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The effect of ethanol on activity level following reward shift

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This study tested the effect of ethanol on activity levels following a downshift in the magnitude of food reward. During the 10 days of Phase 1, four groups of 10 female albino rats drank a nonalcoholic fluid and then received conditioning trials in an operant chamber for a large (two groups) or small (two groups) reward. During the 10 days of Phase 2, all four groups received the small reward in the operant chamber. One downshifted and one control group continued to drink the nonalcoholic fluid, whereas the other downshifted and control group drank an alcoholic fluid. Following the daily conditioning trials, the animals' activity was tested on an open field. The introduction of alcohol during Phase 2 resulted in marked increases in activity. Of the two groups that drank the alcoholic fluid during Phase 2, the downshifted group was more active than the control group. Of the two groups that drank the nonalcoholic fluid, the downshifted group was less active than the control.

Among both animals and humans, abrupt reduction in magnitude of reward results in "poorer" performance than that of subjects consistently rewarded at the smaller value (Black, 1976; Cox, 1975; Flaherty, 1982). This negative incentive contrast effect has been suggested to reflect a negative emotional reaction to the downshift in reward, which may reflect a state analogous to clinical depression among humans (Klinger, 1975, 1977). If so, it is expected that pharmacological interventions that alter such emotional reactions would also affect the negative incentive contrast effect.

A recent study by Cox (in press) on the effects of alcohol on incentive contrast effects supported this prediction. In this study, animals under the influence of alcohol responded differently to a downshift in reward than did animals not under the influence. Specifically, the latter animals showed precipitous declines in running speeds immediately upon being shifted from large to small reward and then quickly recovered from the disruption. By contrast, among the animals that consumed the alcoholic fluid, the disruption in running speeds was less abrupt, but the animals were slower to recover. These results suggest that alcohol alleviated the negative emotional reaction to the downshift in reward but that the consequence of this alleviation was to impede recovery from the incentive reduction.

In the present study, we used the standard design for negative incentive contrast effects to test directly the effects of alcohol on emotional-behaviorial reactions to an incentive reduction. Following Klinger, Barta, and Kemble's (1974) discovery that various emotional reactions that constitute the incentive-disengagement cycle (Klinger 1975, 1977) are observable in rats' open-field activity following incentive loss, we tested the effect of alcohol on the negative incentive contrast effect by using open-field activity as our dependent measure.

METHOD

Subjects

The subjects were 40 female rats (Holtzman Co., Madison, WI), approximately 90 days old at the beginning of the experiment.

Apparatus

Drinking compartments, measuring 18 × 18 × 24 cm, were identical to the rats' home cages. A graduated drinking tube was attached to the outside front wall of each chamber. The spout of each tube extended inside the chamber approximately 5 cm from the floor of the chamber, and each spout had a steel ball to prevent leakage. An operant chamber, Grayson-Stadler Rat Station model no. E3125B-100, was used for the conditioning trials. Activity levels were measured in a 60 × 72 × 63 cm open-field apparatus whose flat gray floor was divided into nine 20 × 24 cm sectors by thin white lines. One wall was made of clear Plexiglas to permit observation.

Procedure

Upon receipt from the supplier, the animals were housed in individual home cages and were given ad-lib food and water until their weights had stabilized. Then the animals were placed on a food deprivation regi-

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men, consisting of 9 g of food each day, until their body weights were reduced to 85% of the ad-lib values. Thereafter, compensatory food was given whenever the weights fell below 85%.

To accustom the animals to the fluids that they would drink during experimental training, they were exposed to them for 8 days immediately prior to the experiment. Each animal had an alcoholic fluid (A) for 4 days and a nonalcoholic fluid (N) for 4 days, according to a counterbalanced ANNA NAAN (20 rats) or NAAN ANNA (20 rats) arrangement. The animals drank the fluids at room temperature for 15 min daily, but were fluid deprived during the remainder of each day. The purpose of fluid deprivation was to facilitate the animals' consumption of the alcoholic fluid.

The palatability of the fluids was enhanced by the addition of sucrose. The nonalcoholic fluid was a 10% sucrose solution that consisted of 10 g of granulated cane sugar per 100 ml of tap water. The alcoholic fluid was a 4.8% ethanol solution that contained 5 ml of 95% ethanol per 95 ml of the 10% sucrose solution. These fluids and our procedure for administering them have been used in several of our prior studies of the behavioral effects of alcohol (e.g., Cox, 1981, in press; Cox & Stainbrook, 1977).

Also during these 8 days, the rats were magazine trained and shaped to press the lever in the operant chamber for food reward (one 45-mg Noyes food pellet) through successive approximations. Each animal was considered shaped when on 2 separate days, without prompts from the experimenter, it made 10 consecutive leverpresses, each of which was followed by consumption of a pellet delivered to the food hopper. The number of minutes that it took each animal to reach this criterion was recorded, and assignment of animals to groups was balanced on the basis of how readily they had been magazine trained and shaped in the operant chamber.

During the experiment proper, four groups, consisting of 10 rats each, were tested. During the 10 days of Phase 1, each rat drank the nonalcoholic fluid for 15 min. Ten minutes later, the rat was placed into the operant chamber and allowed two food-rewarded leverpresses, after which the lever retracted. Two groups received one 45-mg pellet (small reward) and the remaining two groups received 10 pellets (large reward) for each leverpress throughout Phase 1. At the end of Phase 1, a baseline measure of open-field activity (number of sector entries) was taken for 60 sec in the open field.

During Phase 2 (10 days), both large reward groups were downshifted from 10 to 1 pellet of food reward. One group (alcoholic downshifted) now drank the alcoholic fluid prior to leverpressing, whereas the other group (nonalcoholic downshifted) continued to drink the sucrose fluid. Both small reward groups continued to receive the small reward, but one group (alcoholic control) now drank the alcoholic fluid prior to leverpressing, whereas the other group (nonalcoholic control) continued to drink the sucrose fluid. Open-field testing continued throughout Phase 2. However, in order to minimize adaptation effects, each rat was tested on alternate days. During Phase 1, odd-numbered animals had been tested on Day 9 and even-numbered animals on Day 10. During Phase 2, odd-numbered animals were tested on Days 1, 3, 5, 7, and 9, and even-numbered animals were tested on Days 2, 4, 6, 8, and 10.

RESULTS

Body Weights and Fluid Consumption

The four groups of animals had comparable body weights during the two phases and did not show changes in body weight across phases. Their average overall body weight was 187.8 g. During Phase 1, the four groups drank comparable amounts of the nonalcoholic fluid; average daily consumption was 22.2 ml. During Phase 2, the two groups consuming the nonalcoholic fluid drank an average of 25.9 ml per day, and the two groups consuming the alcoholic fluid drank an average of 19.7 ml per day.

Open-Field Activity

The same trends in activity were shown by the animals tested on odd and even days, and the data from a given

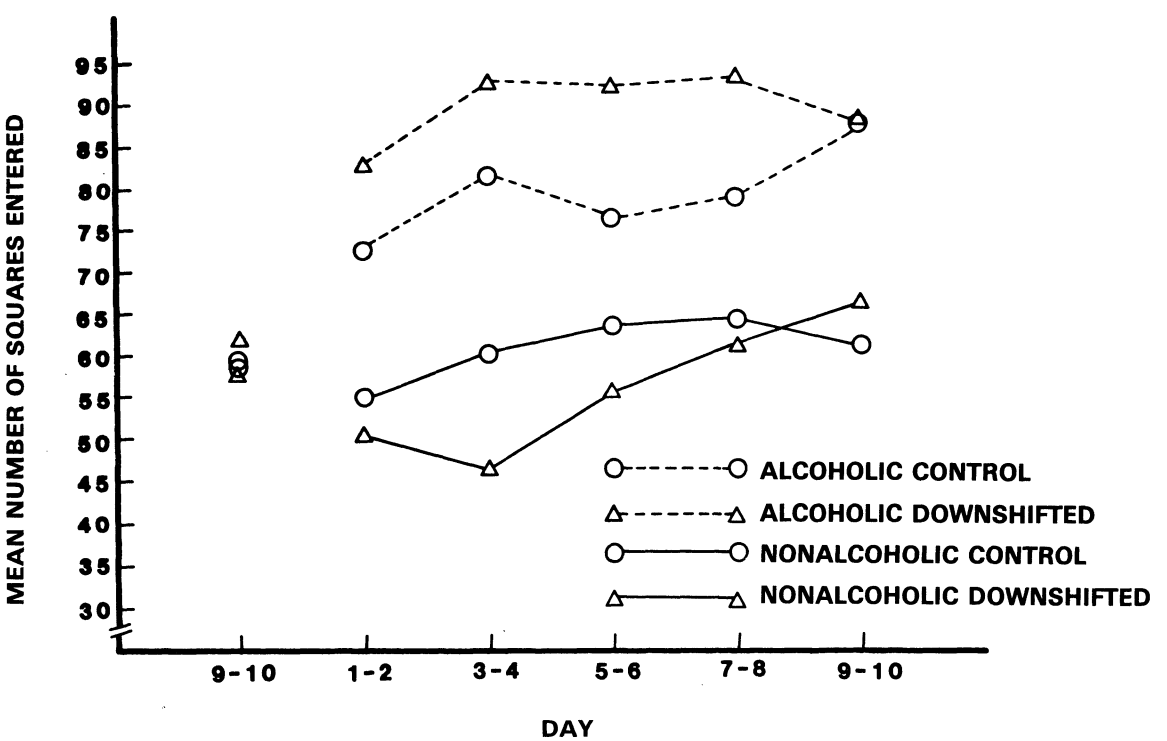

Figure 1. Activity levels of four groups in terms of mean number of squares entered during 60-sec trials.

day on which the odd-numbered rats were tested were combined with the data from the following day on which the even-numbered rats were tested. In Figure 1 we see that the baseline activity levels of the four groups at the end of Phase 1 were equivalent ($F < 1.0$). During Phase 2, on the other hand, the four groups showed changes in activity levels across days, and there were wide differences among the four groups. Specifically, the two groups that drank the alcoholic fluid during Phase 2 showed a marked increase in their activity levels from baseline, whereas the two groups that drank the nonalcoholic fluid showed activity levels that were at or below the baseline. Furthermore, there is a clear interaction between control/downshifted groups and alcoholic/nonalcoholic fluids consumed during Phase 2. Of the two groups that drank the alcoholic fluid, the downshifted group showed an activity level greater than that of the control group that received the small reward throughout the experiment. On the other hand, of the two groups that drank the nonalcoholic fluid during Phase 2, the downshifted group showed a lower level of activity than that of the nonshifted control group, which continued at approximately its baseline level of activity. Finally, within each fluid condition the downshifted and control groups converged by the conclusion of the experiment. A factorial analysis of variance performed on the data from Phase 2 that included fluid, reward, and days as factors confirmed the statistical reliability of these observations. There was a highly significant effect for fluid [$F(1,39) = 53.77$, $p < .001$], for days [$F(4,144) = 4.07$, $p < .01$], and for the fluid × reward interaction [$F(1,36) = 4.27$, $p < .05$]. In addition, follow-up comparisons of each downshifted group with its respective control yielded significant groups × days interactions.

DISCUSSION

The purpose of this study was to determine how alcohol modifies activity levels following a reduction in incentive from its accustomed value. The pattern of activity shown by the animals that drank the nonalcoholic fluid and experienced the incentive loss indicated depression of activity followed by recovery, similar to the pattern previously observed by Klinger et al. (1974). However, unlike the previous study, the animals here did not show the initial invigoration preceding depression and recovery that had previously been observed. There are several procedural differences between the two studies that may account for this difference in outcomes. First, in the present study, albino rats manipulated a lever for reward, were rewarded on every trial although downshifted, and underwent only one open-field trial on alternate days. In the study by Klinger et al. (1974), male hooded rats traversed a runway and were tested on an extinction schedule. There is also a problem of noncomparability of trials. It is difficult to assess whether a single session of two leverpresses rewarded by a reduced number of pellets corresponds to one or two (or some other number) of runway trials. Does the procedure followed by Klinger et al. (1974) correspond to part of the first block of trials in Figure 1 or to some other block? The present results do not provide a basis for distinguishing among genetic strain, ambulation as part of the instrumental response, reduced reward versus extinction, frequency of open-field trials, time intervals between instrumental trials, or other factors as the cause of the difference in invigoration between the nonalcoholic downshifted group and the previous nonalcoholic extinction group.

Alcohol markedly increased activity levels. We can explain this outcome in terms of the commonly observed disinhibiting effects of alcohol and its enhancement of exploratory behavior. That alcohol increases open-field activity has previously been observed (Amit & Stern, 1970), but the nature of the effect varies with the strain of animals and dosage of alcohol (Crabbe, Johnson, Gray, Kosobud, & Young, 1982). The novel aspect of the present results was the alcohol's reversal of the pattern of activity following incentive reduction that was observed among animals in the nonalcoholic condition. Among the latter animals, the downshift in reward reduced activity, whereas among the animals in the alcoholic condition, the downshift increased activity. Thus, alcohol not only counteracted the depressed reaction to the incentive reduction; it led to an *opposite* reaction—invigoration. Alcohol has previously been observed to alter vastly animals' reactions to incentive shifts (Cox, 1981). This alteration may account for organisms' motivation for using alcohol when they experience incentive losses.

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