AN ASSESSMENT OF AUTOMATICALLY DISPENSED PRIMATE REINFORCERS¹

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The use of automated test apparatus has posed a special problem in providing food reinforcement. These reinforcers must satisfy various criteria: reliability of delivery by an automatic feeder; some uniformity of amount and shape; economic availability; and consistency of high-preference value. These experiments are an attempt to determine the relative preference values of a number of reinforcers which, to some extent, meet the other criteria.

EXPERIMENT I

Method

The subjects were seven male and five female *Macaca mulatta*, weighing from 1.9 to 3.5 kg.

A cafeteria-feeding apparatus was constructed by replacing the door of a colony home cage with a panel containing two food cups. A small push switch was located above each cup so that each depression of a switch operated a Davis PD-104 feeder attached to the rear of the panel and delivered a pellet to the appropriate cup.

The basic reinforcer was a pellet made from granulated sugar and 1% by weight magnesium stearate, to facilitate tableting. These pellets were manufactured with a 1/8-in. standard concave punch, and weighed from 53 to 57 mg. Orange- and grape-flavored pellets were prepared by adding commercial soft drink powder in five ratios of flavor-to-sugar mixtures. Four other artificial flavors (raisin, nut, anise, and mixed fruit) were also prepared and surveyed.

After initial training by shaping, daily 30-min sessions were conducted with each *S*. In all comparisons, the sucrose pellet was used as a standard to test one other flavor and concentration condition per session. Each pellet preparation appeared at least once in the right and left positions. The numbers of responses on each switch were recorded.

Results

The data showed no preference for the flavored concentrations over the standard sucrose pellet. Individual *Ss* displayed marked position preferences which were overcome for the orange and grape preparations, but in the direction of rejecting the flavor. In the survey of the other four flavors, the numbers of responses for any of these pellets did not exceed those made for the unflavored standard.

EXPERIMENT II

Method

The subjects were seven female monkeys whose weights ranged from 3.6 to 4.5 kg. Six were *Macaca mulatta*; the seventh was a *Macaca irus*. All were maintained on daily rations of 15 pellets of Purina Monkey Chow.

A modified Wisconsin General Test Apparatus was used as an experimental compartment. An upright panel, containing two small food cups made from conductive material, was placed 6 in. behind the bars forming the front wall of this compartment. A metal contact plate was placed on the floor in front of the panel so that a circuit was completed when *S* touched an activated cup. The completion of this circuit operated a Davis PD-104 feeder,³ dropping a pellet to the cup. A small

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³Feeder plates designed for soybean delivery are available from Davis Scientific Instruments, 12137 Cantura Street, Studio City, California.

red light located $\frac{1}{2}$ in. above each cup indicated which of the two feeders was operative.

Five preparations of soybeans and two commercially available pellet preparations were used as reinforcers. Sucrose pellets of the type described in Experiment I (available from The P. J. Noyes Co.) and Ciba banana pellets were tested. Soybeans were either soaked, lightly salted, heavily salted or roasted. For roasting, raw seed-grade soybeans were placed in an 120°C oven for 2 hr. Soaked beans were placed in water for 3 hr before roasting, while the salted varieties were soaked in salt water for this period. For light salting, the concentration of salt was $\frac{1}{4}$ cup of salt per liter of water, while the concentration used for heavy salting was double this, or $\frac{1}{2}$ cup.

After adaptation and initial training, animals were placed in the experimental compartment with one feeder activated and its appropriate indicator light on. When the animal made the first correct cup-touching response, a timer was started and this cup became operative for 1 min. At the end of this period, the other feeder circuit and light were activated, and the timer was again started on an Ss first correct response. After this cup had yielded pellets for 1 min, the original circuit was again made operative. Each daily session consisted of eight 1-min periods in which alternate cups yielded pellets so that each feeder could be operated for 4 min. The numbers of responses to each cup were recorded electrically. A criterion of at least five 1-min periods was set for session completion.

Four pellet preparations were assessed in each 12-day block of experimental data. Each reinforcer appeared twice with every other reinforcer, and equally often in both right and left positions. Presentation as the first or second item in the alternated series was also balanced. Within each block, each pellet was presented six times.

Two 12-day blocks were run. In the first of these, comparisons were made among roasted, soaked, heavily salted, and lightly salted beans. In the second block, sugar pellets, banana pellets, roasted beans, and raw beans were compared.

Results

To determine the preference score, the cup-touching responses of each animal on each

reinforcer were added; and this sum was divided by the number of completed sessions. All animals completed at least five of the six sessions on each condition. We have called this score mean pellets per session.

By ranking and comparing these scores in a Friedman nonparametric analysis of variance, we have found significant differences ($\chi_r^2 = 16.01$, $p > .01$) among preferences for roasted, soaked, lightly salted, and heavily salted soybeans. Median scores were obtained for daily sessions on the four conditions: heavily salted beans, 82; lightly salted beans, 98, roasted beans, 144; and soaked, unsalted beans, 147.

A similar comparison among sucrose pellets, roasted beans, raw beans, and banana pellets also showed significant differences ($\chi_r^2 = 11.38$, $p > .02$), with medians of 145, 187, 199, and 208, respectively. The response rate was generally higher in this second 12-day block of data. The median score for roasted beans was 144 in the first block and 187 in the second.

DISCUSSION

The results of Experiment I indicate that unflavored sucrose pellets are equally as effective as any of the flavored pellets we have prepared. Flavored preparations have the further disadvantage of being uneconomical to manufacture because of tableting difficulties.

The procedure in the second experiment was designed to enhance the reliability of preference testing by minimizing position preferences. Our raw data indicate that this attempt was successful since Ss consistently selected high-preference reinforcers irrespective of their position.

Because salted peanuts have typically been used in formboard testing, one purpose of the second experiment was to determine preferences for salted soybeans. The usual salting procedure involves an oil coating which might decrease reliability of delivery, but salting can also be accomplished by brief soaking in brine. Because the bean has a soft center after the soaking operation, we thought it would be advisable to make a control preparation with a soft center and no salt. The results of the comparisons in the first data block show that salted soybeans are rejected and that the soft-center unsalted beans are

selected as frequently as the unsoaked variety. Since the bean is swollen in soaking and then shrunken when roasted, extreme care must be exercised to effect an even roast so that size variability does not cause any loss of feeder reliability. For this reason, we decided to adopt the roasted unsoaked bean in further experimentation.

Primate experimenters have typically used roasted peanuts rather than raw peanuts. However, because salting seemed to have a distinct influence on soybeans, we also decided to assess the roasting effect. Accordingly, in the second data block, raw beans were compared with roasted beans and two other commercially available reinforcers. The significance of preference differences here is almost wholly dependent upon the relative rejection of sucrose pellets. Banana pellets, although high in preference, were not consistently preferred. One animal always rejected them in favor of any of the other reinforcers.

Although preference differences between raw and roasted beans are not apparent in

this experiment, further usage has revealed at least one important difference. Raw beans were used as rewards in a two-trial discrimination study with the 12 Ss in Experiment I. All Ss accepted them for nearly 3 weeks; but at the end of this period, two animals were not eating all the obtained reinforcers, and session durations had lengthened for most animals. Subsequent use of roasted beans has remedied this situation, and this reinforcer has been successfully used in the automatic test apparatus for 8 months.

Another observed advantage of soybean reinforcers rather than sugar pellets is in the influence of deprivation on response rates for the two rewards. Slight deprivations markedly increase the acceptance of soybeans, whereas sugar pellets may be rejected after more extensive food withdrawal.

It is concluded that soybeans offer an effective and economical (450 beans per 1¢) means of supplying primate reinforcement from an automatic dispenser.