Failure to obtain behavioral contrast when components change after reinforcement

D. B. PEELE and C. B. FERSTER
The American University, Washington, D.C.

(A. L. Riley, *Sponsor*)

The rate of pecking under the variable-interval component of a multiple variable-interval extinction schedule was investigated as a function of whether the components were changed after reinforcement or were changed on the basis of elapsed time. Behavioral contrast—an increase in the response rate during the unchanged variable-interval component—was observed when the components were changed on the basis of time, but not when the components were changed after reinforcement. These results support the hypothesis that behavioral contrast is primarily a result of selective reinforcement of short interresponse times.

Behavioral contrast, first observed by Reynolds (1961a), is an increase in the rate of responding during one component of a multiple variable-interval, variable-interval (Mult VI, VI) schedule when the other component is changed to extinction (EXT). A number of theoretical explanations of this phenomenon have been offered. One explanation involves the change in reinforcement frequency (Reynolds, 1961b), a second hypothesis focuses on the active suppression of responding by the EXT schedule that occurs in the altered component of the multiple schedule (Terrace, 1968), and yet a third explanation postulates that the summation of instrumental and Pavlovian responses is involved (Schwartz & Gamzu, 1977).

A fourth hypothesis, which accounts for a major part of the behavioral-contrast literature, is found in the details of how the changeover from the VI to the EXT component of the multiple schedule alters the distribution of interresponse times of the reinforced response. In every contrast study we have reviewed, with the exception of that of Reynolds and Catania (1961), change from the VI to the EXT component was scheduled on the basis of a period of elapsed time. Such a changeover procedure selectively eliminates long interresponse times from the distribution of reinforced interresponse times because the VI period is more likely to end after a pause than after a response. As a result, the distribution of reinforced interresponse times will have fewer long intervals than it would otherwise have. Such a truncation of interresponse times is equivalent to the differential reinforcement of high rates, and is similar in effect to the contingencies produced by a limited-hold schedule (Ferster & Skinner, 1957, p. 335). This effect on interresponse times could not occur if the

changeover from one schedule component to the other occurred after reinforcement.

The only study that has found that rates of responding increased when schedule components were changed after reinforcement was that of Reynolds and Catania (1961). However, their results would appear to be due to the characteristics of fixed-interval (FI) schedules, rather than to behavioral contrast. A timeout following short to moderate values of FI schedules would increase the rates of responding because consuming the grain reinforcer, as a stimulus negatively correlated with reinforcement, would no longer control a zero rate of responding at the start of the FI (Ferster, 1954; Ferster & Skinner, 1957, p. 185).

The present experiment tested this hypothesis by comparing identical Mult VI EXT schedules with changeover between components that occurred on the basis of elapsed time or after reinforcement.

METHOD

Subjects

Four experimentally naive adult male White Carneaux pigeons served as subjects. The subjects were maintained at 80% of their free-feeding weight, and had continuous access to grit and water in the experimental and home cages.

Apparatus

A standard experimental pigeon space, 30.5×27.9×33.0 cm, constructed from a portable ice chest, was used. The response keys were illuminated from behind by 6-W green (VI) and red (EXT) Christmas-tree lamps. A relay mounted on the intelligence panel provided a click each time the key was pecked during the experimental sessions. Two 6-W clear bulbs, also mounted on the intelligence panel, served as house lights. White noise masked extraneous noise. Standard electromechanical programming equipment was located in an adjacent room. The data were recorded on electromagnetic counters and cumulative graphic records.

Procedure

After magazine training, all subjects were shaped to peck a key by successive approximation, received 60 continuous reinforcements, and then were placed directly on a VI 3-min schedule with the green key.

The values for the VI schedule were derived from the progressions suggested by Fleschler and Hoffman (1962). Reinforcement consisted of 4-sec access to the lighted food hopper. Sessions were terminated after 60 reinforcements.

The general plan of the experiment was to compare the rates of pecking under the VI component of a Mult VI EXT schedule when the components were changed every 3 min (changeover with time—COT) or after reinforcement (changeover with reinforcement—COR). The duration of the EXT components under both conditions was 3 min; during EXT, the key was red. The order of conditions for all subjects was as follows: VI-only, COR, VI-only, COT, VI-only, COR, VI-only, COT, VI-only. Each condition was maintained for five sessions. Response-rate data were analyzed as a percentage of the rate during VI-only conditions. A Wilcoxen signed-ranks test (two-tailed) was used to compare rates maintained under COR and COT conditions, with alpha level set at .01.

RESULTS

Figure 1 summarizes the results of the entire experiment for all 4 birds (P1, P2, P3, and P4). During the VI-only conditions, mean response rates for the subjects
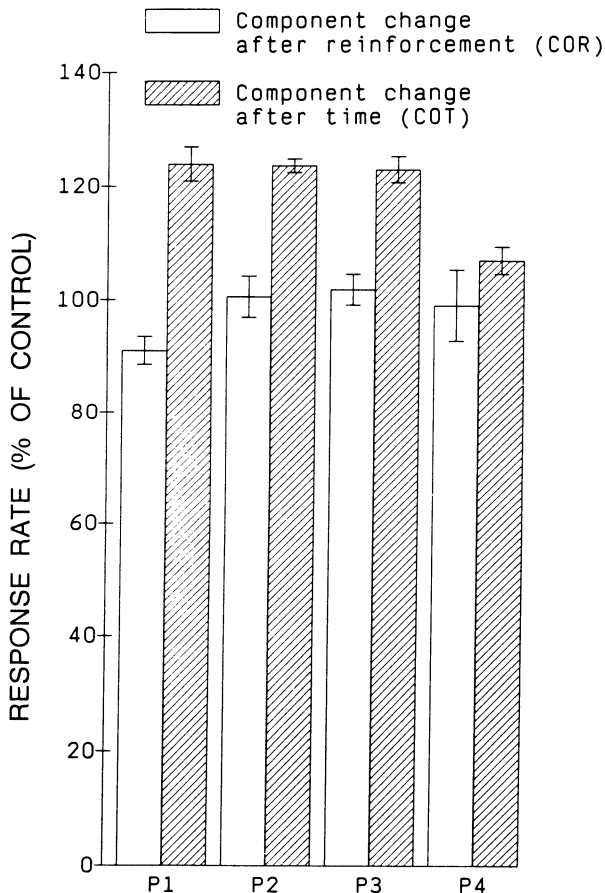

Figure 1. Mean rate of pecking (±SE) in the unchanged component of the multiple schedule expressed as a percentage of the response rates emitted during the VI (variable interval)-only conditions. Response rates during components that were changed after reinforcement (COR) are represented by the unfilled bars. Response rates during components that were changed every 3 min (COT) are represented by the hatched bars. The mean response rates during the VI-only conditions were 53.8, 77.4, 91.4, and 91.0 responses per minute for subjects P1, P2, P3, and P4, respectively.

were 53.8, 77.4, 91.4, and 91.0 responses per minute, respectively, for P1, P2, P3, and P4. The result of changing from one component to the next after reinforcement (COR) is shown in the unfilled bars of Figure 1, in which all subjects showed response rates at or near 100% of that maintained during the VI-only conditions. On the other hand, as shown in the hatched bars of Figure 1, response rates during the VI component increased by as much as 24% when components were changed on the basis of elapsed time. The effects were most dramatic for P1, P2, and P3. The effect of changeover conditions on the rate of responding by P4 was small, but in the general direction shown by the other 3 subjects. A comparison of response rates during COR and COT using the Wilcoxon signed-ranks test yielded statistical significance ($p < .01$).

DISCUSSION

For 3 of the 4 subjects, rates of responding during VI components increased when components of the multiple schedule were changed on the basis of time compared with the VI-only condition. No contrast was obtained when the component changeover occurred after reinforcement. This finding provides clear evidence that the contrast effect obtained in the present experiment was due to the truncation of reinforced interresponse times. A number of experiments in the literature also support this explanation of contrast.

Shimp and Wheatley (1971) and Todorov (1972) studied a Mult VI, VI schedule in which one component had a lower frequency of reinforcement than the other. These researchers found that the rate of responding on the richer reinforcement component increased when component durations were brief. We surmise that the more frequent changeover between components provided more explicit differential reinforcement of short interresponse times. The converse result was obtained in an experiment by Boneau and Axelrod (1962), in which the VI component duration was lengthened from 1 to 8 min. Predictably, they found a reduction in the contrast effect because there were fewer contingencies at changeover.

One possible way to integrate the present finding with the various hypotheses that have been proposed to explain behavioral contrast is a multifactor theory. At first glance, it might appear that emotional effects of changeover or the summation of elicited and operant pecks could operate in addition to rate reinforcement. The failure to find contrast when changeover occurred after reinforcement, however, would rule out such multifactor explanations, although they could conceivably bear on accounts of local or momentary contrast effects (Nevin & Shettleworth, 1966). The failure to find contrast when schedule components were changed after reinforcement does not appear to be compatible with the additivity explanation proposed by Gamzu and Schwartz (1973) and by Schwartz and Gamzu (1977). If additivity were operative, it would predictably occur under the COR condition. Nor are the results of the present experiment compatible with the "worsening of conditions" hypothesis of behavioral contrast (Reynolds, 1961a, 1961b). The proposal by Terrace (1966, 1972), that behavioral contrast is caused by the inhibition of suppression of responding in the component of the multiple schedule, is also contradicted by the failure in the present experiment to find contrast when components were changed after reinforcement.

Experiments in which a change to a low frequency of reinforcement comprised the unfavorable schedule provide results consistent with those described above (Guttman, 1959; Terrace, 1966). In those experiments, components were changed on the basis of a period of elapsed time, and the lean schedule appeared to have a function similar to that of extinction. This interpretation is supported by Bloomfield's (1967) study in which the extent of the contrast effect was determined by the obtained frequency of reinforcement using a differential reinforcement of low rates and a fixed-ratio schedule as the changed component. The rate-reinforcement analysis of the contrast effect obtained with a lean schedule of reinforcement, rather than with a timeout, could not be evaluated, however, until experiments had been done in which the multiple sched-

ules were programmed by changing components after reinforcement rather than on the basis of elapsed time.

In a study by Brethower and Reynolds (1962), an argument for a contrast effect based on a worsening of conditions rather than on rate reinforcement was presented. In that experiment, the changed component of a Mult VI, VI schedule involved the punishment of pecks with an electric shock. It is unclear, however, whether this experiment is generically related to the mainstream of contrast experiments that have been reported, or if it is a homologue related to special effects of aversive stimuli.

In general, behavioral contrast has been a phenomenon demonstrated primarily in pigeons. Although there have been reports of behavioral contrast in species other than pigeons (Beninger & Kendall, 1975; Henke, Allen, & Davidson, 1972; Wilke, 1972), many such studies have reported equivocal results (Pear & Wilke, 1971), or failure to obtain behavioral contrast in these species (Freeman, 1971; Jaffee, 1973; Spealman, 1978; Weiss, 1971). It seems likely that the special success that has been obtained with pigeons is due to the nature of the peck as an operant response that is especially sensitive to rate contingencies, compared with topographies typically used with, for instance, rats or primates. It would seem that the nature of the response and its sensitivity to rate reinforcement could account for the differences between pigeons and chimpanzees on the effect of a pretimeout stimulus on a VI baseline that were reported by Ferster (1958). With pigeons, which are presumably more sensitive to rate contingency, responding increased over baseline during the pretimeout stimulus, whereas with chimpanzees, which are more sensitive to the aversive properties of the timeout, responding decreased.

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