The kindling effect as a part or full-term laboratory exercise in physiological psychology courses

JOHN GAITO

York University, Downsview, Ontario, Canada M3J 1P3

Use of the kindling effect for laboratory work in physiological psychology courses is suggested. This effect can involve a number of learning experiences: making bipolar electrodes, implanting these electrodes in the amygdala, stimulating animals and observing behavior for weeks or months, doing histological analyses. A simple kindling experiment for a full term is described.

Brain stimulation or brain lesioning exercises are favorite ones for student laboratory work for courses in physiological psychology (Hart, 1969). A typical exercise is for students to lesion or to stimulate the lateral hypothalamus (LH) or ventromedial hypothalamus (VMH) to observe changes in feeding behavior. Unfortunately, for beginning students, the LH and VMH nuclei are small in size; thus, they are difficult to hit, and failures are common. This problem exists also in attempting to place electrode tips in many other small nuclei.

Another possibility is to make use of the kindling effect for laboratory exercises (Gaito, 1974; Goddard, McIntyre, & Leech, 1969). A group of researchers (Goddard et al., 1969) have found that repeated low-intensity stimulation, via implanted electrodes in a number of subcortical sites, eventually leads to bilateral clonic convulsions. For example, electrical stimulation administered daily to the amygdala produces clonic convulsions, on the average, in about 10 to 15 trials in the rat. This brain site provides the fastest kindling rate. The initial stimulations have little effect on the animal's behavior (Stage 1, normal exploratory behavior); with a few repetitions, overt indications of seizure activity can be observed, e.g., eye closure, chewing, salivation [Stage 2, behavioral automatisms (BA)]. With further stimulations, these automatisms culminate in a complete convulsion [Stage 3, clonic convulsions (CC)]. The rat stands on its hind paws and bilateral clonic convulsions ensue; these continue after the electrical stimulation is terminated. (For further information on the kindling effect, see Gaito, 1974.)

The advantages of using this paradigm are:

(a) The amygdala, which is a complex group of nuclei, is relatively large in size, and stimulation in any part appears to produce kindling (Goddard et al., 1969); therefore, it is easier to achieve a hit on the amygdala than on other smaller structures such as LH and VMH. This is important for beginning students because it provides positive motivation.

(b) The kindling effect involves a number of experiences extending over a period of several months which would be of value to the student. These learning

experiences are: making bipolar electrodes, implanting these electrodes, stimulating animals, observing behavior over a period of weeks or months, and doing histological analyses.

(c) The procedures could be extended to provide a simple experiment lasting for a complete term. There are a number of simple experiments which would be easy to conduct. One such experiment is described below.

A suggested kindling procedure for laboratory work is the following:

(1) **Constructing bipolar electrodes.** A variety of electrode wires are useful, e.g., stainless steel, platinum, nickel, chromium, nichrome, etc. We have found nichrome wire, with dimel or trimel coating, .127 mm in diam, to be very efficient. This wire is cut in 1½-in. lengths, and the insulation is removed for about ¼ in. at one end. This end is inserted in the open end of the electrode (Amphenol contact, No. 220-P02; Amphenol Industrial Division, 1830 S. 54th Avenue, Chicago, Illinois 60650) and soldered. The continuity of circuit is checked with a current tester (or similar device). Two functioning electrodes are inserted into an Amphenol strip connector (No. 221-1260) which has been cut to accommodate two electrodes. The two wires are twisted together, cut at exactly 8.5 mm length, dipped in epoxylite, and baked at approximately 60°C for 1 h. The tips then are removed of insulation for about .5 mm, and the two tips are separated about the distance of the diameter of one wire (.127 mm). The bipolar electrode circuit should be checked to ensure continuity of circuit with a circuit tester.

(2) **Implantation of electrodes.** We have found that stereotaxic coordinates which provide success with almost every rat are 0.5 mm posterior to bregma, 4.5 mm lateral, and 8.5 mm from the skull (Gaito & Gaito, 1974). Implantation of an electrode is described in a number of books (e.g., Hart, 1969). The adequacy of each bipolar electrode should be checked with a circuit tester just before implantation.

(3) **Brain stimulation.** Approximately 1 week after surgery, the electrical stimulation can begin. We have found that 30 sec stimulation at 100 µA (peak-to-

peak) with a 60-Hz Lafayette sine-wave stimulator to be effective. Although the student might stimulate the rat more than one time each day (with at least 1 h between trials), stimulation at a 24-h interval is the most practical and is supposed to provide optimum kindling (Goddard et al., 1969).

(4) **Histological analyses.** After approximately 30 days of stimulation, most rats should have achieved a number of clonic convulsions. Each rat should be sacrificed and histological analyses performed to discern where in the brain the electrode tip is located. There are many different procedures for histological analyses. A simple one is that by Hart (1969).

In the event that the instructor desires to extend the exercise for a complete term in the form of an experiment, the following simple experiment is suggested. This experiment would be concerned with the effects of handling on the rate of kindling. Each student would prepare bipolar electrodes and implant one in each of 10 rats. One week after surgery, the electrical stimulation would begin. Five of the rats would be gentled by handling for 15 min prior to each stimulation. The other five would not be gentled but would be stimulated immediately after being taken from the home cage. After bringing each rat to a criterion of 3 to 6 trials of CC, or to about 45 trials for those rats not showing a CC response, the experiment

could be terminated. The student could compare the handled with the nonhandled rats in one or more of possible dependent variables, e.g., number of CC; number of trials to first CC, three CC, or six CC; latency of CC; duration of CC. The student should compare his results with those obtained by Arnold, Racine, and Wise (1973). They reported that handling hastened the kindling rate.

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