Rats' Preference for Earned in Comparison with Free Food

Abstract. *Rats were trained to eat free food from a dish, then trained to press a lever for similar food. The free food was then presented while subjects were pressing on several reinforcement schedules. Subjects continued to press for reinforcement when one or two presses were required for reinforcement, and ate little free food. When ten presses were required for reinforcement, rats preferred free food and pressed little or not at all. It was concluded that, when work demands are not too high, rats prefer earned food to free food.*

Jensen (*1*) demonstrated that rats trained to press a lever for food reinforcement would continue to press and eat the food obtained in spite of the introduction of a dish of free food into the experimental chamber. Apparently rats prefer to press and eat rather than simply eat. Alternatively, the tendency to eat free food may have been unable to compete with the strong lever-pressing habit, or the rats may have failed to notice the free food altogether.

In our experiment we attempted first to ascertain whether a preference for pressing actually existed. To rule out the alternative interpretations, we trained rats to eat the free food, and we repeatedly tested to ensure that they noticed it. Having found a preference for pressing, we examined the dimensions of the preference. When the number of presses necessary to earn a reinforcement were increased, we found that the preference for pressing changed to a preference for free food.

Subjects were six male albino rats from the University of California at Los Angeles Department of Biology vivarium; they were more than 90 days old at the beginning of the experiment. Before the experiment they were deprived of food for 24 hours. During the experiment they received food only in the experimental chamber. The subjects had sufficient time in each session to become satiated and were thus 24 hours hungry at the start of an experimental session.

The experimental chamber was a Lehigh Valley Electronics operant conditioning chamber in an enclosure from the same company. The chamber was about 21.5 cm square with a food magazine in the middle of the front wall and a single lever on the right side of the front wall. Reinforcement and free food both consisted of standard 0.045-g Noyes pellets. Reinforcement was delivered by a Lehigh Valley feeder which operated with a quiet but audible click. The only auditory feedback provided by the lever was produced by the operation of its small microswitch. Free food was introduced in a glass dish 6.5 cm in diameter and 2.5 cm deep. The dish held about 300 pellets and was always full when introduced. It was placed against the back wall of the chamber but could be moved across the floor by the rats.

On each of three days, the rats were placed in the experimental chamber and allowed to consume free food. They were then given six daily, 1¼-hour lever-press training sessions with every press reinforced (CRF). They were tested twice with free food, then given two training sessions with every second press reinforced (FR2). They were again tested twice with free food, then given two training sessions with every tenth press reinforced (FR10). After two tests with free food, they were tested with free food twice more on the original CRF schedule.

Training sessions were 1 hour 15 minutes long; testing sessions, 1 hour. Free food was introduced after 25 presses on CRF test sessions and after 50 presses on FR2 and FR10 test sessions. During testing, the number of free pellets taken was counted, as could be done with fair accuracy because rats tend to pick pellets up and eat them one at a time.

Figure 1 presents a record of the preference for lever pressing over free food for each individual rat through the several phases of the experiment. For each test day the number of pellets obtained by lever pressing was divided by the total number of pellets consumed. Thus a ratio of 1.0 would indicate that no free food was consumed. No rat could obtain a ratio of 0 since the subject was required to earn several pellets before the introduction of free food. Each point on the graph represents a mean ratio for the two test days of each subject in each condition.

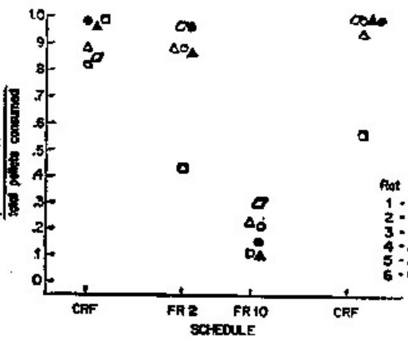

Fig. 1. Proportion of earned pellets to total pellets for individual rats as a function of schedule of reinforcement.

It is apparent that, in the initial CRF phase, all rats showed a strong preference for pressing, although all did eat some free food. The preference for pressing remained strong for five of the six rats on the FR2 schedule. Subject 1 showed a slight preference for free food. (His mean ratio is representative of his individual daily ratios.) At FR10, the rats showed a strong preference for free food, subjects 1 and 2 doing practically no pressing after the introduction of free food at the fifth reinforcement. With the reestablishment of CRF all rats again showed a strong preference for pressing, although subject 1 did not return to the high level of the initial CRF condition.

During exposure to free food in CRF and FR2 conditions rats frequently explored and manipulated the free food dish even though they ate very little from it. On more than one occasion the rat pushed the dish in front of the food magazine and then later pressed the lever. In order to get at the pellet obtained, the rat would actually push the food-filled dish away from the food magazine.

The finding that rats preferred pressing to free food in the initial CRF and FR2 conditions, even though they were previously exposed to free food, indicates that their reluctance to eat free food was not due to a lack of experience in eating it. The fact that all ate some free food in these conditions indicates that they did not fail to notice it. The immediate shift to a preference for free food in the FR10 condition is further support for this statement. Rats prefer to press and eat the pellets thereby obtained as long as the reinforcement schedule is not too demanding.

At FR10, a strong and immediate preference for free food developed and pressing practically ceased. Apparently the pressing seen in earlier phases was not due to some intrinsic reinforcement for pressing; otherwise the rats would have continued to press the lever even though they ate the free food. The pressing seen in CRF and FR2 would thus seem to be the result of a preference for earned food over free food. A possible alternative is that rats prefer pellets delivered one at a time to a mass of pellets presented in a dish. One rat was trained to eat pellets delivered into a magazine one at a time at a rate at which another rat was pressing for continuous reinforcement. At the introduction of a dish of pellets, the rat left the magazine and ate from the dish until satiated. Thus the preference for earned pellets is apparently not a preference for pellets presented one at a time.

The return of a preference for pressing at the reintroduction of CRF is further evidence that the failure to eat free food was not due to inattention or lack of experience. It further supports the contention that, as long as the work demands are not too high, rats prefer earned food to free food.

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Reference

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Acanthaster: A Disaster?

Chesher (18 July, p. 280) has offered the hypothesis that the dredging and blasting activities of man are responsible for the outbreaks of *Acanthaster planci.* Since the outbreaks may result in the permanent damage of coral communities, including the reduction of reef fish for human consumption and the eventual destruction of the reefs themselves by wind and wave, Chesher proposes intensive control measures. However, it is difficult to find compelling evidence that such epidemics have not occurred in the past, or that they constitute a permanent or even a significant threat to reefs and their inhabitants. Therefore, even though the observed outbreaks should be studied, caution in interpretations and in actions seems in order.

The assertion that *Acanthaster* was a great rarity until the observed outbreak on the Great Barrier Reef in 1962 is questionable. Chesher estimates one specimen per hour of search under normal conditions in appropriate habitats and five or more during epidemics. Edmondson (*1*) likewise considered the species uncommon or rare, but he also reported it as "abundant" on Christmas Island to the south, many years ago, and as many as four or five were taken during a single ½-hour dive on Guam in 1948 (*2*). These contradictory reports probably stem from the fact that much of the habitat occupied by *Acanthaster* is within the "Mare Incognitum" of Wells (*3*), a very important portion of reefs of which very little is known.

It is also possible that the interpretation that *Acanthaster* is undergoing "population explosion occurring almost simultaneously in widely separated areas" has resulted from a lack of previous knowledge. The use of skin diving and scuba equipment in making underwater observations is relatively new. That *Acanthaster* eats corals to a significant degree became generally known only 6 years ago. The relationship was then publicized in the mass media, and twice in a semipopular magazine (*4*). Attention being drawn to the phenomenon brought in new reports almost simultaneously from throughout the better part of the tropical western Pacific. However, epidemics could have been occurring sporadically all along, on numerous widely scattered reefs across the Indo-Pacific, without being noticed.

The sequence of events suggested as leading to an outbreak after the destruction of corals involves unknown aspects of larval mortality and behavior. In studies on the Great Barrier Reef, the youngest stages were found only in the interstices of certain living branching corals rather than in association with adult *Acanthaster* (*5*). Thus, settling intensity and initial survival of the starfish may be strongly influenced by an unusual abundance of certain coral species rather than by the destruction of corals. In the light of this alternative explanation, the causes of high population densities of the starfish remain highly speculative.

Earlier suggestions that depletion of *Charonia tritonis* and other gastropod predators by shell collectors might account for local increases in abundance of *Acanthaster* have been discounted. Yet it is generally acknowledged that this gastropod is an active predator on this starfish. Since the relative abundances of the species involved are unknown, the influence of *C. tritonis* and other predators on *Acanthaster* populations must still be considered seriously.

It is assumed that the outbreaks are unnatural and in need of control, even though *Acanthaster* is part of the normal reef community and therefore must play its role in determining the quality of the reef complex. This role is unknown; should it prove to be important, indiscriminate exterminations of *Acanthaster* would then be considered highly irresponsible acts. Although it may be expedient to apply limited remedial procedures, provided there is some assurance they will do more good than harm (*6*), it would seem more valuable to put most of our available resources and energy into studying and understanding the nature of the epidemics before suggesting drastic control measures. Fortunately at least two such studies are now in progress (*5, 7*).

Field observers have noted differences between fish populations on normal reefs and those on depredated reefs. The removal of living corals results in a reduction in diversity, but it also results in more algal-covered substratum on which herbivorous fish can graze (*8*). If ciguatera does not become a problem, fish available for human consumption on depredated reefs could become more abundant.

Although we usually refer to tropical reefs as "coral reefs," many other lime-secreting organisms besides corals are involved in reef building. Many reefs are algal-dominated, for example Kure and Midway (*9*). Various kinds of algae form filler material, and one, *Porolithon*, is a principal binding agent as well as a significant mass producer. It is primarily this alga that forms much of the seaward face of exposed reefs, particularly the algal ridge and groove and spur system, from the sea surface to or below wave base (*3, 10*). As far as we know, this system is not subject to damage by *Acanthaster*, and it is this living system that protects the reef from most of the destructive force of waves (*11*).

For an ultimate cause of *Acanthaster* outbreaks, Chesher looks to disturbances by dredging and blasting, and postulates the course of events leading to the "population explosion." Man is not the sole source of disturbance on reefs, however, and some coral colonies are known to have declined through natural causes within the past century (*12*). If reef damage is the essential initial ingredient, other, com-

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