Psychopharmacology 67, 269–277 (1980)

Psychopharmacology

Conditions Under Which Chlordiazepoxide Influences Gustatory Contrast

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Abstract. Rats shifted from 32% sucrose to 4% sucrose consumed less 4% than animals without prior experience with 32% sucrose. The influence of chlordiazepoxide (CDP) on this successive negative contrast obtained in sucrose ingestion was investigated in four experiments. The results indicated that (1) rats injected with CDP during both preshift experience with 32% sucrose and post-shift experience with 4% sucrose showed an essentially unchanged contrast effect compared with saline-injected rats, (2) CDP injection for the first time on post-shift day 2 eliminated contrast but post-shift day 1 injections had little effect, (3) animals injected with CDP throughout preshift and switched to saline coincident with the sucrose shift showed a contrast effect at least as great as control animals, and (4) injections of CDP tended to elevate lick rate regardless of other conditions. These results indicate a disinhibitory effect of CDP and possible neophobia operating on the first post-shift day.

Key words: Chlordiazepoxide – Incentive contrast – Neophobia – State-dependent learning – Inhibition

Rats trained to run in an alley for a given level of reward and then shifted to a lower level will usually run more slowly for the smaller reward than control animals that experience only the second level of reward (Crespi, 1942; Flaherty and Kelly, 1973). This behavior pattern, termed a successive negative contrast effect, has been shown to be influenced by chlordiazepoxide (CDP), but not by chlorpromazine (CPZ) (Roberts and Pixley, 1965; Rosen and Tessel, 1970). Specifically, rats injected with 2.5 mg/kg CDP show a contrast equivalent to controls, those injected with a dose of 5.0 mg/kg slow down after the reward shift but do not go below control levels, and those injected with 10 mg/kg do not change in behavior after the reward shift (Rosen and Tessel, 1970).

Negative contrast effects also occur in consummatory responding when rats are shifted from a 32 to a 4% sucrose solution. Vogel and Principi (1971) found that this contrast in consummatory behavior was eliminated if CDP (8.0 mg/kg) was administered on the second day after a shift from 32% to 4% sucrose. However, we have found that CDP is ineffective in reducing the 'simultaneous' negative contrast in consummatory behavior that occurs when rats are given brief and repeated sequential access, in one session, to both 32 and 4% sucrose (Flaherty et al., 1977, 1979).

The present paper reports a series of four experiments concerned with elucidating the conditions under which CDP influences successive negative contrast in consummatory behavior that occurs when rats are shifted to 4% sucrose after a long period of access to 32% sucrose.

Experiment I

This first experiment was concerned with the possibility that CDP would eliminate negative contrast in consummatory behavior as in the Vogel and Principi (1971) paradigm, if the drug were administered both preshift and post-shift, as in the Rosen and Tessel (1970) procedure.

Materials and Methods

Subjects. The subjects were 36 naive male rats derived from the Sprague-Dawley strain and purchased from the Charles River Breeding Farms. The animals, approximately 100 days of age at the start of the experiment, were reduced to 82% of their free-feeding weight and maintained at that level by single daily feeding for the duration of the experiment. Water was continously available in the home cage.

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0033-3158/80/0067/0269/$01.80

Apparatus. Testing was conducted in three identical Plexiglas chambers (30 × 25 × 25 cm). On one side of the chamber there were two centrally located 1.5 cm diameter holes spaced 21.7 cm apart and 4 cm above the wire mesh floor. A graduated drinking tube, located outside the chamber, was programmed so that it could be moved into a drinking position in which the orifice of the drinking spout was centered in one of the 1.5 cm holes, flush with the outside wall of the chamber. When the tube moved in, a pilot light mounted close to the access hole was illuminated. A contact relay circuit was used to measure the licking response.

Procedure. The rats were randomly assigned to four groups defined by the factorial combination of preshift sucrose solution (32 or 4%) and drug condition (CDP or saline). Animals in each of these groups were tested for a total of 11 days. On each day the rats were allowed 5-min access (beginning with the first lick) to the appropriate sucrose solution. For the first 8 days of testing (preshift period), this solution was 32% for half of the animals and 4% for the remaining animals. For the remaining 3 days (post-shift period) all of the rats were given the 4% solution.

Drug injections were begin on day 6 of preshift training and continued through the post-shift phase. Half of the animals in each sucrose group were injected with 8 mg/kg CDP and the remaining animals were injected with an equivalent volume of physiological saline. All injections were IP and administered 30 min prior to the start of testing.

Sucrose solutions were prepared by weight (sucrose/sucrose + water) from commercial grade cane sugar and tap water.

Results and Discussion

Mean lick rates as a function of sucrose and drug conditions are presented in Fig. 1. During the first 5 days of preshift training the rats receiving 32% sucrose licked at a higher rate than the rats receiving 4% sucrose [F (1, 32) = 22.79, $P < 0.01$]. There was no effect ($F = 1.00$) of drug group assignments, a pseudovariable at this point.

This preshift concentration effect was maintained on days 6–8 [F (1, 32) = 13.76, $P < 0.01$], and, in addition, the animals injected with CDP licked at a higher rate over this period than did the animals injected with saline [F (1, 32) = 5.62, $P < 0.05$].

The shift of the rats that had been receiving the 32% sucrose to the 4% solution led to an abrupt decrease in lick rate to a point substantially below the level of unshifted 4% controls [F (1, 32) = 40.79, $P < 0.01$]. This negative contrast effect was uninfluenced by the drug treatment (shift- × -drug interaction, $F < 1.00$), although the drug-injected animals continued to lick at an overall higher rate than the saline-injected animals [F (1, 32) = 4.70, $P < 0.05$]. Over the 3 post-shift days there was an overall increase in lick rate [F (2, 64) = 8.40, $P < 0.01$]; however, none of the interactions between days and treatments approached statistical reliability.

The results obtained in this experiment were clear. A successive negative contrast in lick rate was obtained when rats were shifted from a 32 to a 4% sucrose solution and this contrast effect was not influenced by injections of CDP. The drug, however, was not totally without effect; animals injected with CDP had an overall higher lick rate than saline-injected controls in both the preshift and post-shift periods. Such enhanced consummatory behavior associated with CDP injections has been reported previously (e.g., Flaherty et al., 1977).

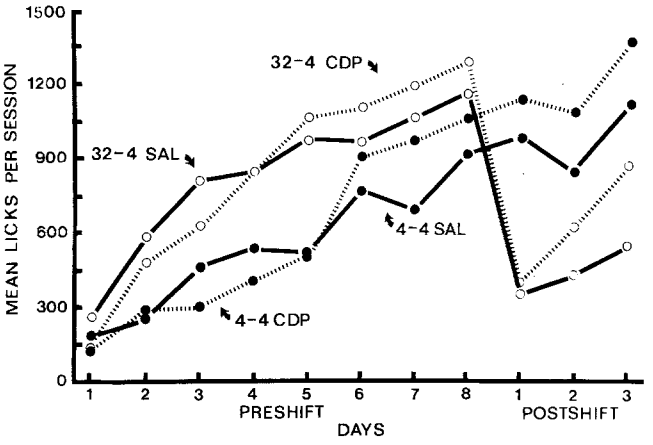

Fig. 1. Mean licks per 5-min session as a function of sucrose and drug conditions. Animals were injected from preshift day 6 onward: CDP = chlordiazepoxide, S = physiological saline

The results obtained in the present experiment appear to conflict with the Vogel and Principi (1971) study in which successive negative contrast in lick rate was reportedly eliminated by CDP at the same dose level as that used in the present experiment. To investigate this difference, a second experiment was conducted.

Experiment II

In the Vogel and Principi (1971) study the animals treated with CDP were not injected until post-shift day 2. In Experiment I, the drug-treated animals were injected during both the preshift (last 3 days) and post-shift period, a procedure similar to that used by Rosen and Tessel (1970). To investigate the possibility that the difference in results between the two experiments was related to this substantial difference in procedure, the present experiment was conducted. This experiment was a replication of the essentials of the Vogel and Principi (1971) procedure.

Materials and Methods

Subjects. Twenty naive male Sprague-Dawley-derived rats purchased from Charles River Farms were used as subjects. The animals were maintained as in the previous experiment.

Procedure. The apparatus was the same as that used in the previous experiment. All rats were given access to sucrose solutions for 5 min per day (beginning with the first lick) for 9 days. During the first 6 days of this period, half of the rats received 32% sucrose and half received 4% sucrose. On days 7–9 all rats were given the 4% sucrose solution. On day 8 (post-shift day 2) one half of both the shifted and unshifted rats were given an injection of CDP (8 mg/kg IP 30 min prior to testing) while the remaining rats were injected with isotonic saline. On day 9, injection conditions were reversed; those animals that had previously received saline were injected with the drug and those previously injected with the drug were given saline. Other aspects of the procedure were similar to the previous experiment.

Results and Discussion

Three rats were dropped from the experiment due to failure to lick the 4% solution during the preshift period.

The data obtained in the present experiment are presented in Fig. 2. Over the 6 preshift days there was a clear concentration effect [$F(1, 13) = 16.71$, $P < 0.01$] but no effect of the pseudovariable drug (main effect and interaction F values < 1.00). On post-shift day 1 no drug was administered and there was a clear negative contrast effect [$F(1, 13) = 6.96$, $P < 0.05$], apparent not only in lick rate but also in contrast ratios, which indicated that the shifted animals licked at approximately 40–45% of the level of the unshifted animals.

On post-shift day 2 the shifted animals that were drug-injected showed a substantial elevation in lick rate to a point slightly above the relevant control group, i.e., there was no contrast effect. In comparison, the shifted animals injected with saline showed only a slight elevation in lick rate (to be expected as part of recovery from contrast) and remained substantially below the level of the relevant control group (licking at approximately 37% of the rate of the saline-unshifted controls). Statistically, these results were reflected in a reliable drug- × -shift interaction [$F(1,13) = 6.88, P < 0.05$] obtained on post-shift day 2. On post-shift day 3, both drug- and saline-injected animals showed numerically small contrast effects, but neither these contrast effects nor overall drug effects were reliable on day 3 [$F(1,13) = 2.69$, $P < 0.10$ and $F(1, 13) = 2.88$, $P < 0.10$, respectively]. However, examination of the data did indicate that all four animals that had been injected with CDP on post-shift day 2 and with saline on post-shift day 3 showed a decline in number of licks on day 3, a trend that is opposed to the normal recovery from contrast. The unshifted animals given the same drug sequence (CDP on day 2 and saline on day 3) showed no clear trend, three of five animals having a decrease in licks from day 2 to day 3. Of the animals given the opposite drug treatment (saline on day 2 and CDP on day 3), three of four in each group (shifted and unshifted) showed an increase in lick rate from day 2 to day 3.

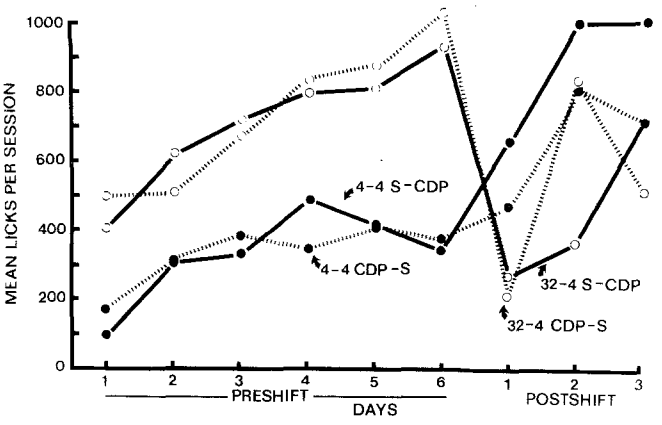

Fig. 2. Mean licks per 5-min session as a function of sucrose and drug conditions. Drug injections were made only on post-shift days 2 and 3. Animals injected with CDP on day 2 were injected with saline on day 3 and vice versa

Vogel and Principi (1971) found that CDP eliminated contrast whereas our previous investigations with both successive and simultaneous contrast failed to find any effect of CDP on contrast. However, when we replicated the Vogel and Principi (1971) procedure of injecting for the first time on post-shift day 2, we obtained results similar to theirs in that contrast was eliminated by this injection. Vogel and Principi (1971) also found that contrast was eliminated in animals injected for the first time on post-shift day 3 and returned in animals switched from drug to saline on this day. We did not replicate this aspect of their results exactly, but the trend of the data was in the same direction.

How are these results to be interpreted? Many investigators have attributed the occurrence of contrast, particularly successive contrast, to the occurrence of an emotional response, concomitants of which interfere with approach or instrumental behavior. This interference is thought to produce the measured contrast effect (e. g., Amsel, 1967; Baltzer and Weiskrantz, 1970; Bower, 1961; Cleland et al., 1969; Crespi, 1942, 1944; Flaherty and Kelly, 1973; Goldman et al., 1973; Rosen et al., 1967). The reduction in contrast obtained following CDP injections has been attributed to a reduction in these presumed emotional responses (Rosen and Tessel, 1970). However, this interpretation was derived principally from studies that involved shifts in the quantity of solid food or schedule of food delivery and that measured some aspect of instrumental performance.

Since there are many experiments indicating differences in results obtained with food and sugar solutions, including the fact that contrast does not occur in runway behavior when the concentration of sugar

solutions is shifted (Collier et al., 1961; Flaherty et al., 1973; Flaherty and Caprio, 1976; Rosen, 1966; Shanab et al., 1975). Since instrumental and consummatory behaviors may be dissociated in contrast experiments with sucrose (Flaherty and Caprio, 1976), and since the pattern of results obtained with CDP in the consummatory contrast paradigm is apparently not the same as that obtained in the runway with food, perhaps alternate interpretations of the effect of CDP on consummatory contrast should be entertained.

The results obtained in the first two experiments suggest two such alternatives. First, in the two consummatory contrast experiments in which contrast was reduced by CDP (Experiment II and the Vogel and Principi study), the rats never experienced the 32% sucrose solution while under the influence of CDP. It is possible that the expectancy of receiving 32% sucrose did not include the stimulus context (or 'state') produced by the effects of the CDP injection. In the absence of an expectancy for 32% sucrose the rats would respond on the basis of the absolute rewarding properties of 4% sucrose rather than on the basis of a comparison of 4 with 32%. A similar line of reasoning has recently been used by Capaldi et al. (1977), who found that no contrast occurred if deprivation conditions were shifted along with a shift in reward. Her interpretation was that the deprivation stimuli elicited the memory of the preshift reward necessary for comparison, and therefore contrast, to occur. In the presence of a different deprivation state there was no memory (or expectancy) of the preshift reward and, therefore, no contrast.

A similar line of reasoning could apply to Experiment II except that the relevant stimuli are produced by drug injection rather than by deprivation. State-dependent learning has been demonstrated with CDP in other tasks, but usually with considerably higher doses than those used in the contrast studies (Goldberg et al., 1973; Iwatiara and Matsushita, 1971; Overton, 1966; Sachs et al., 1963).

A second possible interpretation of the results obtained in Experiment II and by Vogel and Principi (1971) rests on the concept of disinhibition. It has recently been shown that the presentation of a novel stimulus (tone) to rats during the post-shift period of a successive contrast paradigm similar to that used in Experiments I and II will lead to a reduction in degree of contrast (Lombardi and Flaherty, 1978). Various control conditions included in these experiments indicated that the effect of the tone seemed to be one of disinhibition, much like that obtained in operant tasks (Brimer, 1972). It is possible that the injection of CDP for the first time during the post-shift period functioned like a novel stimulus, producing disinhibition. A difference between the Lombardi and Flaherty (1978) results and the data obtained in Experiment II and by Vogel and Principi (1971) is that in the former the apparent disinhibitory effect of the tone was small, whereas in the latter the CDP eliminated contrast. However, such a difference might be expected on the basis of differences in potency between an external tone and an internal stimulus change produced by the drug. To investigate the relative merits of these two interpretations, a third experiment was undertaken.

Experiment III

The state-dependent explanation of the failure of contrast to occur in Experiment II implies that contrast should also fail to occur if rats are injected with CDP throughout the preshift period and switched to saline concurrently with the shift in sucrose concentration. That is, if the expectancy of 32% sucrose is related to the physiological context produced by drug injection, then the removal of this context, concurrent with the shift to 4%, should remove the basis for contrast, i.e., the comparison of the 4% with the memory of the 32% sucrose (Spear, 1967). Thus, two of eight groups included in this experiment were designed to test this possibility. One of these two groups consisted of animals given 32% sucrose during preshift and then shifted to 4% sucrose, the other group received 4% sucrose throughout the experiment. Both of these groups were injected with CDP (8.0 mg/kg) each day of the preshift period and with saline each day of the post-shift period.

The remaining six groups included: shifted and unshifted animals injected with saline during both stages; shifted and unshifted animals injected with the drug during both stages; and shifted and unshifted animals injected with saline preshift and drug post-shift. Thus, this latter saline-drug group is similar to the groups in Experiment II except that the animals were injected with CDP on each post-shift day rather than on days 2 or 3, and that they were injected with saline during the preshift period. The state-dependent interpretation would imply that both the saline-drug animals and the drug-saline animals should fail to show contrast. The drug-drug group is similar to the manipulation used in Experiment I except that drug injections were made throughout preshift rather than just on the last 3 preshift days.

Materials and Methods

Subjects. The subjects were 48 naive male Sprague-Dawley rats purchased from the Ace Animals, Inc. The animals were maintained as in the previous experiments.

Apparatus. The apparatus consisted of six identical Hoeltge steel hanging cages (24.5 × 17.5 × 18 cm). The six cages were placed along a bench in individual 42 cm compartments that were created by 7 mm

thick Masonite partitions measuring 58 × 58 cm. Each cage was mounted on 2 cm blocks to allow droppings to fall through, and equipped with a hinged wooden top. The cages were further modified by mounting an 8.5 × 8.5 cm Plexiglas plate with a 1.5 cm diameter hole drilled in its center on the front of each cage and removing the cage wires behind the plate. A graduated cylinder was mounted on the Masonite partition and the cages lined up so that the drinking spout of the cylinder was centered in the 1.5 cm diameter hole, flush with the outside of the plate.

Procedure. The subjects were randomly assigned to eight groups (N = 6 in each group). The eight groups were derived from the factorial combination of preshift sucrose concentration (32 or 4%) and the following four drug treatments: S−S, in which subjects were injected with saline on each preshift and post-shift day; D−D, in which subjects were injected with CDP each preshift and post-shift day: S−D, in which saline was injected preshift and CDP injected each post-shift day; and D−S, in which CDP was injected preshift and saline was injected post-shift. The rats were tested for 8 preshift days and 3 post-shift days. In the post-shift period all rats received 4% sucrose.

On each day, the rats were injected IP with the appropriate solution (8 mg/kg CDP or an equal volume of saline) 30 min prior to being given 5-min access (starting with the first lick) to the appropriate sucrose solution. In the present experiment half the animals in each group were run on each day, such that an individual animal was run every other day rather than every day as in the previous experiments, and an individual animal was injected only on the day it was run. This modification was made to reduce the aversive effects of repeated injections and to allow for the more complete metabolism of CDP between successive test days.

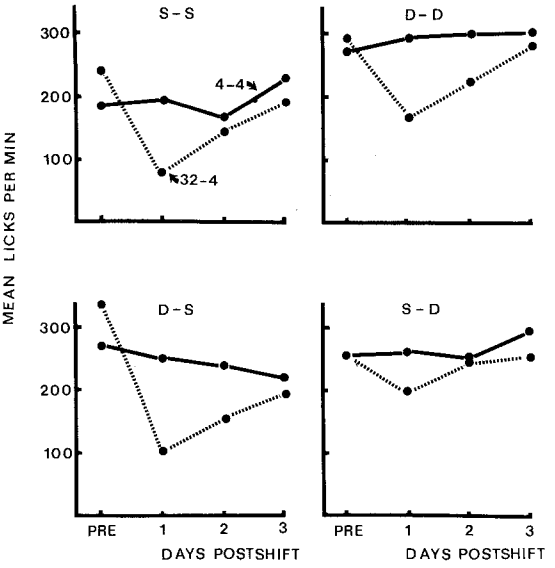

Fig. 3. Mean terminal preshift and daily post-shift licks as a function of sucrose condition and drug condition. Groups labelled 32-4 were shifted from 32% to 4% sucrose on day 1 post-shift. Groups labelled 4-4 received 4% sucrose throughout preshift and post-shift. Other labels indicate preshift and post-shift drug conditions

Results and Discussion

Presented in Fig. 3 are terminal preshift (day 8) and daily post-shift lick rates of all groups. It is clear that negative contrast occurred in all groups on post-shift day 1 [F (1, 40) = 86.99, $P < 0.001$], the day most critical for the arguments presented above. None of the possible interactions of preshift and post-shift drug treatment with sucrose condition were statistically reliable. The occurrence of a substantial contrast effect in the group switched from drug to saline concommitant with the sucrose shift (D−S) renders the state-dependent interpretation of post-shift drug effects unlikely. That is, if expectancy of a particular sucrose concentration was linked to a particular drug state, then no contrast (or reduced contrast) should have occurred in the D−S group. It is clear that this was not the case.

The contrast effect obtained in group D−D replicates the results of Experiment I and shows again that the results obtained in consummatory successive contrast with this drug injection procedure are different from those obtained in instrumental successive contrast (Rosen and Tessel, 1970).

The results obtained in group S−D are similar to those obtained in Experiment II and by Vogel and Principi (1971) in that contrast is numerically smaller in animals injected for the first time during the post-shift period. However, the apparently smaller contrast in this group was not statistically different from that occurring in the other three drug conditions. Of course, in our experiment the S−D group was injected on post-shift day 1 whereas in the two reference experiments the first injection was on post-shift day 2.

In addition to the contrast, there was also an overall effect of the post-shift drug condition [F (1, 40) = 34.51, $P < 0.001$] which indicated that animals injected with CDP post-shift licked at a higher rate than the saline-injected animals.

The pattern of results on post-shift day 2 was similar; an overall negative contrast effect [F (1, 40) = 9.52, $P < 0.004$] and an overall effect of post-shift drug condition [F (1, 40) = 28.73, $P < 0.001$] reflecting the higher lick-rate in the CDP animals. In addition, there was a reliable preshift drug- × -contrast interaction [F (1, 40) = 4.52, $P < 0.041$]. This interaction reflected the occurrence of a larger contrast in the D−S and D−D groups than in the S−S and S−D groups. In the latter two groups, contrast was not reliable on post-shift day 2 (Fisher's *lsd*-test; Li, 1964). This pattern of results was somewhat surprising. The lack of reliable contrast in group S−D might be expected on the basis of Experiment II, but the failure of contrast to occur in the saline-control animals on post-shift day 2 was unexpected. Examination of Fig. 3 indicates that this loss of contrast in the control animals was due to a decrease in lick rate by the unshifted animals, in addition to a rise in lick rate by the shifted animals.

On post-shift day 3 there remained an overall negative contrast [$F(1, 40) = 5.15$, $P < 0.03$] and an overall higher lick rate among the animals given CDP post-shift [$F(1, 40) = 25.47$, $P < 0.001$]. There were no reliable interactions.

The general pattern of the results obtained in this experiment is more consistent with a disinhibitory interpretation of the CDP effects obtained in Experiment II than with a state-dependent interpretation of these effects. However, the failure of contrast to be eliminated by the first CDP injection in group S–D is not entirely in agreement with Experiment II or the Vogel and Principi (1971) data. A fourth experiment was conducted to determine whether contrast is more likely to be eliminated if the first CDP injection occurs on post-shift day 2 rather than on post-shift day 1.

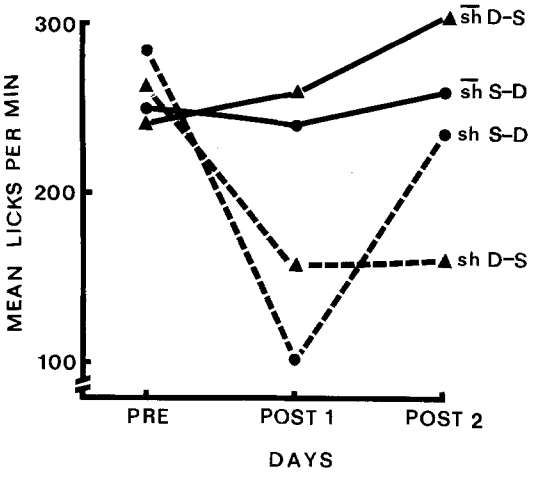

Fig. 4. Mean licks as a function of sucrose condition (shifted and unshifted) and drug condition. Groups labeled D–S received CDP injections of post-shift day 1 and saline on day 2. Groups labeled S–D received the reverse sequence

Experiment IV

This experiment was similar to Experiment II, except that one group of animals was injected with CDP for the first time on post-shift day 1 and with saline on post-shift day 2, whereas a second group of animals was given the reverse treatment. In Experiment II and Vogel and Principi (1971), no injections were given on day 1 post-shift and the first injection on day 2 post-shift eliminated contrast.

Materials and Methods

Subjects. The subjects were 20 naive male Sprague-Dawley-derived rats purchased from Ace Animals, Inc. The animals were maintained as in the previous experiments.

Procedure. The apparatus was the same as that used in Experiment III. The rats were randomly assigned to one of four groups. The groups were derived from the factorial combination of sucrose concentration received during an 8-day preshift period (32 or 4%), and drug treatment during a 2-day post-shift period, during which only the 4% concentration was made available. The drug conditions were D–S, in which the subjects received 8 mg/kg IP 30 min prior to testing on post-shift day 1 and an equal volume of saline on post-shift day 2, and S–D, in which these conditions were reversed. Other conditions were similar to those in the previous three experiments.

Results and Discussion

The mean lick rates for terminal preshift (day 8) and the 2 post-shift days are presented in Fig. 4. Again, there was an overall negative contrast effect [$F(1, 15) = 11.46$, $P < 0.005$]. However, a reliable drug- × -contrast- × -day interaction [$F(1, 15) = 6.09$, $P < 0.03$] reflected the fact that the course of the contrast effect during the post-shift period was influenced by drug administration. In particular, both the drug- and saline-injected animals showed a reliable contrast on post-shift day 1 (*lsd*-test, $P = 0.05$), whereas on post-shift day 2 the contrast was maintained in animals switched from drug to saline, but it was eliminated in animals switched from saline to drug (*lsd*-test, $P = 0.05$).

In Experiment II and the Vogel and Principi (1971) study, animals injected with CDP for the first time on post-shift day 2 showed a loss of contrast. In Experiment III, animals injected with CDP for the first time on post-shift day 1 showed a numerically, but not statistically smaller contrast. When these animals were injected again on post-shift day 2, contrast was lost but the interpretation of this effect was clouded by the fact that saline-injected animals unexpectedly showed no contrast on this day either. In the present experiment the results were clear. Injection of CDP on post-shift day 1 produced little change in degree of contrast. However, injection with the drug on post-shift day 2 eliminated contrast.

General Discussion

The results of our experiments, as well as the Vogel and Principi (1971) study, indicate the following: (1) rats injected with CDP both preshift and post-shift will show an essentially unchanged successive negative contrast effect compared to animals injected with saline; (2) injecting with CDP for the first time on post-shift day 2 will eliminate negative contrast with the parameters employed in these experiments, but injecting with CDP on post-shift day 1 will not substantially alter contrast; (3) animals injected with CDP throughout preshift and then switched to saline coincident

with the shift in sucrose solutions will show a contrast effect at least as great as control animals; and (4) injections of CDP tend to elevate lick rate regardless of other conditions.

At various points in this paper we have mentioned three interpretations of the effects of CDP on contrast, i. e., that it reduces emotional consequences of the reward shift, that it has state-dependent effects, and that it has a disinhibitory effect. The tranquilizing properties of CDP were used by Rosen and Tessel (1970) to explain the reduction in runway contrast behavior produced by the drug, an explanation consistent with the known punishment-suppressing effects of CDP (e. g., Fowler and Price, 1978; Miczek and Lau, 1975). However, the contrast-reducing properties of CDP in the runway were found when the drug was administered during both preshift and post-shift periods. In Experiments I and III we found that this pattern of drug administration led to CDP having no effect on consummatory contrast. This fact, plus the restricted conditions under which CDP does affect consummatory contrast, indicates that a different interpretation of the present results is in order. The state-dependent interpretation was examined and discussed in Experiment III and found inapplicable to the present results.

Thus, we are left with the possibility that CDP injections during the post-shift period reduce contrast through a process of disinhibition. The term 'disinhibition' has been used previously to explain the enhanced consummatory behavior produced by the drug, an affect attributed to the disinhibition of satiation (Margules and Stein, 1967; Wedeking, 1969, 1973). We are using this term differently, since it is unlikely that the animals in the present experiment were approaching satiation at all. They were highly deprived and licking at low rates for a dilute sucrose solution when the apparent disinhibitory effect occurred. Our use of the term is more akin to its application in learning experiments where the presentation of a novel stimulus leads to the elevation of a previously suppressed response rate (Brimer, 1972). As discussed previously, the presentation of a tone during the post-shift period of a consummatory contrast experiment led to a small but statistically reliable reduction in contrast (Lombardi and Flaherty, 1978). The apparent disinhibitory effects of CDP found in Experiments II and IV and by Vogel and Principi (1971) were much larger than those produced by the tone.

In the Lombardi and Flaherty (1978) study, several controls were used to rule out the possibility that the apparent disinhibitory effect of the tone was not simply a rate-dependent effect, enhancing drinking that was at a low rate even if this low rate was not the result of contrast. The controls included in those experiments showed that this was not the case; only animals shifted from a higher to a lower sucrose concentration were affected by the tone. Similar controls have not been included in the CDP experiments as yet. However, it is unlikely that the effects of CDP were simply rate-dependent because the drug had very little effect when injected on post-shift day 1, a time when lick rates are generally lower than on subsequent days. Thus, the apparent disinhibitory effects of the drug are not likely to be related to satiety mechanisms, and it is not likely that they represent simple rate-dependent effects.

The interpretation of these results in terms of disinhibition has its own problems, however. In particular, CDP was effective in reducing contrast only when administered on the second or subsequent post-shift days. Administration on post-shift day 1 had no effect. It is possible that contrast is stronger on post-shift day 1 and that a larger dose of CDP would be necessary to have a disinhibitory effect. Another possibility is that contrast in consummatory behavior was determined by more than one causal mechanism, and that those operating on post-shift day 1 may be different from those controlling contrast on subsequent days. For example, the reduced drinking that occurs on post-shift day 1 may be related to neophobia induced by the new sucrose solution (Barnett, 1963; Mitchell, 1978) as well as by lowered hedonic properties of the 4% sucrose solution resulting from the comparison of it with the memory of the 32% preshift solution (Spear, 1967). Some evidence supporting a possible role of neophobia in consummatory contrast has recently been obtained by Lombardi (1978).

Post-shift day 2 must be different in some way from post-shift day 1 because of the differential effects of CDP. Normally, the process of recovery from contrast has begun on day 2. This recovery could reflect the loss of neophobia because of the previous day's 'safe' experience with the preshift solution plus an increasing reward value of the post-shift solution due to a now more remote comparison with the preshift solution. Thus, CDP may be more effective on post-shift day 2 because the factors suppressing intake of the post-shift solution are losing their effectiveness. An implication of this interpretation is that a drug known to reduce neophobia in other situations, such as CPZ (Mitchell et al., 1977), might be effective on post-shift day 1. It is interesting that CPZ does not seem to be effective in runway contrast situations (Roberts and Pixley, 1965; Rosen and Tessel, 1970). It is also interesting in this regard that CDP, which did not affect contrast on post-shift day 1, increases the intake of a familiar, but not a novel food in a choice situation (Cooper and Crummy, 1978).

Another way of conceptualizing post-shift day 2 is that there is an approach-avoidance conflict related to

the absolute and relative rewarding properties of the post-shift solution. The CDP may be effective on post-shift day 2 because it reduces the aversive aspects of approach. This possibility would bring the consummatory contrast paradigm closer theoretically to the runway successive contrast situation, where such a conflict is often assumed to occur subsequent to a shift in reward and where the effectiveness of CDP in reducing contrast is attributed to its reduction of the aversive aspects of the reward shift (Rosen and Tessel, 1970).

One problem with this interpretation is the behavior of animals injected with CDP both preshift and post-shift. In both Experiments II and IV this treatment was shown to be without effect in reducing contrast. If CDP is effective on post-shift day 2 because of a property of reducing aversive aspects of the reward shift, and thereby allowing approach tendencies to predominate, the continued administration of CDP preshift and post-shift should also be effective. The potential argument that CDP might not be effective under these conditions because the animals are developing tolerance to the drug is contraindicated by the runway data just cited and by the continued effectiveness of the drug in increasing overall lick rate under these conditions (see Fig. 1 and the D – D group in Fig. 3).

Thus, the evidence at present seems in favor of the neophobia and altered hedonic properties sequence of post-shift mechanisms of contrast rather than the possible conflict sequence However, why this sequence should be subject to apparent disinhibition by CDP is not yet clear.

Acknowledgements. This research was supported by grants from the Rutgers Research Council and a Biological Research Support grant.

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Received December 12, 1978; Final version November 11, 1979