TECHNICAL NOTE

OPERANT CONDITIONING IN THE GUINEA PIG[1]

A technical note to this journal (Berryman, 1976) is the most recent of several reports distributed over the last 50 yr which suggest that the guinea pig demands unusual treatment, relative to that accorded more familiar subjects of behavioral research, if it is to be employed in operant conditioning studies. The inordinate time investment, frequent behavioral instability, and the general recalcitrance of the animal reported by those few investigators successful in training the guinea pig to perform simple operants, has led some to question the viability of the species as a standard behavioral preparation (*e.g.,* Jonson, Lyle, Edwards, and Penny, 1975; Valenstein, 1959).

In contrast, we have found that the guinea pig can be readily trained as a reliable observer in a relatively demanding psychophysical task for determining absolute auditory thresholds. The final testing procedure is a variant of the basic methods used in our laboratory (Moody, Beecher, and Stebbins, 1976). Two transluscent Gerbrands pigeon response keys are located on one wall of a 25.4-cm by 25.4-cm by 25.4-cm testing chamber constructed of 0.6-cm hardware cloth. The keys are mounted 3.8 cm above the floor of the chamber, 11.5 cm apart. The chamber is mounted on a portable cart and the entire assembly is contained within an Industrial Acoustics double-walled sound-insulated booth during testing. The guinea pig repeatedly pushes on the illuminated left key (the observing disk) with its nose. Response feedback is provided by a 50-msec darkening of the observing disk following each nose press that exceeds 0.14N. After a variable period of time, a response on the observing disk is followed by a 3-sec tone presentation from a transducer mounted on the chamber ceiling directly over the observing disk. A nose press on the lighted right-hand key (the reporting disk) during the tone results in delivery of a Noyes formula D 45-mg food pellet to a tray located midway between the keys and projecting into the experimental space. Report responses in the absence of a tone result in a 15-sec timeout, during which all lights are extinguished.

We receive the animals at approximately six weeks of age, at which time they weigh about 300 g. The animals remain on free feed until body weight reaches 400 g. Subjects are then maintained on a restricted diet and deprived to 80% of this nominal weight. For the duration of the experiment, the animals are fed 20 to 25 g per day and receive a supplement of 100 g of parsley twice a week. The exact amount of food allowed per day is adjusted for each animal on an individual basis by determining the minimum amount necessary to sustain a healthy, active, and well-motivated subject whose weight increases steadily over the course of the experiment.

Figure 1 presents an average growth curve for the free-feeding laboratory guinea pig (*Cavia porcellus*) constructed with data from Poiley (1972) and Ediger (1976), along with a curve derived from the data of Rood (1972) on growth rates for one of the common wild species of guinea pig (*Cavia aperea*), which is recognized as a close relative of the domesticated guinea pig. These two curves may be compared to growth functions plotted for two subjects (*C. porcellus*) S5 and S6, maintained on the present deprivation regimen. The figure clearly suggests that our deprivation schedule yields growth rates that correspond more closely to the growth rates of guinea pigs in the wild than to the growth of free-feeding, domesticated animals. Indeed, the three sets of data points for S5, S6, and *C. aperea* are clustered so closely together that they could easily be summarized by a single growth function.

It should also be noted that free-feeding, domesticated guinea pigs, represented by the uppermost curve, are often very obese animals, with clearly visible pockets of fatty deposit lining their flanks and underbelly. So, although a comparison of the free-feed *C. porcellus* function with the functions for S5 and S6 might initially appear to suggest that the experimental animals were severely deprived (to approximately 50% free-feeding body weight), in fact, the animals were reduced to a weight that probably more closely approximates the level at which they function and survive in the wild.

The figure also illustrates that within 10 to 12 months of age, the experimental animals weigh nearly twice their original 80% deprived weight. It is important to realize that, unlike the common laboratory rat, domesticated guinea pigs allowed to feed freely continue to grow until they are 12 to 15 months old, at which time females weigh up to 850 g and males up to 1200 g (Edi-

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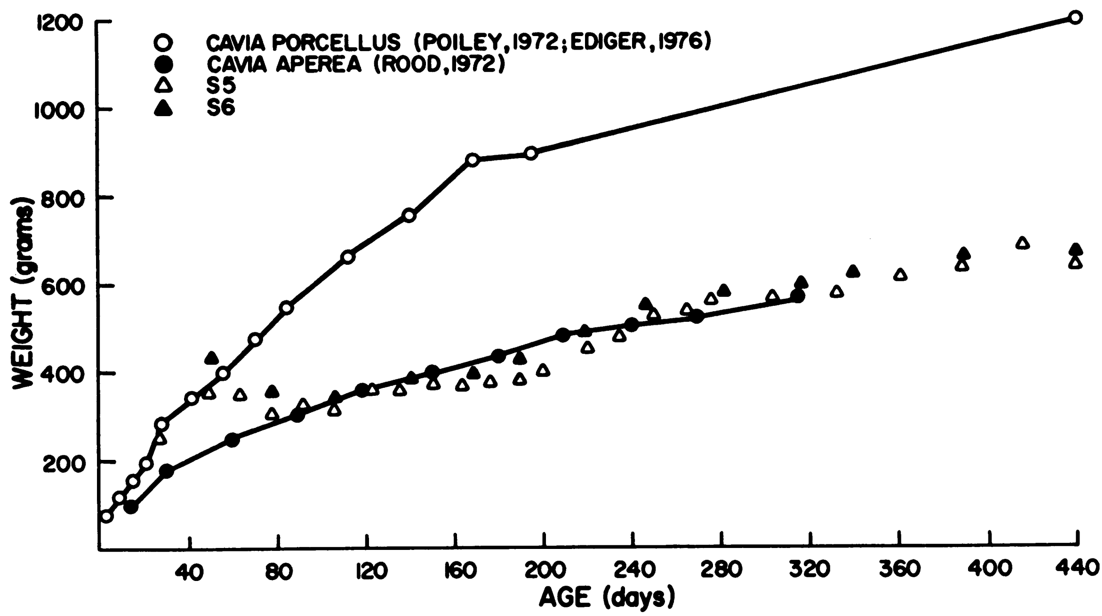

Fig. 1. Growth functions for: (1) the free-feeding, domestic guinea pig (*Cavia porcellus*); (2) *C. aperea*, a wild relative of *C. porcellus*, and (3) two food-deprived members of *C. porcellus* (S5 and S6) trained on the experimental task reported here.

ger, 1976). Therefore, the objective of our deprivation scheme is merely to retard, rather than halt, this developmental process.

Upon satisfying the initial 80% weight criterion, the subject is placed in the experimental chamber, where it finds a food tray containing several Noyes pellets. During this initial shaping stage, only the observing disk is illuminated. Each time the feeder operates the observing disk light is extinguished for approximately 2 sec. After a period of adaptation ranging from 5 min to 4 hr, during which the animal assumes the typical freezing or immobility posture (Bayard, 1957; Glickman and Hartz, 1964; Miller and Murray, 1966), the animal begins roaming about the chamber and eventually consumes the available food pellets.

The frequent assertion that solid food is not an effective reinforcer (see Jonson *et al.*, 1975) for any of a variety of reasons, receives little support from us. We find that animals maintained on the simple deprivation schedule described above readily accept and rapidly consume the standard formula D guinea pig food pellets manufactured by the P. J. Noyes Co.

We have found that operating the pellet feeder while the animal is consuming the free pellets minimizes the disruptive behavioral effect observed in response to the sound of the feeder operation. Within several minutes, the animal reliably and rapidly approaches the food tray upon hearing the feeder operate. After several reinforcers have been delivered, the subject begins orienting to and eventually approaches the illuminated disk. Normally, the animal contacts the disk in the process of nosing and "rooting" about in a manner characteristic of that seen when the animals are observed both in their home cages and in the wild (Rood, 1972). Observation of the guinea pig in its home cage revealed that the animal spends a good deal of time poking and thrusting its nose into the various slots available in the enclosure. The topography of the response is remarkably stereotyped: the animal repetitively lowers its snout and rapidly moves it through a smooth arc in raising its head. The increased activity that accompanies adaptation to the test cage included a good deal of this nosing or rooting behavior; we took advantage of this high-probability behavior by mounting the two response disks flush with the wall at guinea pig "nose-level." This arrangement facilitated the task of reinforcing the nosing behavior at the illuminated disk. Once the animal begins approaching the illuminated disk, inducing it to push on the disk is simply a matter of reinforcing successive approximations to the desired terminal behavior. When the animal is reliably pushing the observing disk, the consequence of a response is changed from delivery of a pellet to illumination of the reporting disk. Thus, a response on the observing disk extinguishes that light and illuminates the reporting disk. Reinforcement is now made dependent upon, in succession, orienting to, approaching, contacting, and eventually pushing the reporting disk. During this stage, reinforcement is accompanied by extinction of the reporting-disk light and re-illumination of the observing disk. When the animal is reliably completing this two-link response chain, a tone of moderate intensity (*e.g.*, 8000 Hz at 50 dB SPL) is turned on with illumination of the report disk. Introduction of this novel stimulus produces a mild but short-lived disruption of behavior, which dissipates within a few minutes. The next step is to turn both keylights on simultaneously and introduce a 5-sec timeout for any report responses in the absence of a tone. Then, the probability of a tone following an observing response is gradually lowered by changing the observing response schedule from FR 1 through VR 2, 4, and 8 to the final

Table 1

Sessions Required to Complete Successive Training Stages

Subject	*Adaptation and Feeder Training*	*Nose-Press Shaping*	*Keylight Discrimination*	*Keylight + Tone Discrimination*	*Tone Discrimination to Final Program Values (VI 10-sec, 3-sec tone, 15-sec timeout)*
S8	3	6	1	1	14
S9	1	2	3	3	6
S10	2	1	4	2	8
S11	1	2	5	2	9

schedule of VI 10-sec. At the same time, the duration of the tone is gradually decreased to the final value of 3 sec. Finally, the timeout duration is progressively increased from 5 to 15 sec. Each of the 11 animals we have attempted to condition have acquired this discrimination. Table 1 contains a summary of the number of sessions necessary to complete the successive stages of training for each of the four animals most recently trained according to the guidelines specified above.

Although every animal is exposed to the various steps in exactly the sequence outlined here, we have found that certain tactics facilitate the training. For instance, placing thin, Plexiglas, disk-shaped extensions on the response disks, so that the operanda project into the experimental chamber, markedly reduces the time lag between feeder training and acquisition of the nose press. Initially, the animal often appears to chew on the extension disk, an observation that led us to avoid using a protruding manipulandum later during psychophysical testing. Once the animal has acquired the response with a 0.32-cm extension, we replace it with a 0.16-cm extension. Eventually, the extensions can be removed without seriously disrupting the animal's responding. In addition, we have found that once the animal is approaching and contacting the disk, but not yet applying quite enough force to close the contact switch, it is often worthwhile to leave the animal in the chamber for extended periods of time—usually over-

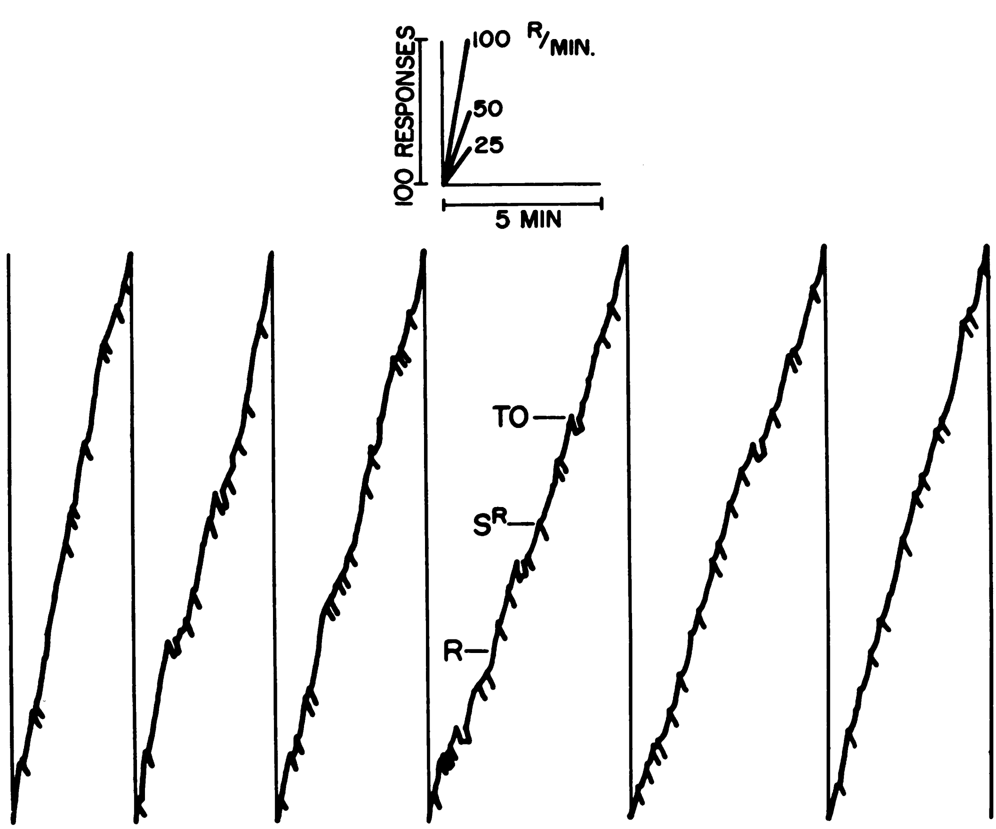

Fig. 2. Cumulative record from a portion of a session for Subject 6. Observing responses (R) step the cumulative pen upward, brief deflections of the pen indicate reinforcement (S^R) of a correct report response, more prolonged deflections represent timeouts (TO) for incorrect report responses.

night. During the night, the animal begins pushing the key with sufficient force to actuate the electrical circuit and produce a pellet. Once the animals have acquired the nose-press response, they progress through the remaining stages of training quite rapidly. Within three months of receiving the animals, we are able to gather psychophysical data that show little between-session or between-subject variability.

Figure 2 is a cumulative record from a portion of a session for Subject 6. As can be seen, the well-trained guinea pig responds continuously and rapidly on the observing disk, rarely pushing the reporting disk until a tone is presented. All animals work consistently and steadily through experimental sessions that often last up to 150 min—during which time they ingest approximately 200 to 300 food pellets.

In our experience, the guinea pig can be trained as a reliable psychophysical observer in approximately the same amount of time it takes to train monkeys, chinchillas, rats, and gerbils on similar tasks. Our success in training guinea pigs on the present experimental task leads us to conclude that future behavioral work with the guinea pig should pose no unusual problems. We believe that a large measure of our success can be attributed to the choice of an easily executed response drawn from the animal's natural repertoire, and to the use of a deprivation schedule that maintains the effectiveness of the reinforcer, as well as the animal's health. Perhaps similar ethologic and ecologic considerations would assist in the selection of potentially conditionable responses and effective reinforcers in future behavioral work with exotic, putatively intractable, or heretofore unstudied species.

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REFERENCES

Bayard, J. The duration of tonic immobility in guinea pigs. *Journal of Comparative and Physiological Psychology*, 1957, **50**, 130-133.

Berryman, J. C. Operant conditioning in nondeprived adult and infant guinea pigs. *Journal of the Experimental Analysis of Behavior*, 1976, **25**, 400.

Ediger, R. D. Care and management. In J. Wagner and P. Manning (Eds), *The biology of the guinea pig*. New York: Academic, 1976. Pp. 5-12.

Glickman, S. E. and Hartz, K. E. Exploratory behavior in several species of rodents. *Journal of Comparative and Physiological Psychology*, 1964, **58**, 101-104.

Jonson, K. M., Lyle, J. G., Edwards, M. J., and Penny, R. H. C. Problems in behavioral research with the guinea pig: A selective review. *Animal Behavior*, 1975, **23**, 632-639.

Miller, J. D. and Murray, F. S. Guinea pig's immobility response to sound: Threshold and habituation. *Journal of Comparative and Physiological Psychology*, 1966, **61**, 227-233.

Moody, D. B., Beecher, M. D., and Stebbins, W. C. Behavioral methods in auditory research. In C. Smith and J. Vernon (Eds), *Handbook of auditory and vestibular research methods*, Springfield, Illinois: Charles C Thomas, 1976. Pp. 439-497.

Poiley, S. M. Growth tables for 66 strains and stocks of laboratory animals. *Laboratory Animal Science*, 1972, **22**, 759-779.

Rood, J. P. Ecological and behavioral comparisons of three genera of Argentine cavies. *Animal Behavior Monograph*, 1972, **5**, entire part one.

Valenstein, E. S. The effect of reserpine on the conditioned emotional response in the guinea pig. *Journal of the Experimental Analysis of Behavior*, 1959, **2**, 219-225.

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