INSTRUMENTATION & TECHNIQUES

A motor-driven feeder for operant training in song birds

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Conventional pigeon feeders can make noise, spill food, and injure birds in applications using small song birds as subjects. We developed a motor-driven feeder based on the principle of the piston to address these concerns.

Studies of discrimination learning in song birds are becoming commonplace (Braaten & Hulse, 1991; Hulse & Cynx, 1986; Weary & Weisman, 1991). However, providing food rewards to song birds is problematic. Some researchers have little trouble using conventional solenoid-driven pigeon grain feeders with small song birds. In terms of our own experience, however, conventional feeders make noise, spill food, and injure birds. So, since we needed a quiet feeder that did not spill small grains or finely ground food and that never injured birds, we developed a motor-driven feeder to accommodate these requirements.

The following provides an overview of the operation of the feeder (see Figure 1) during a feeding cycle. The presence of the bird at the feeder opening is detected by light-sensitive diodes, which then send a signal that activates the motor. As the motor rotates the crank, the food cup (piston) is pushed upwards by a piston rod. Upward movement of the food cup is stopped when the unslotted edge of the disk opens the optical switch. After a timed interval, as the motor rotates the crank, the food cup is pulled downwards by the piston rod. Downward movement of the food cup is stopped when the slotted edge of the disk closes the optical switch.

The Feeding Area

The 6-mm Plexiglas frame of our motor-driven feeder is divided into two sections (Figure 1): a feeding area (115 mm high $\times$ 100 mm deep $\times$ 115 mm wide) and a housing for the feeder mechanism (210 mm high $\times$ 100 mm deep $\times$ 115 mm wide). The feeding area is enclosed on top and on three sides, with one side open to

allow the bird to enter from an aviary. The bird's presence at the feeding area is monitored by a bank of four infrared light-emitting diodes (Figure 1, item 2) and phototransistors (Figure 1, item 1) opposite each other 2 mm above the feeder cover in the feeding area (Figure 1, item 3).

The Feeder Mechanism

The bird's access to the feeder mechanism is limited by the feeder cover. The cover (27 mm o.d., 10 mm high) has six 17-mm-i.d. openings, which permit access to food during reinforced trials. Food is present in a circular food cup (61 mm o.d., 23 mm high; Figure 1, item 4). The cup is located within a cylinder (62 mm i.d., 62 mm high; Figure 1, item 5). The cylinder guides the rise and fall of the food cup. A 96-mm-long piston rod (Figure 1, item 6) connects the food cup to a 30-mm-long crank (Figure 1, item 8). The crank connects the piston rod to the motor shaft (Figure 1, item 9), which is centered 85 mm above the base of the feeder. A 75-mm-o.d. disk (Figure 1, item 7), slotted to a depth of 30 mm over 180° (Figure 1, item 9), is mounted on the motor shaft between the crank and the motor. As the disk rotates, its unslotted edge passes through a slotted optical switch (Figure 1, item 10), producing on/off logic signals that indicate the up or down position of the food cup. A motor-control relay (Figure 1, item 11) allows 28 V dc to operate the 110-V ac motor. Wiring (not shown) leads from the infrared diodes and phototransistors, motor, and motor-control relay to an 8-pin Jones connector (Figure 1, item 12). While most components of the feeder are widely available and substitution is not critical, the specifics of two components are important. The feeder cup should be machined from a solid block of Plexiglas to fit the cylinder, and the feeder motor should be a synchronous 10-rpm, 88-oz/in. torque (hi-torque) Hurst AB 3006-004.

To be effective, the cylinder and the food cup should be cleaned weekly. We recommend that an extra feeder be available as a replacement during such times. The

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Figure 1. Schematic diagram of feeder assembly. (1) Infrared phototransistors, (2) infrared light-emitting diodes, (3) feeder cover, (4) food cup, (5) cylinder, (6) piston rod, (7) disk, (8) crank, (9) motor, (10) slotted optical switch, (11) motor control relay, (12) Jones connector.

motor-driven feeder has performed successfully for 2 years over many thousands of reinforcement trials. We have used the feeder in operant discrimination experiments using zebra finches (*Taeniopygia guttata*), wild-caught black-capped chickadees (*Parus atricapillus*), and wild-caught white-throated sparrows (*Zonotrichia albicollis*)

without experiencing difficulties in shaping or in maintaining approach to the feeder. We therefore recommend the motor-driven feeder over conventional grain feeders in experiments using song birds.

Finally, we compared the noise, spillage, and potential for injury of the motor-driven feeder and the conventional pigeon feeders. First, we measured the amplitude of the sounds produced by the feeders when in operation; for a conventional (Gerbrands Model G5610, Cambridge, MA) feeder, it was 82 dB(A), and for our motor-driven feeder, it was 66 dB(A). Then we observed the behavior of song birds with the two types of feeders: the operation of the conventional feeder provoked startle and avoidance responses, whereas with our motor-driven feeder, the birds stood unruffled on its cover. Zebra finches and white-throated sparrows eat millet grains, which are very light and discharge in large amounts onto the floor of the experimental chamber with each operation of a conventional feeder, but they remain inside the food cup of a motor-driven feeder. Also, while zebra finches and chickadees have, very occasionally, become trapped inside the grain housing of a conventional feeder and become injured, a bird has never been injured by the motor-driven feeder.

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