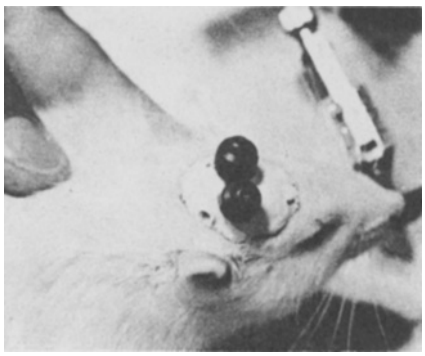

Fig. 6. Completed surface-mounted cannulae cap in place.

Also, growth of the cranial area is sufficient to loosen the cap if it is left in place for any length of time. Further, the position of the trephine holes with relation to the cannulae may be altered significantly. Animals larger than 300 g demonstrate increased growth and development of the sternoclidomastoid muscle group as well as extension of cranial muscles with insertion posterior to the occular ridge and extending back over the parietal region. Such muscle growth requires more extensive surgery to clear an area adequately for placement of the cannulae.

Observations of three experimental animals were made at the end of an 8-week period. With cannulae removed there remained no manifest signs of any reaction to the aluminum material.

REFERENCES

BUREŠ, J., & BUREŠOVÁ, O. Cortical spreading depression as a memory disturbing factor. Journal of Comparative & Physiological Psychology, 1963, 56, 268-272.

BUREŠ, J., BUREŠOVÁ, O., & FIFKOVÁ, E. Interhemispheric transfer of a passive avoidance reaction. Journal of Comparative & Physiological Psychology, 1964, 57, 326-330.

BUREŠ, J., BUREŠOVÁ, O., & ZAHOROVÁ, A. Conditioned reflexes and Leao's spreading cortical depression. Journal of Comparative & Physiological Psychology, 1958, 51, 263-268.

BUREŠOVÁ, A., & BUREŠ, J. Interhemispheric synthesis of memory traces. Journal of Comparative & Physiological Psychology, 1965, 59, 211-214.

MARSHALL, W., II. Spreading cortical depression of Leao. Physiological Reviews, 1959, 39, 239-279.

TAPP, J. T. Reversible cortical depression and avoidance behavior in the rat. Journal of Comparative & Physiological Psychology, 1962, 55, 306-308.

TRAVIS, R. P. The role of spreading cortical depression in relating the amount of avoidance training to interhemispheric transfer. Journal of Comparative & Physiological Psychology, 1964, 57, 42-46.

NOTE

1. Requests for reprints should be addressed to Douglas K. Zwemke, Department of Psychology, Sacred Heart College, Wichita, Kansas 67213.

An inexpensive brine shrimp dispenser for fish[1]

R. E. DAVIS *and* M. S. HIRTZEL, *MENTAL HEALTH RESEARCH INSTITUTE, UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan 48104*

Various methods of dispensing small amounts of food to reward operant responses in fish have been described. Some deliver powdered or granulated dry food (Deterline, 1956; Mark, 1967). Commercially manufactured food pellets and dispensers could be used, but the smallest available pellet is 20 mg (e.g., P. J. Noyes Co., Lancaster, New Hampshire), which is a large bite for a small fish. Smaller pellets or pills are difficult to make. Longo and Bitterman (1959) used pellets of a special mixture of fish food. Most investigators have worked with live or with fresh food (Hogan & Rozin, 1961; Longo & Bitterman, 1963; Haralson & Ralph, 1966; Northmore, 1968). Recently described methods of pumping preset amounts of preserved food or of freshly prepared soft foods through a catheter to a feeding place in the experimental tank (Ames, 1968; Holmes & Bitterman, 1968) would seem to have certain advantages.

Figure 1 is a diagram of a brine shrimp dispenser that we have used for 2 years in investigations of operant behavior in goldfish. It is based on the principle of the mariotte bottle (see Niederl & Niederl, 1942), which acts as a constant-pressure reservoir.[2] In our application, tap water from the reservoir drains through a pipette that contains a slurry of brine shrimp. Momentary activation of a control valve releases a drop of water with several shrimp into the experimental tank.

A volumetric pipette is used because its shape facilitates movement of shrimp into a tube from which drops can be formed, and it is a readily obtainable item (cost, approximately $3.00). The pipette tubes are cut 2.5 cm from the body and fire-glazed. The tip of the output tube is further heated and rotated in an oxygen flame to reduce the diameter of the opening to 3-4 mm. Narrower openings frequently become clogged with shrimp, and wider ones form irregular drops. The polyethylene stopcock and twistcock connector (Cole Parmer Co., Chicago, Illinois; Stock Nos. 6074 and 6395; approximately $3) ease the job of filling and cleaning the pipette.

The solenoid valve is a two-way, normally closed valve obtained from Skinner Precision Industries, Inc., New Britain, Connecticut (Stock No. V52DA2200, 24-V dc coil; approximately $9). The valve is connected

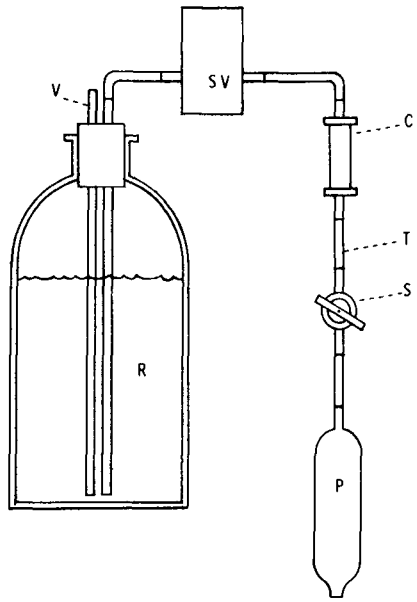

Fig. 1. C, twistcock connector; P, 50-ml volumetric pipette; R, water resevoir; S, stopcock; SC, solenoid valve; T, vinyl tubing; V, glass vent tube. Shrimp are placed in the pipette. When the twistcock connector and the stopcock are open, activation of the solenoid valve for 20 to 30 msec releases a few shrimp in a drop of water, which is replaced by water from the resevoir.

to 3/16-in.-i.d. and 5/16-in.-o.d. vinyl tubing with polyethylene adapters, ¼-in. MIPT, obtained from Cole Parmer Co. (Stock No. 6450-2). We activate the valve with a monostable multivibrator, or one-shot, and a relay driver of a BRS-Foringer, DigiBit system.

A reservoir is simply a 1-gallon bottle. A two-hole rubber stopper holds the drain tube and the vent tube, which admits air as the water is removed. When the apparatus is first set up, water is siphoned through the valve to obtain a continuous column in the drain tube to the level of the twistcock connector. Thereafter, water flows instantly on each operation of the valve and only when the valve is open; there is no afterflow.

The pressure in the system can be adjusted by varying the height of the reservoir above the pipette. Water flows at a steady rate until the level falls below the tip of the vent tube. The vent tube must extend below the surface of the water for uniform drop formation; the simple siphon which otherwise results is a workable reservoir but control of the drop size is difficult to maintain. There are similar devices for delivering liquid in which the control valve is on the air-vent side of the reservoir instead of the liquid-output side. In our feeder, regulation of the air input results in very sluggish control of the water output.

The amount of shrimp released with each operation of the valve is adjusted by varying the duration of the one-shot pulse. In a typical unit, a 20-msec pulse releases 0.1 ml of water containing a few shrimp. A hundred successive drops show no appreciable variation in volume, though the exact number of shrimp may vary.

This feeder was developed specifically to administer fresh frozen brine shrimp to goldfish for striking a target at the water surface. Brine shrimp are a highly attractive food to goldfish, and they are easy to obtain and to store in the laboratory. The feeder handles all sizes of shrimp, including frozen nauplii, but freeze-dried shrimp do not dispense well as they resist wetting and tend to float in the pipette. The main difficulty is that shrimp may clump either at the neck or the tip of the tube. Clumping is rare so long as the pipette is kept clean and the shrimp are clean and fresh. We thaw shrimp in standing water and then gently wash them until the rinse water is clear. If the shrimp is partially decomposed, possibly as a result of having been thawed and refrozen, the fish may show no aversion to eating it, but no amount of washing will prevent clumping.

REFERENCES

AMES, L. L. A liquid-food, limited-access feeder for fish. Journal of the Experimental Analysis of Behavior, 1968, 10, 435-437.

DETERLINE, W. A. An automatic device for the investigation of operant behavior in fish. American Journal of Psychology, 1956, 69, 291-295.

HARALSON, J. V., & RALPH, G. S. A further improvement in the automatic dispensing of live food for fish. Journal of the Experimental Analysis of Behavior, 1966, 9, 153-154.

HOGAN, J., & ROZIN, P. An automatic device for dispensing food kept in a liquid medium. Journal of the Experimental Analysis of Behavior, 1961, 4, 81-83.

HOLMES, N. K., & BITTERMAN, M. E. Measurement of consummatory behavior in fish. Journal of the Experimental Analysis of Behavior, 1968, 12, 39-41.

LONGO, N., & BITTERMAN, M. E. Improved apparatus for the study of learning in fish. American Journal of Psychology, 1959, 72, 616-620.

LONGO, N., & BITTERMAN, M. E. An improved live-worm dispenser. Journal of the Experimental Analysis of Behavior, 1963, 6, 279-280.

MARK, R. F. A simple dry-food dispenser for automated fish training. Journal of the Experimental Analysis of Behavior, 1967, 10, 191-192.

NIEDERL, J. B., & NIEDERL, V. *Micromethods of quantitative organic analysis.* (2nd ed.) New York: Wiley, 1942. Pp. 114-115.

NORTHMORE, D. P. M. A simple live-worm dispenser. Journal of the Experimental Analysis of Behavior, 1968, 11, 617-618.

NOTES

1. Supported by NIMH Research Development Award K2-MH-22,183 (R.F.D.). Reprints may be obtained from R. E. Davis, Mental Health Research Institute, University of Michigan, Ann Arbor, Michigan 48104.

2. We wish to thank our colleague, Norman Radin, for suggesting that we use the mariotte bottle.

An instrument to produce surface colors of continuously variable brightness

STANLEY COREN, *GRADUATE FACULTY, THE NEW SCHOOL FOR SOCIAL RESEARCH, 66 West 12th Street, New York, New York 10011*

Many experiments on the perception of brightness require a surface color of adjustable intensity. This has been accomplished by some workers through the use of a series of color samples of known brightness such as is found in the Munsell Color System (Beck, 1961; Burzlaff, 1931; Takasaki, 1969) or by use of a rotating disk upon which the percentage of the test color is systematically varied (Coren, 1969; MacLeod, 1947; Stewart, 1959). The former method suffers from difficulties due to the discontinuous nature of the steps, and the necessity of interpolating between samples. The color-disk method suffers from the fact that the motor must be stopped between each setting, making this procedure costly in terms of time and effort. There are some continuously variable color rotors (mixers) on the market, but these tend to be rather expensive (Gerbrands, $645; Lafayette, $590; Marietta, $750). They are also noisy and occupy quite a sizable amount of space, which makes them difficult to integrate into many experimental displays. In order to provide a variable-brightness surface color that is easy to use and allows continuous variations of intensity while still being economical and easy to use, the system illustrated in Fig. 1 was designed.

Let us consider the components in order from the light source. First we have a microscope stage upon which is mounted a metal plate. In front of the microscope stage (Edmunds No. 30,060, $12.95) is a square aperture. The metal plate and the aperture serve as a diaphragm that limits the amount of light entering the system. A piece of flashed opal glass then diffuses the light input. This input is then uniformly distributed across the surface of the final piece of opal glass by means of the multiple internal reflections that take place inside the optical integrating bar. This optical integrating bar is nothing more than a rectangular bar of clear glass or plastic polished on all sides. As a rule, the bar should be at least three times as long as it is wide. If a texture is desired on the final surface, a piece of translucent white paper may be substituted for the final piece of opal glass.

The operation of this apparatus is quite simple. Varying the area of the entrance aperture covered by the metal plate mounted on the microscope stage varies the brightness of the final surface of the system. Readings can be taken directly from the vernier scale on the microscope stage. A flexible cable attached to the knob on the scale would allow the O to adjust the brightness himself. The actual color seen on the surface may be varied by inserting filters between the light source and the unit.

The advantages of this system are that it is compact, inexpensive (about $15 for a unit with a 1-in.-square face) and provides a continuously adjustable brightness with no vignetting, even at very low levels of intensity.

REFERENCES

BECK, J. Judgments of surface illumination and lightness. Journal of Experimental Psychology, 1961, 61, 368-375.

BURZLAFF, W. Methodologische Beiträge zum Problem der Farbenkonstanz. Zeitschrift für Psychologie, 1931, 119, 177-235.

COREN, S. Brightness contrast as a function of figure-ground relations. Journal of Experimental Psychology, 1969, 80, 517-524.

MacLEOD, R. B. The effects of "artificial penumbrae" on the brightness of included areas. In A. Michotte (Ed.), *Miscellanea Psychogica.* Paris: Librairie Philosophique, 1947.

STEWART, E. C. The Gelb effect. Journal of Experimental Psychology, 1959, 57, 235-242.

TAKASAKI, H. von Kries coefficient law applied to subjective color change induced by background color. Journal of the Optical Society of America, 1969, 59, 1370-1376.

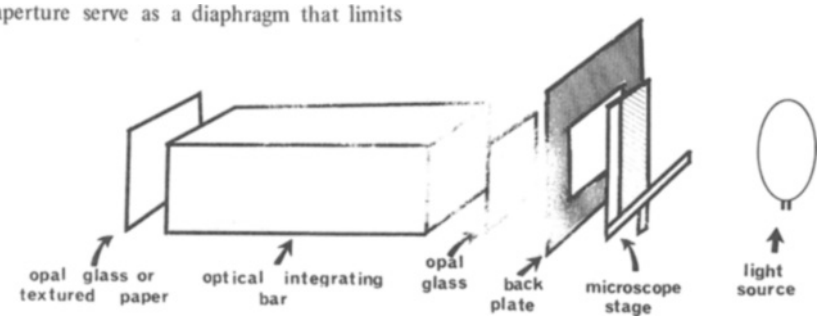

Fig. 1. Schematic drawing of an apparatus to produce a variable-brightness surface color.