Odor-mediated runway performance of the rat as a function of Thorazine injection

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Two groups of runway-trained rats received a double-alternation sequence of reward-nonreward in a straight runway in the presence of odors exuded by startbox donors injected with Thorazine and saline, respectively. Appropriate start- and run-measure patterning was initially displayed only when the donors were saline injected. However, reversing the donor-injection condition resulted in the development of such patterning by the subjects having donors shifted from Thorazine to saline and the maintenance of patterning by the subjects having donors shifted from saline to Thorazine.

Previous studies by Ludvigson and Sytsma (1967), Seago, Ludvigson, and Remley (1970), and others have shown that the reinforcement events experienced by any one rat can affect the performance of subsequent animals. This has been particularly evident when rats are exposed to alternating schedules of reward (R) and nonreward (N), for example, single-alternation schedule (Amsel, Hug, & Surridge, 1969), double-alternation schedule (Seago et al., 1970). Specifically, when rats are administered a double-alternation schedule of reward and nonreward, responding in the goal section of a runway appears to be mediated by odor cues from previously run animals. Rats apparently exude a distinctive odor on the N trials of a reinforcement schedule (Morrison & Ludvigson, 1970). Furthermore, Collerain (1978) has suggested that these odors may be linked to an emotional response associated with frustrative nonreward.

Through the use of an odor-donor technique, similar responding has been selectively established in the start and run sections of the runway (Davis, Prytula, Harper, Tucker, Lewis, & Flood, 1974; Davis, Prytula, Noble, & Mollenhour, 1976; Prytula & Davis, 1974, 1976). This procedure involves the direct placement of a donor rat into a designated section of the runway, the start area or middle of the run section. The donor rat experiences an R or N event at this location and is then removed from the apparatus. A runway-trained animal

is immediately placed in the start area and allowed to traverse the entire runway, with the influence of the donor's odor being reflected primarily on the start and/or run segments of the instrumental-response chain.

Howard and McHose (1974) have shown that, when donor animals were drugged with sodium amobarbital, discriminatory responding by run animals was eliminated, that is, double-alternation patterning failed to develop. Their interpretation was that sodium amobarbital reduced the emotional response to frustrative nonreward in the donor animals, thereby reducing or possibly eliminating the production of odor cues to be utilized by the run animals. However, it should be noted that in the Howard and McHose (1974) study, drugged donors were allowed to traverse the entire runway, thus allowing a possible interaction of donor and experimental subjects' odors in the goal.

The purpose of the present study was to: (1) replicate and extend the findings of Howard and McHose (1974), since this is one of the few studies that has assessed the effect of drug influence upon odors, and (2) more clearly isolate the effects of the drug state on the production and utilization of such odors. The technique utilized in the present study was to confine the drugged-donor odors to the start area, thus more clearly separating the influence of donor- and run-subjects' cues on behavior.

Even if one accepts the position that odors are reduced under the drug state, it is still conceivable that the run animals may be learning something about the odor process. In order to evaluate this possibility, a second phase in which the donor conditions were reversed was conducted.

METHOD

Subjects

Twenty-eight male albino rats purchased from the Holtzman Company, Madison, Wisconsin, served as subjects. The subjects were approximately 90 days old at the beginning of experimental testing. All subjects were individually caged, with water available on an ad-lib basis. One week prior to the beginning of pretraining all subjects were placed on a food-deprivation regimen which maintained them at 85% free-feeding body weight for the duration of the experiment.

Apparatus

The apparatus consisted of a single straight runway (11.4 cm wide x 12.7 cm high) having a gray startbox (28.1 cm), black run section (91.4 cm), and black goalbox (30.5 cm). Masonite guillotine doors separated the startbox and goalbox from the run section. Start, run, and goal times, produced by the activation of a microswitch located on the start door and the interruption of a series of photoelectric cells (located 15.2, 92.4, and 116.8 cm beyond the start door) were recorded on all trials. A plastic receptacle recessed into the end wall of the goalbox served as the goal cup. A thin sheet of transparent plastic covered the top of the alley to prevent odors from dissipating.

Procedure

Prior to pretraining, two equal-sized (n = 14) groups, run and odor-donor, were formed. Subjects within each group were randomly assigned a permanent number (1-14). Two squads (T-S and S-T), consisting of Run and Odor-Donor Subjects 1-7 and Run and Odor-Donor Subjects 8-14, respectively, were subsequently formed.

A 4-day pretraining phase immediately preceded the experiment proper. Pretraining consisted of handling and taming (Days 1-2) and habituation to the 45-mg Noyes reward pellets in the home cage (Days 1-4) for all subjects. Each run subject received a 5-min exploration period in the unbaited apparatus on Days 3-4. Odor-donor subjects received additional handling on these days.

All subjects received eight daily trials (4 R and 4 N) in a double-alternation (RRNNRRNN) sequence during both phases of the experiment. Subjects were tested within respective squads on all days. All daily trials were administered to a particular squad before the next squad was run. The order for running squads alternated daily.

To run a trial, the appropriate odor-donor animals (e.g., Odor-Donor 1 was used with Run Subject 1, etc.) was removed from the home cage and placed into the startbox. As soon as the reward (12 45-mg Noyes pellets) was consumed (R trials) or a 30-sec confinement period elapsed (N trials), the odor-donor subject was removed and the appropriate run subject was placed into the startbox. Following a 10-sec confinement, the start door was raised and the run subject allowed to traverse the runway. Reward and nonreward events experienced by the run subjects in the goalbox were the same as those experienced by the odor-donors in the startbox.

During Phase 1 (14 days, 112 trials) each odor-donor subject in Group T-S received a daily 2-mg/kg intraperitoneal injection of Thorazine 1 h prior to experimental testing. Each odor-donor subject in Group S-T received a daily 2-mg/kg intraperitoneal injection of saline 1 h prior to experimental testing during Phase 1. During Phase 2 (7 days, 56 trials) the injection procedures were reversed (i.e., donor subjects in Group T-S were injected with saline and donor subjects in Group S-T were injected with Thorazine). Thus, the only difference between Groups T-S and S-T was the type of injection given to the donor animals. Run animals were maintained as in Phase 1.

RESULTS

Prior to analysis, all time scores were reciprocated and multiplied by the appropriate constant to yield speed scores in meters per second. The speed scores were then combined for each subject as follows: The first two trials were averaged to yield an R_1 composite score, the next two trials were averaged to yield an N_1 composite score, and so forth. Mean start, run, and goal speeds for Phases 1 and 2 are shown in Figures 1-3, respectively.

Phase 1

Anlaysis of variance incorporating groups, R vs. N, and days effects was performed on the speed data from
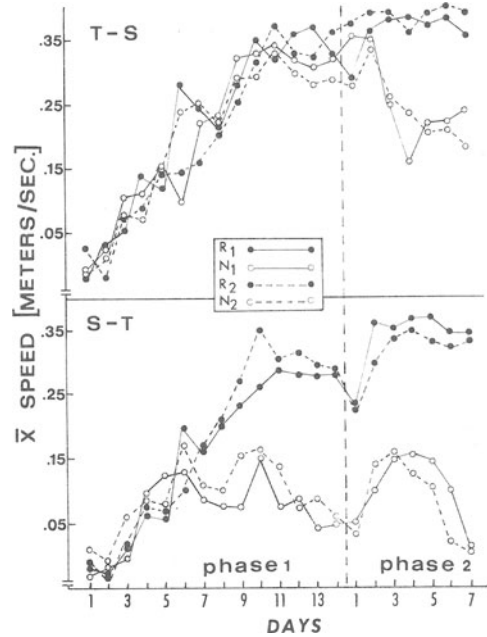

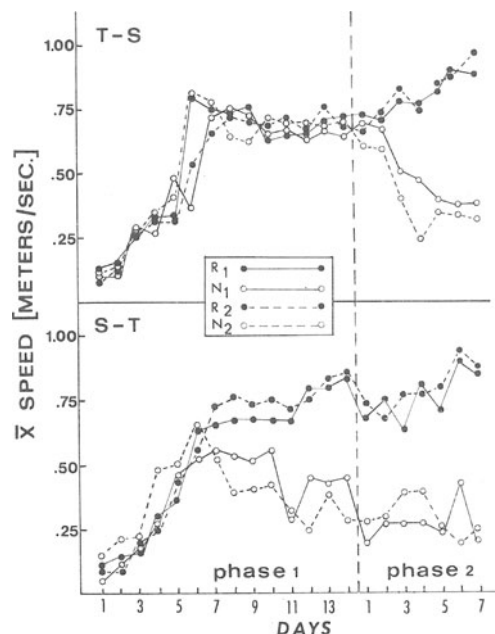Figure 1. Mean start speeds, Phases 1 and 2.

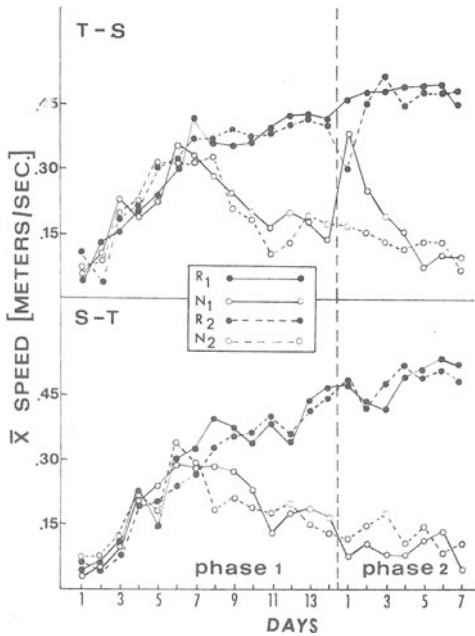Figure 2 Mean run speeds, Phases 1 and 2.

Figure 3. Mean goal speeds, Phases 1 and 2.

Days 8-14 (the point at which patterning appeared to have been established) for each measure.

A significant groups effect [$F(1,12) = 5.38$, $p < .05$], an R vs. N effect [$F(1,12) = 6.21$, $p < .05$], and a Groups by R-N interaction [$F(1,12) = 14.11$, $p < .01$] were obtained in the start segment. Subsequent evaluation of the significant interaction (Tukey's procedure) showed that significant R vs. N differences ($p < .01$) existed only for Group S-T.

Analysis of the run segment showed that the Groups by R-N interaction [$F(1,12) = 7.55$, $p < .05$] and the Groups by R-N by Days interaction [$F(6,72) = 3.03$, $p < .05$] were significant. Subsequent comparisons showed that significant R vs. N differences ($p < .05$) existed only for Group S-T; furthermore, these differences were limited to Days 11-14.

Analysis of goal-measure speeds showed that the R vs. N effect [$F(1,12) = 16.87$, $p < .01$] and the R-N by Days interaction [$F(6,72) = 2.72$, $p < .05$] were significant. Subsequent comparisons showed that significant R vs. N differences ($p < .01$) existed on Days 10-14.

Phase 2

Analyses, similar to those performed on the Phase 1 data, were performed on the data from Phase 2. These analyses revealed that the R vs. N effect was significant in all three measures [start, $F(1,12) = 12.10$, $p < .01$; run, $F(1,12) = 13.63$, $p < .01$; and goal, $F(1,12) = 20.17$, $p < .01$]. Additionally, the Groups by R-N by Days interaction was found to be significant in all

three measures [start, $F(6,72) = 2.41$, $p < .05$; run, $F(6,72) = 2.58$, $p < .05$; and goal, $F(6,72) = 2.24$, $p < .05$]. Subsequent comparisons of this interaction revealed that for Group S-T significant R vs. N differences ($p < .01$) were obtained across all measures on all days of Phase 2. Significant R vs. N differences ($p < .01$) were shown by Group T-S on Days 3-7 in the start and run measures and on Days 2-7 on the goal measure (see Phase 2, Figures 1-3).

DISCUSSION

In the present study, the run animals of Group T-S failed to develop patterned responding in the start and run segments when they followed Thorazine-injected donor animals. These results appear consistent with the prior findings by Howard and McHose (1974). In contrast, Group S-T, which followed saline-injected donors, developed strong patterning in these sections of the alley. As would be expected, patterning in the goal section, which was not under the influence of odors exuded by the donor animals, was shown by both groups during Phases 1 and 2.

Of potentially more interest was the finding that patterning was maintained in the start measure during Phase 2 by Group S-T when their saline donors were shifted to Thorazine. It is possible that once an animal is trained in the presence of relatively strong odors it becomes highly sensitized to these odors. Hence, weaker odors disseminating from the goal area may have served to maintain the behavior of these animals (see also Prytula, Davis, & Fite, in press). It is possible that the donor animals learned to make a frustrative response on N trials during Phase 1 and that this predominant response continued during Phase 2 even under the Thorazine condition. Patterned responding was rapidly established in Phase 2 in the start and run measures by the run animals whose donors were shifted from Thorazine to saline (i.e., Group T-S). This rapid acquisition of patterning suggests the possibility that, during Phase 1, odor-cue production by the donor animals was substantially reduced, but not completely eliminated. Thus the run animals may have learned something about donor odors during this phase. This learning, however, did not manifest itself until Phase 2, when the donor odors were intensified. On the other hand, it may be that the pattern responding shown by Group T-S in the start and run measures of Phase 2 reflects generalization of responding learned in the presence of frustrative odors in the goalbox during Phase 1.

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