TECHNICAL NOTE

A NEW DEVICE FOR MEASURING GENERAL LOCOMOTOR ACTIVITY IN INSTRUMENTAL CONDITIONING SITUATIONS¹

Several methods have been described to record overall activity of experimental animals. One is the treadmill type and its many modifications, *e.g.*, the nutating annular cage (Kissel, 1963). Others make use of magnetic pick-up (Mitchell, 1959) or loudspeaker (Word and Stern, 1958), self-centering contacts (Davis and Ellison, 1964), photocells (French and Harlow, 1955) and capacitance sensing devices (McClelland, 1965).

This note describes a simple, inexpensive recording system with an electromagnetic transducer. It has been developed for detecting quantitative changes in overall activity of pigeons in connection with brain lesions and for studying correlations of general locomotor activity and instrumental responses. The test animal stands and moves on a screen floor. The oscillations are transmitted by mechanical means to a loudspeaker, not by air pressure as in the stabilimeter of Word and Stern (1958). Movement of the speaker varies with the vertical component of forces on the screen floor, independent of the locus of application. An output voltage from the speaker is thus obtained which is proportional to the velocity of the vertical motion of the screen floor. This voltage is amplified and integrated into units which can be recorded by a cumulative recorder or by counters.

The construction of the oscillation receiver is shown in Fig. 1. A permanent magnetic loudspeaker (Philips AD 3500AM-06 or any type with an impedance of

about 800 ohms) is mounted in the center of a square panel (H). A cardboard tube (G) is centered in the cone of the speaker with flexible adhesive (F). Four aluminum levers are attached at right angles to the top of this tube. At the other end, these levers are bent rectangularly and support the screen floor in a fork. To transmit every motion of the pigeon, the screen floor should be as light and stiff as possible. It was made with 38 strips of material (each 8.5-mm wide and 380-mm long) cut from a 1.5-mm thick plate of Epoxy resin reinforced with glass fibers. The strips were slotted every 20 mm with half-width cuts. By putting these strips together crosswise and glueing them with Epoxy cement, a screen with a mesh size of 20 mm was obtained. Each of the four levers carrying the screen floor is equipped with a shaft (D) supported by two bearing

Fig. 1. Oscillation detector. A: Plexiglas covering; B: foam rubber; C: bearing block; D: shaft; E: rubber; F: adhesive; G: cardboard tube; H: wood panel; J: foam rubber support; K: test chamber.

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Fig. 2. Circuit of the amplifier-integrator. C_1 : Electrolytic capacitor 2.5 μF /2.5 V, C_2 : Two electrolytic capacitors in parallel, 2000 μF /2.5 V each, C_3 : Capacitor 0.15 μF /60 V or higher, C_4 : Capacitor 0.22 μF /60 V or higher, C_5 : Capacitor 0.1 μF /60 V or higher, C_6 : Electrolytic capacitor 3.3 μF /35 V; D_1 : D_2 : D_3 : D_4 : D_5 : D_6 : D_7 : 1N659, D_8 : 1N957a; Q_1 : Q_3 : Q_7 : Q_8 : Q_9 : 2N1613, Q_2 : Q_6 : 2N2904, Q_4 , Q_5 : Dual transistor 2N2913 or SP 8309 (Fairchild); R: 12 V Relay, e.g. Siemens Trls 154d or Leach E-A1BD, r_1 : r_2 : Relay contacts; CR: cumulative recorder.

Fig. 3. Sample of recorded locomotor activity (A) and pecking responses (B). Oblique lines indicate reinforcement; arrow indicates wing flapping.

blocks (C). The shaft protrudes on both sides of the lever and connects firmly with it. A bearing consists of a piece of rubber hose (E) slipped over each end of the shaft and clamped in the bearing block. A Plexiglas plate (A) covers the bearing blocks. It can easily be removed for cleaning. The oscillation detector rests freely on four foam rubber cylinders (J). The output voltage of the loudspeaker ($2-7\text{mV}_{\text{rms}}$) is applied through a shielded cable (length not critical) to an adjustable amplifier and integrator (Fig. 2). Only the frequencies between 1 and 10 cps are amplified, because the locomotor activity of pigeons lies about in this range; higher frequencies are caused only by noise. The amplified voltage is rectified and integrated. When this voltage reaches a certain value, a relay closes and the integrator is reset to zero. By changing the resistance at the 500-ohm potentiometer, the sensitivity of the system can be adjusted. In the present system, one relay

closing (one unit) equals a vertical force of 2 dynes at a value of 270 ohms.

Reliable recordings of the walking activity of pigeons were achieved on fixed-interval, variable-interval and differential-reinforcement-of-low-rate (DRL) schedules of reinforcement. Pigeons normally show a large amount of non-pecking behavior on DRL schedules. Figure 3 shows a sample from a DRL 10-sec session. The system failed to respond to the pecking activity (B), but reacted immediately to every locomotor movement (A). A marked increase in the recorded rate of activity is seen with wing flapping (arrow).

The described apparatus and circuit have been used for more than six months without any maintenance problems or readjustments. The total cost of materials was approximately \$20. The apparatus can be used for small as well as large species, since the sensitivity may be easily adjusted and the loudspeaker endures even strong impacts.

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