly similar.

METHOD

Data have been compiled on self-stimulation behavior of 20 rats with the two types of contact devices shown in Fig. 1. Formal presentation of data in this paper is limited to 8 rats in which current thresholds and stimulation rates were compared using the contact and conventional stimulation methods. Other observations are presented in the discussion section.

Animals and Implants

Eight male Sprague-Dawley rats weighing between 350 and 400 g were used. A single monopolar electrode was

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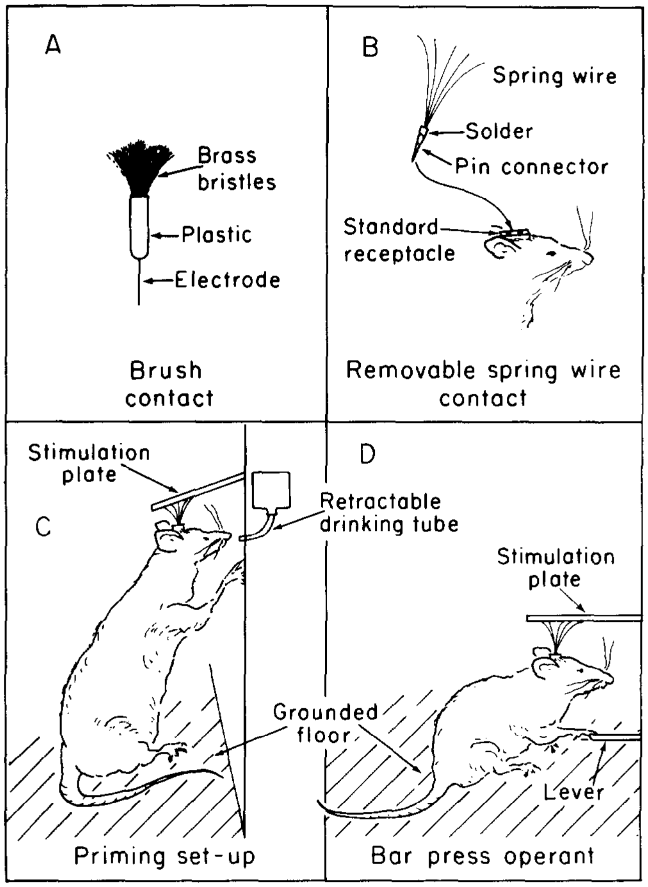

FIG. 1. (A) Brass brush contact assembly used in present study. (B) Removable spring wire contact assembly which may be used with standard pin connector to allow contact or conventional self-stimulation. See Discussion for other uses of the two types of contacts. (C) Contact set-up requiring rearing to make contact with stimulation plate and allowing automated priming via programmed access to retractable drinking spout below stimulation plate. (D) Contact set-up utilizing bar press operant to activate stimulation plate.

implanted into the posterior lateral hypothalamus of each rat using standard stereotaxic techniques. The electrodes were 0.010 in. dia. NiCr wire insulated except for the tip. A bundle of brass wire bristles taken from a suede brush were attached to the top of the electrode as shown in Fig. 1A. The entire assembly of electrode and brush were held in the electrode carrier and implanted so that the brush protuded about 1 in. above the rat's head from which it was insulated via a plastic collar.

Contact method. An 11 x 8 x 7 in. chamber with a stainless steel plate floor and a stainless steel plate covering half of the ceiling was used for delivering the stimulation current. When the rat stood up on his hind legs so that his brush made contact with the stimulation plate, he received a 300 msec train of 60 Hz sine waves. In order to initiate another train of pulses the rat was required to break and remake the contact between the plate and floor. A current sensing device in series with the stimulator monitored the contacts and triggered the programming equipment controlling the stimulator. A subsequently devised simpler method for identifying contacts is described in the Discussion section.

Initial training of the operant response of standing on the hind limbs and contacting the stimulation plate with the brush was accomplished very rapidly. Upon first being placed in the chamber the rat was induced to investigate the top of the chamber by tapping it with a pencil. When the rat stood up and his brush contacted the plate he received a 300 msec train of pulses at 30 to 50 μA. All animals quickly learned to move their heads up and down to repeatedly contact the plate and receive stimulation at this intensity.

Conventional method. A standard self-stimulation chamber (5 x 12 x 12 in.) with 4 x 4 in. lever mounted on the wall at one end about 1 in. above a stainless steel plate floor was used. An external lead was firmly connected to the brush protruding from the rat's head by means of a small spring clasp. The lead passed through a slot along the length of the ceiling of the chamber to an overhead boom to allow relatively free movement through the box. Depression of the lever delivered 60 Hz current for 300 msec at 30 to 50 μA intensity. Animals were shaped to press the lever within a few moments after being placed in the chamber and continued to press repeatedly until the training session was terminated.

Threshold determination. Following the initial training sessions individual current thresholds were determined by the methods of limits under both contact and conventional self-stimulation conditions. Response rates were recorded at 5 min intervals with ascending and descending orders of current intensity. The ascending order began at 7.5 μA and increased in 7.5 μA steps to at least 3 steps beyond the threshold. The descending order mirrored the ascending order. The threshold was defined as the current at which responding increased at least 100% above the baseline.

RESULTS

Thresholds, stimulation rates, and intensity–response curves were highly similar using the two self-stimulation methods. The mean current intensity threshold for the contact method was 31 μA with a range of 15–60 μA, and the mean stimulation rate at threshold intensity was 191 per 5 min period with a range of 68–326. With the conventional method the mean threshold current intensity was 30 μA with a range of 22–60 μA and the mean stimulation rate at threshold intensity was 185 per 5 min period with a range of 54–319. The correlation between the thresholds obtained by the two methods was 0.81.

DISCUSSION

The results indicate that critical parameters of self-stimulation behavior such as current threshold and stimulation rates are not altered when the current is presented via the contact method described here. Thus in many instances the contact method can be substituted for the conventional method with great advantage, and several new experimental paradigms become feasible.

Several other observations we have made during the course of our investigations will be of interest. The best all around method of delivering and monitoring current which we have found to date is to use a small (2–3 in. square) stimulation plate such as shown in Fig. 1C and 1D which is attached to the wall by a hinge so that slight pressure from brush contact lifts it to close a microswitch. We have also successfully used a conventional bar press to activate a stationary stimulation plate overhead (Fig. 1D). The more rigid bristle contact assembly shown in Fig. 1A is best for the plate lifting operant while the flexible spring wire contact assembly shown in Fig. 1B is best for maintained contact with a stationary plate.

When priming is necessary to initiate self-stimulation it can be accomplished in several ways. Most simply, one can place the rat's head in position under the plate and make several contacts manually – generally the rats immediately commence making voluntary contacts. Priming can also be automated by placing the stimulation plate above a retractable drinking spout as shown in Fig. 1C. The rat is trained to approach the spout to obtain a palatable solution and thereby makes contact with the stimulation plate. Closure of the stimulation circuit activates the retraction of the drinking spout.

We have monitored the self-stimulation current on an oscilloscope to determine if there are any particular distortions of amplitude or waveform associated with the contact method. When a microswitch activated hinged plate is used so that good contact is assured the current parameters are perfectly stable and indistinguishable from those of the conventional current delivery method. Even with a stationary plate which delivers current continually as long as contact is maintained, the current parameters generally remain stable except for occasional distortions at the make or break of a contact.

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REFERENCES

1. Atrens, D. M. An inexpensive swivel device for the delivery of brain-stimulation to unrestrained animals. *Physiol. Behav.* **5**: 707–708, 1970.
2. Cooper, B. R., D. L. Mores, W. J. Potts and W. C. Black. A simplified and inexpensive swivel for electrical stimulation. *Physiol. Behav.* **4**: 117–118, 1969.
3. Delgado, J. M. R. Telemetry and telestimulation of the brain. In: *Bio-Telemetry,* edited by L. Slater. New York: Pergamon Press, 1963.
4. Hoebel, B. G. Feeding and self stimulation. *Ann. N.Y. Acad. Sci.* **157**: 758–778, 1969.
5. Moss, D. E. and D. D. Avery. An inexpensive, programmable, electromechanical commutator. *Physiol. Behav.* **7**: 649–651, 1971.
6. Olds, J. Hypothalamic substrates of reward. *Physiol. Rev.* **42**: 554–604, 1962.
7. Rugh, J. D. A biphasic radio-controlled stimulator. *Physiol. Behav.* **6**: 267–269, 1971.
8. Valenstein, E. S. The anatomical locus of reinforcement. *Prog. physiol. Psychol.* **1**: 149–190, 1966.
9. Zeier, H., G. Tschannen, H. Seitz and A. Fideler. A device for wireless brain stimulation in operant conditioning situations. *Physiol. Behav.* **3**: 587–590, 1968.