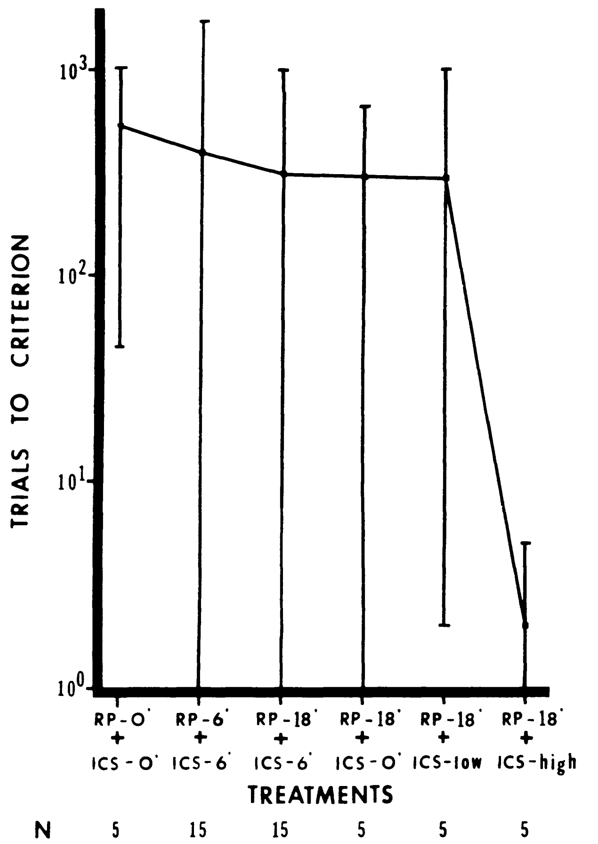

Fig. 1. Mean trials to criterion and range of scores. Number of Ss in each treatment group is shown on the abscissa below each of the treatments.

responding was frequent ICS throughout the longer response prevention period. Because we used small numbers of Ss in each group, there is, however, a danger of concluding that there are no differences, when indeed there are differences among the treatments. If more Ss were tested, the trend in the data that ICS just prior to testing for extinction led to less responding might prove reliable. The achievement of statistically reliable differences among the various groups with differentially spaced counterconditioning, however, would not detract from the conclusion that can be drawn from the data. The combination of response prevention and counterconditioning is surely not more efficient than frequent application of counterconditioners throughout response prevention.

These data, combined with considerable other data of the animal laboratory (e.g., references cited in the introduction), support the conclusion that a counterconditioning procedure is the technique of choice for reducing persisting avoidance, a conclusion that confirms the germinal work of Jones (1924) and Wolpe (1958).

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Preference for reward and nonreward odor trails as a function of reinforcement history*

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Two hundred and twenty-five rats were tested for preference of reward, nonreward, and neutral odor trails. Rats which had previously received partial or varied reward training showed no preference for reward odor trails, while rats which had previously received continuous reward training preferred reward odor trails. The results were seen to have both methodological and theoretical implications for past and future instrumental conditioning experiments.

In recent years, a number of studies have shown that the reinforcement event administered to one rat will, under certain circumstances, influence the behavior of another rat in the running order. More specifically, it would appear that rats exude different odors on rewarded (R) as compared with nonrewarded (N) trials and that odors exuded by one S often perseverated until the next S in the running order is administered a trial in the same apparatus. One series of studies has demonstrated that the R and N odor trails left by one S can serve as discriminative stimuli for a subsequent S (e.g., Ludvigson & Sytsma, 1967; McHose, 1957; Morrison & Ludvigson, 1970). These data, then, indicate that Ss will learn to respond differentially to R as compared with N odors when these odors are differentially reinforced. More importantly for present purposes, rats react differentially to reward-related odors even when they are not differentially associated with

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Table 1
Reinforcement Conditions Administered Prior to Preference Testing

Group C		Group CS		Group VP	
Reinforce-ment	N	Reinforce-ment	N	Reinforce-ment	N
0	6	20-4-0	6	1/0	6
1	42	4-20-0	6	2/0	6
2	6	4-1	9	4/0	6
4	6	10-1	18	8/0-1/0	6
7	18	15-1	9	15/0-1	9
		16-1	6	16/0-1	6
		20-1	9	16/0-2	6
		12-4	6	16/0-1/0	6
				16/0-2/0	6
				20/0-1	9
				20/4-0	6
				20/4-1	6

Note–Reinforcement conditions are indicated according to the number of 45-mg pellets received, with a "/" indicating a varied reward schedule and a "-" a shift in reward conditions.

reinforcement (Collerain & Ludvigson, 1972; McHose & Ludvigson, 1966). Collerain & Ludvigson (1972), for example, found that Ss avoided N odors when allowed a free choice between loci in which other Ss had been rewarded or nonrewarded.

Aside from any interest in the precise experimental conditions under which Ss exude differential odors, or in the nature or anatomic source of the odiferous substance, the observation that Ss exude odors to which other Ss can and do respond is of critical importance in the design and interpretation of experiments nominally unconcerned with odor effects. Simply put, it would seem obvious that odor trails should be "controlled" in some fashion in any such study.

Two procedures for controlling odor trails would appear to have evolved in the instrumental conditioning literature since 1966, both of which may be exemplified by reference to previous studies from the author's laboratory. The first tactic is simply to remove the odors from the apparatus through the use of exhaust fans (e.g., McHose, 1973). The second, and probably generally more common, technique is to insure, through the procedure by which Ss are administered trials, that R and N odors exuded by one S are not differentially associated with reinforcement for other Ss, and that all Ss are equally as often exposed to one odor as to another (e.g., McHose, 1969). This "randomizing" procedure for controlling odor trails is of central interest in the present paper.

While the randomizing procedure would appear to be satisfactory for eliminating the possible influence of cue or discriminative stimulus properties of odor trails in most experiments, this procedure may well be unsatisfactory for eliminating any contaminating effects of odor trails which are not dependent on within-experiment reinforcement contingencies. Recall that Collerain & Ludvigson (1972) have shown an aversion for N odors which is apparently not learned or learned preexperimentally. This primary (odor) stimulus effect apparently accounts for the observation that, in the straight runway apparatus, nondifferentially reinforced Ss run faster to the locus of large reward for other Ss than they do to the locus of small reward for those Ss (McHose & Ludvigson, 1966). It should be apparent that the randomizing procedure "controls" for the primary stimulus effects of odors between experimental controls only to the extent that the experimental conditions do not themselves generate different levels of reactivity to the odors. The present paper reports data bearing on the possibility that the reinforcement schedule administered to an S may affect that S's response to odor stimuli. More specifically, the present paper reports the effects of varied or partial reward training as compared with continuous reward training on the preference of Ss for different odor trails.

METHOD

Subjects

The donor Ss were 10 experimentally naive male albino rats, approximately 120 days old at the beginning of the experiment. The experimental Ss were 225 male albino rats, also approximately 120 days old at the beginning of preference testing.

Apparatus

There were three apparatus, one used to obtain odor trails from donor Ss, one to test for odor trail preferences among experimental Ss, and one in which experimental Ss received regular instrumental conditioning trials prior to preference testing. The odor trail apparatus consisted of a straight runway, subdivided into two sections: a 10-in.-long start section and a 20-in. run-goal section, separated by a 1-in.-high hurdle. The height and width of this apparatus were 4 in. throughout. The preference apparatus consisted of a flat black startbox, 12 in. long, 5 in. wide, and 5 in. high, a choice-point section, and three stems, each 16 in. long x 5 in. high x 5 in. wide, with these sections located 45, 90, and 135 deg from the center of the startbox. The apparatus in which experimental Ss received instrumental conditioning trials was a conventional straight runway apparatus described elsewhere in detail (Peters & McHose, 1973). Of note with respect to this apparatus is the fact that it was equipped with a continually running exhaust fan (Pamotor Model 1000A).

Procedure

The experimental Ss were drawn from a series of straight runway experiments concerned with topics irrelevant to the present paper. In each of these experiments, Ss were placed on a 23-h food-deprivation schedule prior to training and were maintained on that regimen throughout preference testing. Handling and prefeeding procedures were identical to those described elsewhere (Peters & McHose, 1973). The reinforcement conditions received by the 78 Ss which received varied or partial reward training, by the 78 Ss which received continuous reward training, and by the 69 Ss which experienced a shift from large to small continuous reward are presented in Table 1. Table 1 also indicates the number of Ss in each of the subgroups constituting the three major conditions.

Donor Ss were placed on a 23-h food-deprivation regimen 12 days prior to preference testing. On each of the last 2 days prior to the advent of preference testing, these Ss received 15 trials in the odor trail apparatus on a double-alternation cycle of reward (R, 12 45-mg Noyes pellets) and nonreward (N, 20-sec confinement).

On preference test days, the procedure was as follows: Two donor Ss first received an R trial with paper tacked to the floor of the odor trail apparatus, the paper was removed, the apparatus loaded with fresh paper, and the two Ss administered N trials, and the paper removed. The R paper, N paper, and fresh paper were then tacked to the floor of the three choice stems of the preference apparatus, and an experimental S was tested for preference. Following the preference test, these papers were discarded and the entire procedure repeated for the next experimental S. The order in which a pair of donor Ss received their R and N trials was counterbalanced, as was the position of R, N, and neutral paper in the preference apparatus (for each experimental subgroup). Two donor Ss were used for each set of 45 experimental Ss.

RESULTS

The number of Ss within each group choosing the stem containing the R, N, and neutral papers is presented in Table 2. As may be seen in Table 2, Group C displayed a marked preference for R odors as compared with either N or no-odor conditions. Groups VP and CS, however, displayed only a slight preference for R as compared with N odors. Analysis of the frequency data depicted in Table 2 yielded a significant effect for Group C ($\chi^2 = 17.40$, df = 2, $p < .001$). Pair comparisons of these data indicated that the frequency difference between R and neutral paper choice frequencies was statistically reliable ($\chi^2 = 4.54$, df = 1, $p < .05$), but not the difference between neutral and N choices. For Groups CS and VP, neither the overall frequency comparisons nor any pair comparisons were statistically reliable.

DISCUSSION

Ss that received, prior to preference testing, continuous reinforcement at some constant reward value (Group C) preferred R to N odors, while Ss that received varied or partial reward training (Group VP) or downward shifts in reward amount (Group CS) did not. In the present data, it would appear that Group C was attracted to the R odor locus, rather than averse to the N odor locus, since the frequency with which the "neutral" locus was chosen approximated the N odor choice frequency. In view of previous data (Collerain & Ludvigson, 1972; Morrison & Ludvigson, 1970), however, it is perhaps more reasonable to assume that the basis for the observed differential preference of R and N odors was indeed an aversion of N odors, and that the "neutral" condition was also avoided for some reason (e.g., because the neutral paper was devoid of any conspecific odor).

Whatever the basis for the preference of R as compared with N odor trails in the present data, it is clear that this preference differed among Ss as a function of their reinforcement history in a situation presumably free of reward-related odor trails. Now, previous data indicate that the performance of an instrumental response varies with the odor trail present even though odor trails are not differentially associated with reinforcement (McHose & Ludvigson, 1966; Spear & Spitzner, 1966). These data have been interpreted to reflect some tendency of odors associated with (contextually) minimal rewards to elicit interfering behaviors (McHose & Ludvigson, 1966). If the present data may be applied to the instrumental conditioning situation, they suggest that the extent to which interfering responses would occur to N odors would depend on the reinforcement history of the organism that is exposed to those odors. Clearly, the merit of the randomizing procedure for controlling the exposure of Ss to different reinforcement odors rests upon the assumption that the effects of these odors on behavior is independent of the reinforcement history of the organism—an assumption contradicted by the present data.

Table 2
Preference Frequencies for Each Group

Group	Reward	Nonreward	Neutral
C	43	14	21
CS	27	17	25
VP	32	23	23

Viewing the present data in a methodological framework, they merely point up the practical importance of eliminating odor trails in any study unconcerned with odor effects. More disconcerting are the questions raised by the present findings with respect to theoretical interpretations placed upon the results of previous experiments. Consider as an example the sometimes reported observation that, in simple instrumental conditioning, partially reinforced Ss respond at a higher level than do continuously reinforced Ss, an observation of considerable theoretical import (cf. Amsel, 1967). If partial reward generates less aversion to N odors than does continuous reward, and consequently fewer interfering responses in an N odor situation, it is possible that the partial reward acquisition effect is an odor artifact, i.e., an effect of partial reward on reactions to odor trails rather than an effect of partial reward on traditionally conceptualized associative or motivational systems. In this context, it will be particularly important to determine whether the extent of the differential preferences for R and N odors generated by different reinforcement schedules in turn depends upon whether the reinforcement schedules are experienced in (reinforcement) odor-free situations (as in the present study) or in odor-permeated situations (as in the preponderance of the previous literature).

Finally, it should be emphasized that the major thrust of the present data is that reactions to odor trails vary with reinforcement history. These data are obviously not particularly helpful in isolating the precise features of the various reinforcement schedules which produced the preference differences among Groups C, Cs, and VP. For example, most of the Ss in Group VP not only received partial or varied reward, but shifts in reinforcement schedules as well.

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