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Food-rewarded operant learning in the guinea pig

W. F. ANGERMEIER
Universität zu Köln, Köln, Federal Republic of Germany

and

J. McLEAN, D. MINVIELLE, and C. GRUE
University of New Orleans, New Orleans, Louisiana

Sixteen young adult guinea pigs (*Cavia porcellus*) of mixed sex were used as subjects in a study of food-rewarded operant learning. All but one of the animals learned the required task. Although the general slope of the learning curve was more variable than that of other mammals, neither learning time nor number of rewards to criterion differed significantly from data obtained from other mammals. The results are discussed in terms of an evolutionary model of comparative learning, including ratio of brain weight to body weight and genetically fixed versus variable behavior categories.

Previous research on food-rewarded operant learning using various mammalian species has shown that they do not differ from one another with respect to number of rewards to criterion if this criterion is determined empirically (Angermeier, 1984). They also do not differ significantly as far as the percentages of learners and nonlearners are concerned. Significant differences in learning time disappear, in most instances, if one uses a different index, namely corrected learning time (which is the interval between the first rewarded response and the time when the learning criterion is reached).

Mammals need significantly more rewards to criterion than do birds, and birds need significantly more rewards than do fishes. In all instances, the significant differences in number of rewards exceed the .001 level (Angermeier, 1984). Until now, mice, rabbits, raccoons, opossums, and human infants have made up the mammalian species tested under this paradigm. We chose the guinea pig as a subject because—in contrast to other mammalian organisms—it is a highly precocial animal.

The purpose of the experiment reported here was to measure, for guinea pigs, the number of rewards to criterion, learning time, and percentage of animals that learn, and to make meaningful comparisons between these and the data obtained from other mammalian and nonmammalian species.

METHOD

Subjects

Sixteen young adult guinea pigs of both sexes served as subjects in this study. The animals were obtained from a licensed dealer and housed in pairs in stainless steel cages (90 × 60 × 60 cm wide), which contained special nesting boxes (30 × 60 × 12 cm high) with wood shavings and shredded paper. The animals were adapted to laboratory conditions for 1 week, during which they had access to commercial dry food and water ad lib. Every second day they received a supplement of fresh parsley.

Apparatus

The apparatus consisted of an operant box, 23 × 35 × 45 cm long, constructed of translucent plastic. Inserted into the bottom of the cage was a floor of sheet metal, which was connected to one pole of a drinkometer device. A Gerbrands rat lever, affixed to one end-panel of the box about 7 cm off the floor, was connected to the other pole of the drinkometer. Two centimeters to the right of the lever was a circular 2.5-cm-wide opening through which food could be delivered. Beneath the opening on the floor of the cage was a metal food receptacle, half-circular in shape with a diameter of 4 cm.

Procedure

After 23 h of food deprivation the animals were placed singly into the apparatus. Each response to the lever was reinforced with a small pellet of food, weighing about 0.1 g, which was about $\frac{1}{300}$ of the average daily food consumption. The animals were run for 1 h per day on consecutive days or until they had obtained 50 rewards on a continuous-reinforcement (CRF) schedule. At this time they were removed from the apparatus and returned to their respective home cages.

Three days later they were returned to the apparatus, given 10 pieces of food, and then exposed to extinction for 1 h. All contingencies were controlled by a computer, with the exception of the food delivery, which was manual.

Responses to the lever, as well as entries into the food magazine, were recorded in terms of hours, minutes, and seconds. From these time measures were obtained number of rewards to criterion, corrected learning time, and the learning criterion itself. The latter consisted of the average number of rewarded responses attained per minute after the response rate had stabilized (Angermeier, 1984). Thus, the learning criterion was established empirically. The data also permitted the construction of a learning and extinction curve and thus meaningful comparisons with the behavior of other mammals, as well as birds and fishes, from which data were obtained in an identical or similar fashion.

RESULTS

As can be seen from Table 1, 15 of 16 animals learned the required task, but not all reached 50 rewarded

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Table 1
Food-Rewarded Operant Learning in the Guinea Pig

Animal	Rewards to Criterion	Responses	Rewards	Responses in Extinction	Learning Time (min)
1	18	95	36	38	41
2	12	144	46	132	30
3	26	147	50	173	20
4	20	291	50	155	23
5	11	205	36	117	27
6	19	282	50	130	21
7	10	111	50	110	10
8	10	255	50	202	21
11	15	62	53	144	69
13	13	66	50	73	22
14	23	152	56	305	76
15	10	103	50	151	22
16	16	64	28	191	34
17	18	118	44	29	57
18	9	73	39	242	14
Median	15	118	50	155	23
Mean	15.3	144.5	45.9	146.1	32.5
SD	5.2	78.8	7.7	72.6	19.8

responses. The data show that the guinea pigs needed a median of 15 rewarded responses to reach the empirically determined learning criterion. The individually determined criteria turned out to be three or four rewarded responses per minute, depending on the speed of responding for the individual animal. Table 1 also shows that the guinea pigs needed an average of more than three responses to obtain one reward. Observations during the learning phase revealed that the guinea pigs were very persistent in chewing or touching the lever before going to the food magazine. Some animals did so, even after they had "learned," for 25 or more responses before going to the food magazine. Median corrected learning time was 23 min; percentage of learners was about 94%. These results agree with observations and data obtained from other mammalian species.

Figure 1 shows the placement of the guinea pig within the cluster of mammals with respect to number of rewards to criterion.

The learning curve for the guinea pig, which is based upon intertrial intervals between rewarded responses, is compared with those of the rat, the rabbit, the raccoon, and the opossum in Figure 2. The learning curve for the guinea pig shows a rather erratic slope compared with the curves of other mammalian species. This slope mirrors the data shown in Table 1, where ratio of responses to rewards (despite the CRF schedule) was 3.15. Normally, this ratio lies somewhere between 1.2 and 1.4 for mammals (W. Brusten, personal communication, December, 1986).

Figure 3 shows a comparison between the guinea pig's cumulative response curve during extinction and those for the rat and the opossum. All animals used in this comparison had previously received 50 rewards on a CRF schedule. There does not seem to be any difference between the three curves of extinction.

DISCUSSION AND CONCLUSIONS

The data presented here show that even a precocial mammal such as the guinea pig does not differ from other mammals with respect to neces-

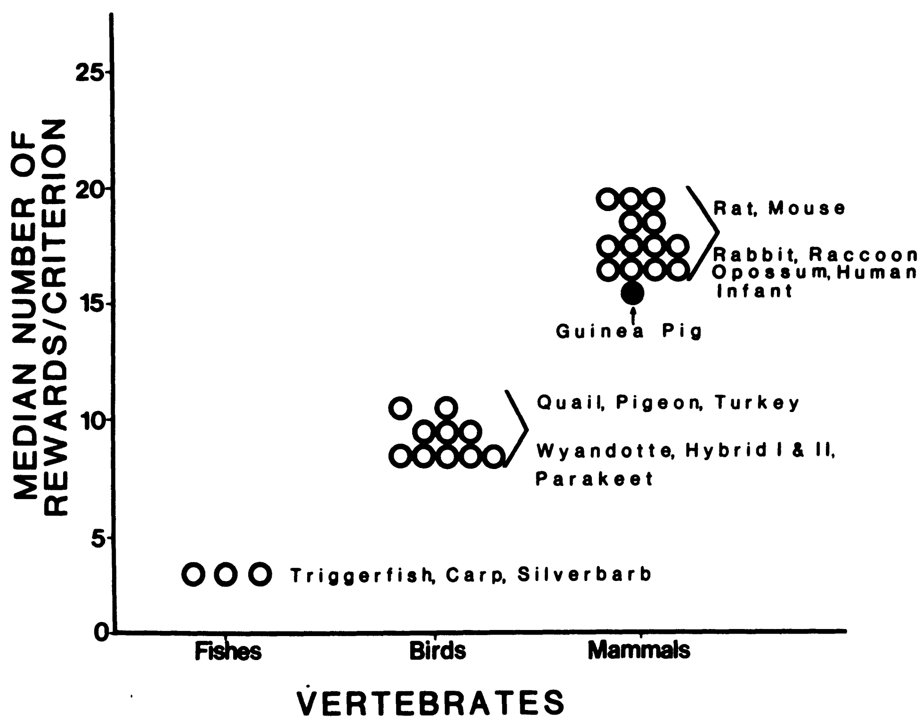

Figure 1. Placement of the guinea pig within the cluster of mammals with respect to number of rewards to criterion. Clusters of birds and fishes are also shown.

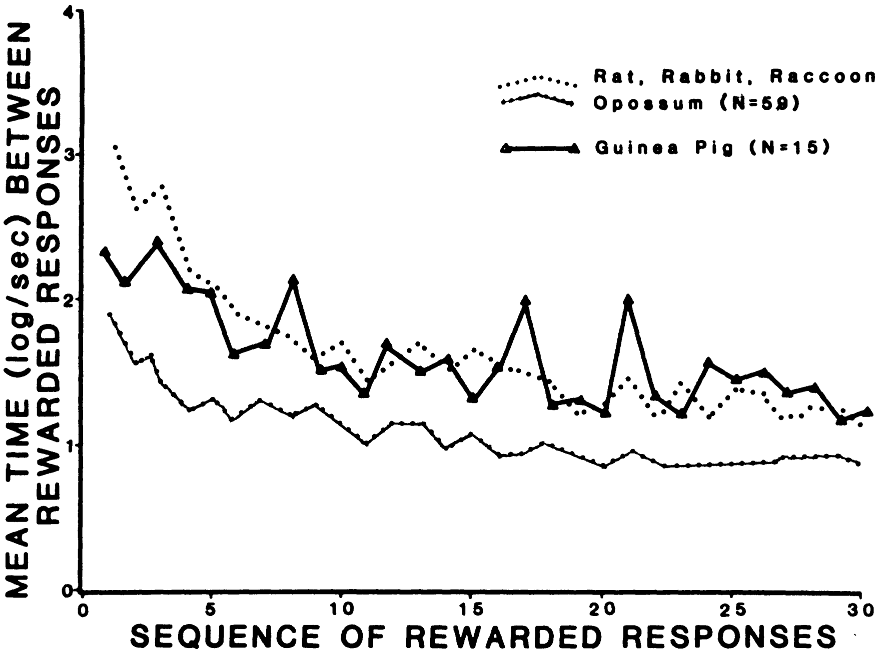

Figure 2. Comparison of the guinea pig's learning curve with those of the rat, the rabbit, the raccoon, and the opossum.

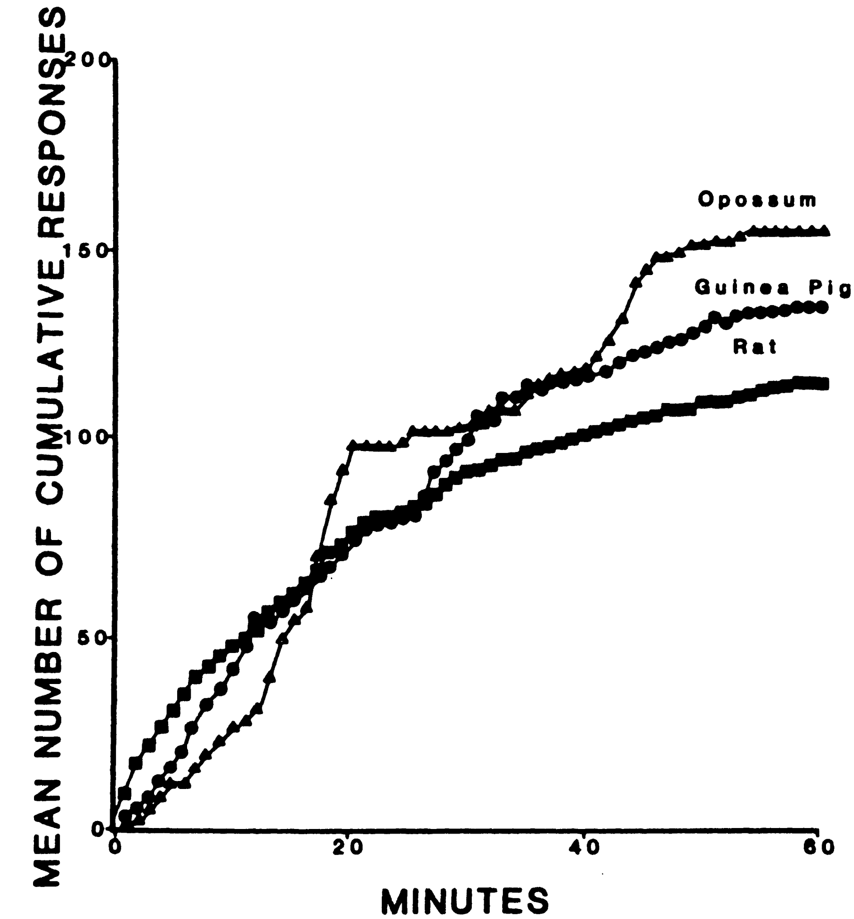

Figure 3. Cumulative extinction curve for the guinea pig, compared with those for the opossum and the Wistar rat.

sary number of rewards to learning, corrected learning time, and percentage of animals that learn. This is another confirmation of the hypothesis that simple operant learning ability apparently did not evolve with growing encephalization. On the contrary, animals with a comparatively small number of neurons, such as fishes and birds, perform much better in a simple food-rewarded operant task than do mammals. The answer is probably to be sought in the variations of the behavioral repertoires represented by brains with smaller and larger numbers of neurons.

Aside from that, food-rewarded behavior ranks high in the hierarchy of behaviors necessary for survival. For organisms with a relatively short life span and those in relatively stable environments, stereotyped foraging behavior leads to a high rate of success. For animals with a longer life span, living in more complex and changing environments, a degree of flexibility in foraging is more appropriate. There is evidence from our own work (Angermeier, 1984) and that of Harlow and Mears (1979) that one of the major processes occurring in learning is the suppression of situation-irrelevant behavior patterns. In a learning task in which only one behavioral approach leads to success, as in simple food-rewarded operant learning, lower organisms are favored because they have fewer situation-irrelevant behavior patterns relating to food-getting behavior. Higher organisms (in the sense of brain weight/body weight ratios) have to suppress irrelevant behavior patterns and, in addition, are also more easily distracted from the task at hand (Jerison, 1973; Razran, 1971).

The guinea pig appears to have an additional handicap: the persistent gnawing and chewing of objects, a genetically fixed behavior pattern observable in many rodent species.

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