INEXPENSIVE AND UNATTENDED OPERANT CONDITIONING AND HOME CHAMBER FOR MICE IN ISOLATION

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The apparatus is designed to maintain a mouse in a fully-automated chamber used as a living and experimental cage. The unit is housed in a sound-attenuated, thermostatically-controlled and well-ventilated room, requires a few minutes care once a week and has been in continuous use for 18 months with many mice. There has been no apparatus failure or breakdown nor injury to any mouse. The apparatus relieves the experimenter of routine laboratory procedures and minimizes experimenter-subject interactions.

A lever and liquid reinforcement (S^R) receptacle (cup) are made available to the animal while the apparatus serves as experimental chamber. For the regular feeding period, solid laboratory chow is delivered down a chute. For the rest of the 24-hr cycle the apparatus serves as a living cage without lever, cup or solid food. The three different arrangements are provided on a collar peripheral to a rotating cylindrical cage (Fig. 1).

The cage, an erect plastic tube², is suspended by a motor held by a bracketed frame. Three switches are fastened onto the bracket, parallel to each other and above the radius of the cage. The switches control (a) the brake on the motor, (b) the direction of rotation and (c) recorders, by means of small plastic cams

on the roof of the cage. A rectangular window is cut in the cylinder and surrounded by a black strip painted on the outside surface of the cage, restricting visual stimuli from the collar. The floor is of wire mesh welded to a

Fig. 1. Operant conditioning and home chamber with accessories. (A) Diagonal side-view of apparatus; (B) Side-view, emphasizing structures supporting floor of cage; and (C) Top-view. 1, Cylindrical cage; 2, window; 3, water bottle; 4, reversible motor with clutch-brake attachment; 5, sub-subminiature microswitches; 6, cams; 7, collar unit; 8, lever with switch; 9, liquid reinforcement receptacle (cup) with tube; 10, solid food chute; 11, solid food reservoirs or cups; 12, motor for solid food disc; 13, sawdust tray; 14, cage floor grid; 15, cage floor rim; 16, cage floor support; 17, brackets; 18, platform; 19, platform slits; 20, relay; 21, multi-lead plug. All electrical wires are brought to the multi-lead plug, to which a cable from the controlling equipment is connected. Note in (B) the vertical broken lines refer to grate or vertical bars across the food chute opening and the horizontal broken lines, to the top of the collar. Also note in (C) stippled areas indicate solid vertical wall on inner side of collar facing the cage.

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²A cylindrical Skinner-box was first manufactured by Davis Scientific Instruments, 12137 Cantura Street, Studio City, California; Model DB 101. Commercial manufacturing of the present apparatus for mice, rats, pigeons, etc. is being undertaken by Davis Scientific Instruments for the near future.

stainless steel rim. It is supported by two, parallel U-shaped rods soldered onto the rim and held by two cross-brackets. In this manner, the floor is separated from the cage and can be disengaged easily for removal of sawdust tray for waste. When the cylinder rotates, the floor remains stationary. Two slits in the wooden platform supporting the apparatus permit the removal of the cage floor when placing the mouse in the chamber.

On the periphery of the cage is a stationary collar having at one end a lever, a solid partition and a cup for S^R , which are exposed to the mouse during the experimental session. The solid partition between the lever and cup requires the mouse to (a) release the lever during consummation of S^R and (b) remain in the cage (rather than in the otherwise large opening in the collar). The relay may be operated to accompany food presentations, functioning as the S^D for food. A solid wall extends across the next segment of the collar. When the cylinder is rotated so that the window is in this "neutral" position, the chamber is the living cage.

The last section of the collar includes a grated opening (with vertical bars) of the solid food chute exposed for only 1-hr regular feeding time. A rotating disc with seven bottomless and topless cups is superimposed on a stationary disc having only one hole directly above the chute in the collar. A motor, activated at feeding time, drives the cup disc, which in turn empties the contents of one cup down the chute as it passes over the hole. The disc travels about 51° in 2 min. Specific amounts of food are placed in each of the seven cylinders, necessitating refilling only once a week. A bottle filled with water and multivitamin drops is available to the mouse at all times.

The sequences and durations of events are programmed by switches activated by motor-driven notched cams, completing one revolution in 24 hr.

The events include: cage motor activation always accompanied by a tone, food disc motor activation and control of the background white noise and overhead house lights for day-night cycles in the sound-attenuated experimental room. Controls for direction of cage rotation, energizing and releasing of the brake, initiation and termination of control and recording equipment are programmed

through timers and relays in a sound-attenuated enclosure in a separate control room and connected at the multi-lead plug.

The liquid pump (Lester, 1958), delivering egg-nogg (Williams and Teitelbaum, 1956) as S^R during conditioning, is located in a refrigerator in the control room. PE 160 polyethylene tube connects the pump with the receptacle in the collar. Water from a refrigerated reservoir and pump unit is delivered into one end of a $\frac{1}{2}$ -in diameter tygon tube and brought back from the other end, analogous to the operation of a distilling condenser water jacket with the food tube in the center. In this manner, egg-nogg in the tube between the pump and the cup is kept cold, thereby retarding decay.

A major disadvantage of the equipment is that one unit is required for full-time use with one animal. This limits the number of animals in the experiment at any one time to the number of available chambers. However, one control and recording unit may, of course, be remotely switched so that the termination of a run on one cage will initiate the experimental session in a second one. In this manner, through continuous use of one control unit, several cages may be operated successively on a daily schedule. Similarly, for the apparatus to be beneficially utilized, a minimum of several days is necessary, as experiments of only one day duration annul its functions.

The present system is inexpensive, simple in design, flexible in function and allows complete isolation of the animal. The total cost for the unit shown in Fig. 1A (excluding control, recording and reinforcing equipment) is \$40 for parts, and approximately 10 man-hr to build.³

REFERENCES

- Lester, D. Water feeder. *J. exp. Anal. Behav.*, 1958, 1, 234.
- Williams, D. R. and Teitelbaum, P. Control of drinking behavior by means of an operant-conditioning technique. *Science*, 1956, 124, 1294.

³Schematics of the electrical circuits and exact dimensions of the chamber and accessories may be obtained from the author upon request. Following is a parts list: Hurst Reversible Motor, Model PC-DA 120-in.-oz.; 95-130 V., 60 cycles, 7 watts at 2 RPM (motor for cage rotation). Bristol Motor, 511 DH 2A 1/15 RPM or 4 RPH (motor for food disc). 3 MICRO SWITCH Sub-Subminiature Switches, 1 S X 1-T with JX 25 Roller lever actuators.