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The effect of chlordiazepoxide on the stimulus-intensity phenomenon.

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THE EFFECT OF CHLORDIAZEPOXIDE ON THE STIMULUS-INTENSITY PHENOMENON

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INTRODUCTION

It is well established that the strength of a response varies directly with the intensity of the eliciting stimulus. This phenomenon is observed in paradigms ranging from simple classical conditioning to more complex instrumental learning situations. The first theorist to present a formal statement of the stimulus-intensity phenomenon was Hull (1949). He regarded stimulus-intensity as affecting the intervening variable and included it as a postulate in his behavior system by the name "stimulus-intensity dynamism (V)." With other factors constant, Hull assumed that the magnitude of the stimulus-intensity component (V) of reaction potential to be a monotonic increasing function of absolute stimulus intensity.

Hull's main basis for the dynamism postulate was an unpublished experiment carried out in his laboratory by Ruth Hays in 1946. She trained two groups of twenty rats to jump eight and one-half inches on a Lashley apparatus to a single stimulus object. One group jumped to a black card for food and the second group jumped to a white card. The cards were always presented singly. The result revealed that the latencies for the group trained to the white card were significantly less than the latencies for the group trained to the black card. This difference in response latency favoring the animals trained to the more intense stimulus was taken by Hull (1949) to be support for the dynamism postulate.

A study by Hovland (1937) using human subjects in GSR conditioning to tones of varying intensity also demonstrated the stimulus-intensity effect. He found that the amplitude of GSR to a tone of 86 db to be greater than that to a tone of 40 db. Hull (1951) reported an experiment carried out by Spence in which rats were trained to discriminate black from white, with the two stimuli being presented simultaneously. Rats having white correct made fewer errors than animals having black correct. Hull again interpreted these results to mean a direct relationship between response strength and the intensity of the eliciting stimulus, thus further supporting the stimulus-intensity dynamism postulate.

Another hypothesis to explain the effects of stimulus-intensity has been proposed by Perkins (1953). Specifically in an instrumental conditioning paradigm he tested the hypothesis that the direct relationship obtained in the experiments cited above between intensity of the CS or eliciting stimulus and response strength may be the result of differential conditioning. Logan (1954), using a classical conditioning set-up, formalized the differential conditioning interpretation of stimulus-intensity effects in such a way as to make the dynamism postulate redundant within Hull's system. There is such a striking similarity between the hypothesis by Perkins and that by Logan as to render them alike in their treatment of the stimulus-intensity effect. Both treatments

are based on discrimination between background stimuli, or, in Logan's terms "contextual environment", and the eliciting stimulus. In addition, the formulations hold that since any responses to the contextual or intertrial stimuli are not reinforced, these stimuli acquire inhibitory properties which are capable of generalizing to similar stimuli. The closer together the training and the contextual stimuli on a common stimulus-intensity continuum, the greater will be the generalized inhibition to the eliciting stimulus. Stated conversely, the greater the contrast between the unreinforced background cues and the reinforced eliciting stimulus, the greater will be the response strength.

Chlordiazepoxide (CDP)

Chlordiazepoxide is a psychosedative drug of a new chemical class, the benzodiazepines, synthesized by Sternbach and Reeder in 1933. Recently its unique taming effects in animals and powerful anti-anxiety effects in human subjects has led to intensive investigation. In many respects CDP is quantitatively similar to meprobamate as a tranquilizer but is more potent and in addition has taming, muscle relaxant, anticonvulsant, and appetite stimulating effects. Its effects on blood pressure, heart rate, and the autonomic nervous system has been found to be minimal (Randall, et. al., 1960). In the same study, chronic

administration of chlordiazepoxide to rats and dogs produced no severe toxic manifestations, and no evidence of cumulative toxicity or deleterious effects on the process of reproduction were detected.

Randall (1960) performed a series of comparison tests with meprobamate, phenobarbital, chlorpromazine and CDP. Among the several findings are the following: (a) in mice stimulated to fight by applying grid shock, CDP abolished fighting episodes in amounts below the muscle relaxant dose, while supra-relaxant doses were required for the other drugs, (b) the taming effects of CDP in vicious monkeys was observed at doses below sedation and ataxia, while reduction in aggression with meprobamate and chlorpromazine was accompanied by ataxia and sedation, (c) the lack of autonomic blocking effects by CDP were supported by the fact that blood pressure and heart rate remained unaltered, and (d) CDP was the only drug to cause an increase in food consumption with subsequent increases in body weight.

Another study by Randall, et. al.,(1960) presented a comparison of the effects of CDP and meprobamate on several behavioral measures. In contrasting the depressant effects of the drugs on the behavior of rats and monkeys, they reported that CDP was twice as effective as meprobamate in depressing spontaneous locomotor activity. With rats subjected to the Sidman avoidance situation CDP was found to be more potent than meprobamate in depressing avoidance responses and as a consequence, rats on CDP took more shock.

With monkeys in the same situation, CDP only affected the regularity of responding while meprobamate did not affect avoidance behavior at all. In comparing the calming and taming effects of the two drugs in rats, dogs, monkeys, and cats, CDP again proved to be superior to meprobamate. For example, CDP was 8.6 times as potent as meprobamate in depressing the irritability of rats with septal lesions and 6.3 times as potent as meprobamate in the control of rats with cortical lesions.

With respect to the above findings, there has been increasing evidence that the limbic system is involved in emotional responses (MacLean, 1958). This suggests that drugs that alter affective arousal might produce changes in this part of the brain. The participation of the limbic system in emotion is clear when the septum and amygdala are stimulated or ablated. Kluver (1958) found that bilateral removal of the amygdaloid complex in monkeys resulted in sex abnormalities manifested by attempts to derive sexual satisfaction from any potential source of gratification, hypermetamorphosis in which the organism exhibited short attention span, and emotional changes as indicated by failure to respond to normally fearful objects. Gloor (1960), in a review of the function of the amygdala, stated that the basic defect produced by amygdaloid lesions is a disturbance in the motivational mechanism which normally permits the selection of behavior appropriate to a given situation.

Recent neurophysiological studies investigating the

effects of psychotropic drugs also indicate that the amygdala and other limbic structures to be sites for many of the drug effects. Schallek and Kuehn (1960) inserted electrodes into the cat's anterior and posterior septum, amygdala and hippocampus to compare the effects of psychotropic drugs on electrically evoked discharges. They found that iproniazid caused an increase in duration of after-discharges in the amygdala, and imipramine and meprobamate decreased the duration of septal and hippocampal discharges. Chlordiazepoxide, on the other hand, decreased the duration of septal and hippocampal discharges, and also decreased amplitude of amygdaloid discharges. In a more recent investigation, Schallek, et. al. (1962) found that septal lesions in rats resulted in extremely vicious behavior that was depressed by the following drugs in order of decreasing potency: reserpine, chlorpromazine, chlordiazepoxide, pentobarbital, and meprobamate. The above studies consistently indicated that the amydaloid component of the limbic system, which is directly involved in emotional behavior, is depressed by CDP.

In a recent study by Lewis (1964), rats were subjected to a Bright-Dark discrimination problem on the Lashley apparatus and an experimental group was injected daily with CDP just prior to testing. The no-drug control rats quickly learned the discrimination, but significantly fewer of the drugged rats solved, and the drugged rats that were able to solve took a significantly longer time to reach criterion than the no-drug controls. The suggestion was that CDP

depressed the amygdala and lowered the motivation to avoid the negative window.

STATEMENT OF PROBLEM

The following hypotheses are proposed:

1. If rats are trained with both windows Dark or both Bright on a Lashley jumping apparatus and then subjected to a subsequent Bright-Dark discrimination problem, the influence of stimulus-intensity will reveal its effects in one of the following two ways.

   a. If there is transfer effects of the training conditions (Bright or Dark) to the discrimination problem, according to the Perkins-Logan formulation animals trained on Bright and having Bright-correct in the problem will perform equally as well as animals trained on Dark and having Dark-correct, since the habit and generalized habit will be the same in both cases. The Perkins-Logan hypothesis further predicts that the acquired habit within the discrimination problem will also be the same for both Bright trained Bright-correct and Dark trained Dark-correct groups. Similarly, groups of animals trained with the stimulus opposite to the one correct in the discrimination problem will be equal in performance, i.e., group B-D will perform as well as group D-B. However, groups B-B and D-D will each be superior to group B-D and group D-B because of greater habit and transfer effects. A numerical derivation of the Perkins-Logan formulation is presented in the appendix.

   b. If, on the other hand, Hull's stimulus-intensity

postulate is applicable, Bright-correct animals will be superior to Dark-correct animals regardless of the conditions under which they are trained. According to Hull the stimulus-intensity component of reaction potential is a monotonic increasing function of the absolute intensity of the eliciting stimulus. The relationship between stimulus-intensity and the existing habit strength is assumed to be multiplicative, i.e., E=H x V. The habit and generalized habit transferred from training, and also the habit and generalized habit built up during the discrimination problem operates in the same manner as in the Perkins-Logan's formulations. However, according to Hull the Bright-correct groups will be superior to Dark-correct because Bright has a greater value for the stimulus-intensity component of reaction potential than the Dark stimulus. Thus the stimulus-intensity postulate predicts that groups B-B and D-B will each be superior to Group D-D and group B-D. This prediction is applicable whether or not there is transfer from training conditions. A derivation of Hull's stimulus-intensity postulate is presented in the Appendix.

2. Considering CPP as having its principle effect on negative incentives (in this case the incorrect window) thus, if the hypothesis l_b should prove to be correct, the drug should have little effect on the performance of Bright-correct subjects since they will have a greater

tendency to respond to the Bright window than to the Dark, thus rarely encountering the negative (Dark) window. However, the Dark-correct animals, because of the strong tendency to respond to the Bright window, will encounter the negative incentive (Bright window) and the depressive effects of CDP should impede learning for this group.

METHOD

Subjects.

The subjects in this experiment were 60 male albino rats of the Sprague-Dawley strain approximately 60 days old at the start of the experiment. They were housed in individual cages, allowed free access to water, and placed on a 23-hour food deprivation schedule. Following daily trials the animals were returned to their home cages and given a daily ration of 40 grams of fox chow mash.

Apparatus.

The apparatus was a semi-automatically controlled Lashley jumping stand similar to the one described by Feldman (1946). The essential features of the apparatus are a pair of translucent stimulus windows six inches square which could be independently locked or unlocked and differentially illuminated, bright or dark; a jumping platform with an electric grid placed eight and one-half inches in front of the stimulus windows; and a food platform behind the stimulus windows where the animals received a food reward following a response to the positive unlocked window. A response to the negative (locked) window resulted in a bump and a fall into a net four feet below. If the animal failed to make a response within 30 seconds, the grid was electrified by a current of 0.35 ma in intensity from an Applegate Model 228 shock source and a Foringer scrambler. After 60 minutes the current increased to 0.70 ma.

Training

The training procedure for this experiment follows essentially that described in detail by Feldman (1953). For the first three days the animals were allowed to become familiar with the apparatus and accustomed to eating on the food platform. Attention was given to carrying out all steps of the procedure at nearly the same time of day in order to keep the hunger drive as constant as possible. Following the familiarization stage, training for jumping to the stimulus windows began. In the beginning both windows were completely opened with the jumping platform (grid) one inch away so that the animals were only required to step from the jumping platform to the food platform. On successive days the grid shock was moved an additional inch further back from the window. When the animals were jumping the full distance the stimulus windows were gradually closed until the animals were jumping eight and one-half inches to fully closed but unlocked windows. Throughout this training both windows were dark for half of the 80 subjects and the other half had both windows bright. Ten trials per day were given and a guidance technique was used in order to minimize position preferences. The guidance technique consisted of the experimenter manually forcing the animal on even numbered trials to respond to the side opposite to the one responded to on odd numbered trials. No grid shock was applied during this stage of training and the animals ate on the food platform between trials.

Preference Trials.

On satisfactory completion of the above training, animals were given 40 trials (10 trials per day for four days) in order to determine their preferences before starting the discrimination problem. During this stage both windows were unlocked. If the animals failed to respond within 10 seconds, grid shock was automatically applied to force a response. During the first three days, if a consistent response to the same position (left or right) occurred on three successive trials, on the fourth trial the animal was guided by the experimenter to the opposite position. On the fourth day no guidance was given so that the animals' preferences could be clearly assessed.

Discrimination Problem.

During this stage the stimulus windows were differentially illuminated in a prearranged random sequence with the restriction that the positive (correct) window was on the animal's preferred side on the first trial of each day. This restriction served to give at least one trial of warm-up free of punishment to all animals. All animals were given a bright-dark discrimination problem. For the 40 animals trained with both windows dark, two groups of 20 subjects were formed and for convience can be designated as Group L-D and Group L-B. Subjects in Group L-D had the DARK window positive while Group L-B had the BRIGHT window positive. Similarly, the animals trained with both windows bright were divided into two groups designated as Group B-D and Group B-B. Subjects in Group B-D had the DARK window

positive and for Group B-D the DARK window was correct. In both cases attention was given to equating groups in terms of preferences and response latency. The learning criterion was no more than one error in three consecutive days (29 correct out of 30 trials). If the learning criterion was not met within 200 trials (10 trials per day, 20 days) the testing was stopped.

The drug groups consisted of one-half of each of the above four groups. This group received injections of CPP (15 mg/kg, i.p.) one-half hour before daily trials. Thus the completed counter-balanced design consisted of eight independent groups of 10 subjects each.

RESULTS

Training Period.

During the training period, since both windows had the same illumination, the animals developed position preferences. During the fourth day of preference trials 36 animals showed left and 44 showed right preferences. Measures of response latency during this preference test showed that the mean latency for Bright-trained and Dark-trained animals was 8.26 and 5.82 seconds respectively. A t-test showed that this difference was not significant, P>.30.

Number of Solutions.

During the subsequent soluble problems 51 animals solved, 20 developed position fixations, and 4 developed fixations or strong preferences for the Bright window.

Table 1 presents the number of solutions that occurred under variation of the three conditions. A chi-square test was performed comparing the 8 groups with reference to the number of solutions. With respect to the training variable, it was found that 27 of 40 animals (67.5%) trained on Bright and 29 of 40 animals (72.5%) trained on Dark were able to reach the learning criterion. This difference was not significant. Considering the discrimination problem, 39 of 40 "Bright-correct" (97.5%), and 17 of 40 "Dark-correct" (42.5%) animals were able to solve the problem, a difference that was highly significant (P<.001). CPP did not have a significant effect on the number of solutions, 29 or 40 (72.5%) drugged animals vs. 27 of 40

TABLE 1

Number of Solutions Obtained Under the Training, Learning, and Drug Conditions

Training	Bright				Dark			
Learning	Bright		Dark		Bright		Dark	
Drug	CDP	---	CDP	---	CDP	---	CDP	---
% Solution	100	100	30	40	100	90	60	40

TOTAL

	Bright	Dark
Training	27	29
%	67.5	72.5
Learning	39	17
%	97.5	42.5

DRUG

	CDP	Control
Solutions	29	27
%	72.5	67.5

(67.5%) controls. Considering the drug effect on Bright- and Dark-correct groups independently, it is first noted that since all but one Bright-correct animals solved there were obviously no drug induced differences in solutions for the Bright-correct group. For Dark-correct rats, 9 of 20 (45%) of the drugged and 8 of 20 (40%) of the control rats solved, and this difference also was not significant.

Trials to Criterion.

Table 2 presents the mean number of trials to criterion for the 8 groups, and Table 3 summarizes an analysis of variance of these data. Since actual criterion-trials were not included in the analysis it was necessary to assign arbitrary numbers to animals that reached criterion within their first 3 trials, and for those animals that failed to reach criterion in 200 trials. These scores were one and 200 for the former and latter respectively. Inspection of Table 3 again revealed negligible main effect for both training and drug factors, with F ratios less than unity. However, the mean number of trials to criterion for "Bright-correct", 14.7, was significantly less than that for "Dark-correct", 126.9 ($P < .001$) If one considers only the 39 Bright-correct and the 17 Dark-correct animals that solved, the mean learning scores for the 8 animals is 9.7 and 27.9 trials respectively and this difference was shown by a t-test also to be significant ($P < .01$). These data indicated that intensity of the eliciting stimulus within the discrimination

TABLE 2

Mean Number of Trials Required to Reach the Learning Criterion

Training	Bright				Dark			
Learning	Bright		Dark		Bright		Dark	
Drug	CDP	---	CDP	---	CDP	---	CDP	---
Mean trials to learn*	10.50	8.30	152.00	136.00	11.50	21.30	43.10	126.30

* Not including criterion trials.

TABLE 3

Summary of the Analysis of Variance for the Number of Trials Required to Reach the Learning Criterion

Source of Variance	Degree of Freedom	Mean Squares	F
Total	79		
A (Training)	1	2532.20	.64
B (S+ vs S-)	1	251776.80	57.16***
C (Trig)	1	1264.05	.28
AB	1	10035.20	2.27
AC	1	5814.05	1.32
BC	1	8.45	.00
ABC	1	1140.05	.25
S:A/ABC	72	4404.25	

*** P .001 level of significance

problem was the most important factor in determining the probability and the speed of reaching the learning criterion.

Part of the results described in the foregoing analysis is shown in Fig. 1. Three curves in this figure show the results of animals that were trained under what is here for convenience termed non-differentiated (Non-Diff) conditions, i.e. both windows had the same illumination as in the present study, and one curve is for animals in Lewis' (1964) study that was trained under differentiated (Diff) conditions, i.e. one window Bright and one window Dark, alternated at random from side to side. Here responses to the Bright windows are plotted as a function of trials for the no-drugged animals that either solved or failed to solve. Since responding at the 50% level represents chance, curve 1 representing Non-Diff Bright-correct animals shows that on the first day these animals responded to Bright 73% of the time indicating they had a preference for Bright. These animals quickly reached the learning criterion. Curve 2 shows that the Non-Diff Dark-correct group that failed and developed position fixations had a similar initial preference for Bright.

Curve 3 represents the Diff Dark-correct animals from Lewis' (1964) experiment that solved. (These are no-drug controls, hence, directly comparable.) The first point on this curve, just slightly above chance (55%), indicates little if any preference for Bright. Ninety-three per cent (14 of 15) animals in this group reached the

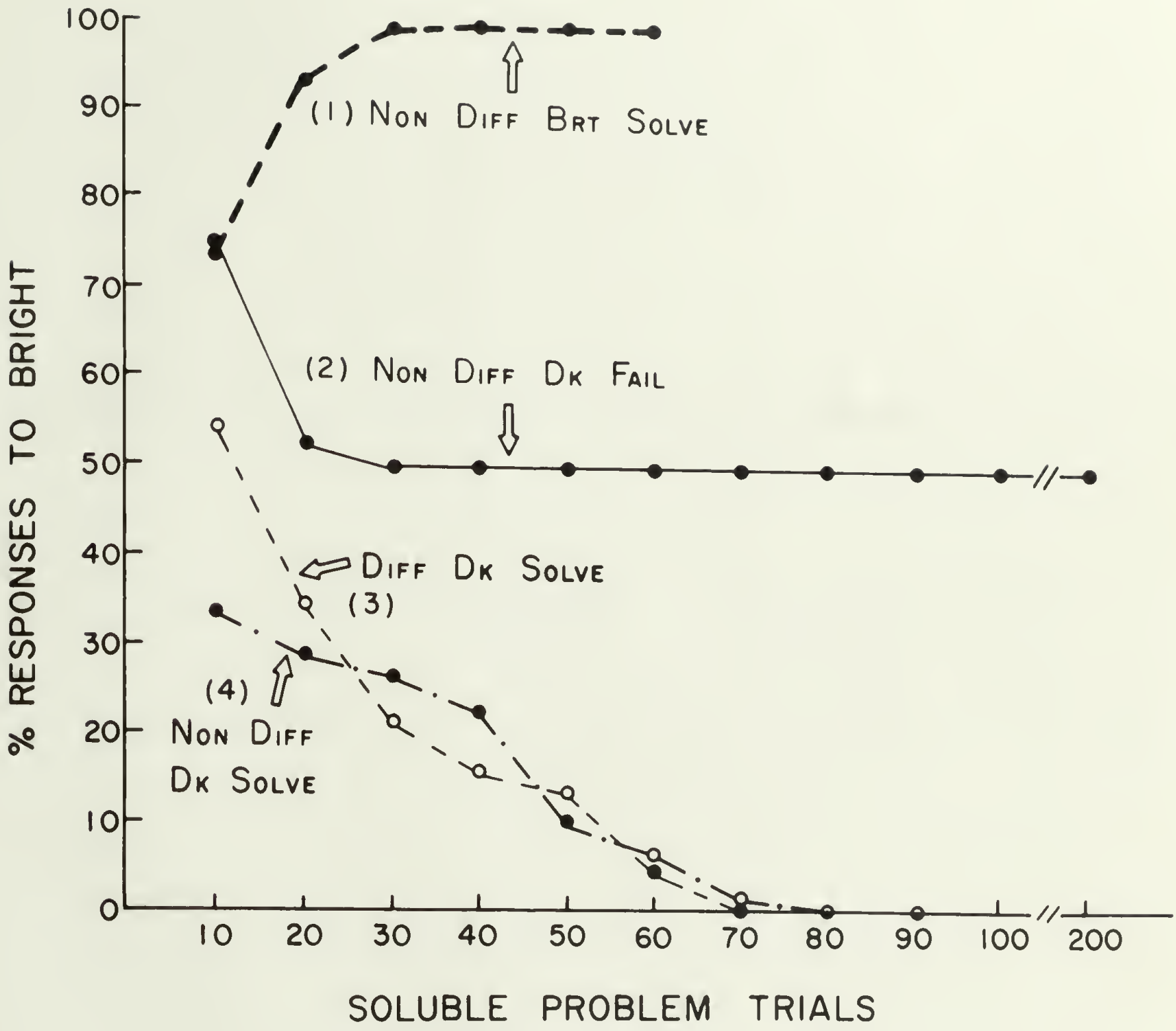

Figure 1. A comparison of learning curves among animals receiving non-differentiated and differentiated (Lewis) training.

learning criterion within 90 trials.

Curve 4 shows the acquisition for Dark-correct solvers in the present experiment. The low initial percent-response to Bright (33%) indicates a preference to Dark (67%) for this group. These animals also reached the criterion within 90 trials. Further, even though it has already been stated that there was no significant relationship between training and the results of the discrimination problem it should be mentioned that an actual count showed almost equal numbers of Bright and Dark trained rats in the three groups represented by curves 1, 2 and 4 from this study. Thus, the preference for Bright in curves 1 and 2, and the preference for Dark in curve 4 cannot be traced to the training conditions.

Of additional interest is a comparison among curves 1, 3 and 4. The Bright-correct animals in curve 1 reached learning criterion before the animals shown in curves 3 and 4, and it can be seen that though the Dark-correct animals shown in curve 4 had a preference for Dark this did not aid them in the speed of acquisition over the animals shown in curve 3 which had no such preference.

Latency

Two analyses of variance were done on the latency measures. For the first analysis the total number of trials for each animal was divided into three proportional trial blocks. Mean response latency to the Bright and to the Dark stimulus within each third of the trials was calcu-

lated for each animal. Again the main effects for training and drug factors had F ratios less than unity. First and second order interactions were also insignificant. However, the main effect for response latency to Bright and to Dark stimulus was significant ($P < .001$), indicating that the Bright stimulus elicited significantly faster responses than the Dark stimulus.

The second analysis of variance was done specifically to determine what effect the drug had on the latency of fixated animals. Only Dark-correct non-solvers were used because only one Bright-correct animal failed to solve and all the other non-solvers had a prolonged and equal period of time for the drug effects to be evaluated. It should be pointed out that three non-solvers developed fixations to the Bright window and followed it consistently, and 10 drugged and 11 no-drugged animals became position fixated. First, one animal was discarded by a chance selection from the latter group to equate the cells. Then the latency for the 10 drugged position fixated non-solvers were compared to 10 of the 11 no-drug animals which were similarly fixated. Mean of median response latency to the Dark (correct) and to the Bright (incorrect) stimulus within each day of testing (20 days) was calculated for each group. These latency data are plotted in Figure 2, and Table 4 summarizes the results of this analysis. Main effects for latency to positive vs. negative stimulus, and latency over

TABLE 4

Summary of the Analysis of Variance of Latency for Drug and No-Drug Position Fixated Dark-Correct Non-Solvers.

Source of Variance	Degree of Freedom	Mean Squares	F
Total	799		
Between Ss	19		
A (Drug)	1	91.120	1
Ss/A	18	1680.629	
Within Ss	780		
B (D$^+$ vs D$^-$)	1	29965.240	105.945**
AB	1	1501.520	5.401*
B x Ss/A	18	273.426	
C (Days)	19	94.259	1.554*
AC	19	190.554	3.143**
C x Ss/A	342	60.618	
BC	19	77.196	2.365**
ABC	19	61.402	1.495*
BC x Ss/A	342	41.052	

* P .05 level of significance

** P .025 level of significance

*** P .01 level of significance

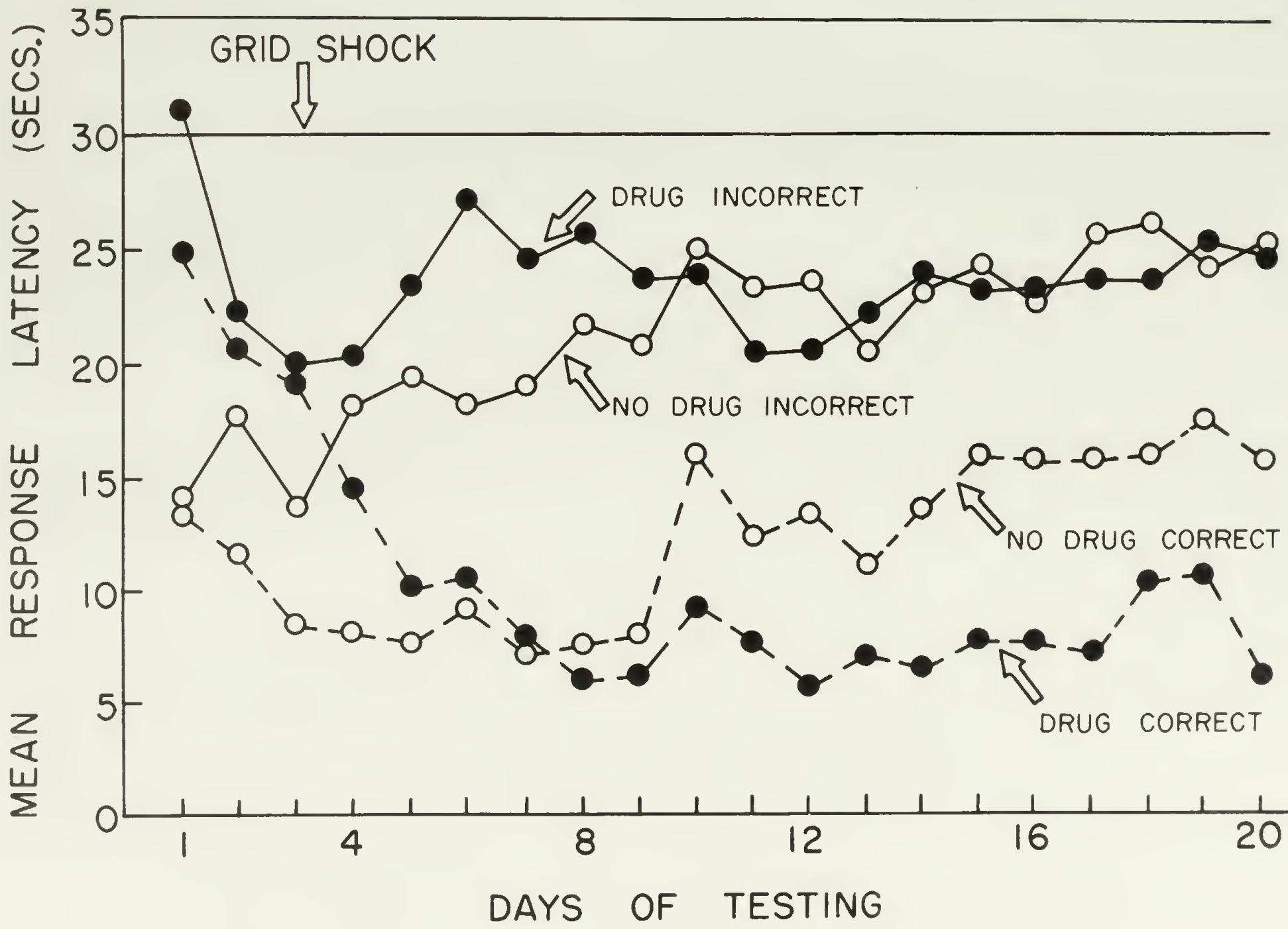

Figure 2. A comparison of response latency for dark-correct, position fixated animals in the drug and no-drug groups.

days were significant, $F < .01$ and $F < .05$, respectively. Main effects for the drug factor were insignificant ($F < 1$). All first order and the second order interaction effects were significant. The interactions Drug x Stimulus and Drug x Days are of particular interest. Inspection of Figure 2 reveals that compared to the no-drug animals the drug has an especially noticeable effect of decreasing latency for the correct stimulus ($F < .05$). There is also evidence that CS+ increased response latency over days ($F < .01$). And finally, the interaction Drug x Stimulus x Days was significant ($F < .05$) suggesting that the drug effect of decreasing latency was greater for the correct window over days than for the incorrect window.

The principle findings of the present study may be summarized as follows:

(a) Training animals with both windows Bright or Dark produced no detectable effect on performance neither during the training period nor on the subsequent discrimination problem.

(b) Animals with the Bright stimulus correct within the discrimination problem were consistently superior to Dark-correct animals in terms of number of solutions, trials to criterion, and response latency.

(c) The only difference between drug and no-drug groups was that for position fixated non-solvers, the animals that received CPF had reduced response latency especially for responses to the correct window.

In the absence of any significant effect for the training factor, the stimulus-intensity effect was identified as a greater reaction potential to the Bright window only during the discrimination problem. This conclusion is supported by the finding that Bright-trained animals did not differ significantly with respect to response latency from Dark-trained animals during the training stage. This can be interpreted to mean that during training stimulus intensity was an irrelevant cue. However, during the discrimination problem, stimulus intensity was obviously related to the superiority of the Bright-correct group

over turn-correct. The turn-correct animals on the other hand, experienced punishment and conflict because of their initial strong tendency to respond to the bright stimulus, and with continued punishment and conflict fewer solutions and more fixations for turn-correct animals occurred as could have been expected according to Hsiao (1956). Thus, all of the findings of this experiment point to the conclusion that the stimulus-intensity effect was a variable affecting on-going performance as predicted by Hull's stimulus-intensity postulate.

It is further believed that the nerve influence of the intensity effect was due to the training with both windows of the same intensity and then for the first time confronting the animals with the contrast between the bright and dark window during the discrimination problem. Support for this contention was found by comparing present results with those of Lewis (1964). In Lewis' study animals were trained under differentiated conditions as opposed to non-differentiated training in the present study. The dark window was correct for all of Lewis' animals and it will be recalled that 14 of 15 (93%) of his no-bias controls solved the problem. In contrast only 8 or 20 (40%) of the turn-correct no-bias animals in the present study solved. Thus, when curves 1, 2 and 3 in Fig. were compared it was observed that Lewis' animals (curve 3) had virtually no initial preference for bright, thus eliminating conflict between the

incorrect stimulus (bright) and the correct stimulus (dark). On the other hand, animals of curve 1 had a strong preference for bright which led to punishment and conflict and finally to fixation. It can be argued that both animals readily solved intensity effects were eliminated by differentiated training, having little or no disposition to respond to the bright window.

The animals above in curve 4 had a bias for turn, and this initial preference for turn contributed toward solution, but did not really aid the learning process since both groups three(3) reached the learning criterion in about the same number of trials. This finding offers support for the contention that the initial preference for bright in the bright-correct group (curve 1) and the preference for dark in the dark-correct group (curve 2) contributed to solution only by eliciting conflictful encounters with the incorrect window that could lead to fixation. Correspondingly, an additional observation pointing to the influence of the intensity effect is revealed by comparing curves 3 and 4. Both both groups are differentially trained, bright-correct animals reached the learning criterion within 50 trials while dark-correct animals required significantly more (87 mean) trials. (These figures include criterion trials.)

Another aspect of the present study is that subjects were further counterbalanced for dark and bright position. The essential question of interest here is what effects if

had on performance in a discrimination problem where the stimulus-intensity phenomenon was manifest. The previous study by Lewis concluded that the principle drug effect was one which reduced the significance of negative incentives. In the present study if CDP were to act on negative incentives only, then the drug should show no effect on performance for the Bright-correct group, since these animals would encounter the negative incentive (the incorrect window) rarely if at all. However, if CDP affected motivation in general, then the drugged groups should have been inferior to no-drug groups. Present findings revealed no difference between drug and no-drug groups that had the Bright window correct (100% solutions vs. 95% respectively). However, this result might also indicate that the strength of the stimulus-intensity effect, when Bright was correct, masked any possible drug effects. On the other hand, for the Dark correct groups, there was no difference between the drugged and no-drug groups, 45% and 40% solved respectively.

Comparing results of Dark-correct animals with those of Lewis' study it is noted that Lewis found a significant difference between drug and no-drug groups, 60% vs 93% respectively, while there was virtually no difference between drug and no-drug groups in the present study, 45% vs. 40% respectively. To account for the difference in results between the two studies, it is again suggested that

the drug in Lewis' experiment reduced the motivational significance of the negative incentive which led to performance inferior to that of the no-drug controls. The animals of the present experiment, because of the training-induced disposition to respond to Bright, experienced considerable conflict. In this conflict situation drugged animals being less affected by the negative incentive may have been prevented from developing large amounts of conflict and fear, and these animals were thus relatively better able to cope with the discrimination than the drug group in Lewis' experiment. Therefore in this conflict situation, the drug resulted in a net benefit.

Finally, the latency analysis with respect to drug effects on the performance of frustrated animals revealed a negligible main effect for drug, but there was an important significant interaction between windows and drug (Table 4). Figure 2 shows that drugged animals were initially slower than no-drug animals, probably due to a sedative effect of CPZ. However, as the animals began to discriminate between the positive and negative windows as shown by the separation of the latency curves, the latency for drugged animals for the incorrect (Bright) window decreased to that of the no-drug animals. For the correct (Dark) window, the latency for drugged animals declined below that for the no-drug animals. Studies now in progress show that non-frustrated animals show increased latencies when treated with CPZ, and prior studies by Feldman and Lewis (1963) have shown that frustrated

animals show significantly shorter response latencies when treated with CDP. The deduction here is that the animals in the present experiment gradually became frustrated and fixated, and the drug-induced drop in latency reflects the development of the fixated state.

SUMMARY

This study investigated the relationship between the psychodepressive effects of chlordiazepoxide and the stimulus-intensity phenomenon. Eighty rats were counterbalanced on a Lashley jumping stand for training (Bright or Dark), learning (Bright-correct vs. Dark-correct), and drug or no-drug conditions. Training conditions had no effect on performance in the subsequent discrimination problem. In the discrimination problem, Bright-correct animals were superior to Dark-correct animals in terms of number of solutions, trials to reach criterion, and latency. The conclusion was that the stimulus-intensity effect is a performance variable in accordance with Hull's stimulus-intensity postulate.

For Bright-correct animals, chlordiazepoxide either had no effect, or the effect may have been masked by the stimulus-intensity effect. However the number of fixations probably was reduced in the drugged Dark-correct group because of the attenuation of conflict and fear. Also, for position fixated Dark-correct non-solvers, response latencies to the correct window were initially longer and then shorter for drug animals than for no-drug animals. The suggestion was that CDP induced latency change reflected growing conflict and fixation.

APPENDIX

Derivation of Perkins-Logan's Hypothesis.

Given that animals are trained with both windows bright or both dark, there will be a growth of habit (H_1) to the training stimulus and a smaller amount of generalized habit ($\overline{H}_1$) capable of generalizing to the stimulus absent during training, but present during the subsequent discrimination problem. When subjected to the discrimination problem, there will be further growth of habit (H_2) to the reinforced stimulus and an amount of generalized habit ($\overline{H}_2$) to the non-reinforced stimulus present in the discrimination problem. The magnitude of H_1 and $\overline{H}_1$ are assured to combine with H_2 and $\overline{H}_2$ in the determination of the final reaction potential to the positive and negative window in the discrimination problem, i.e. $\mathcal{E}$ pos. - neg. = $(H_1 + H_2) - (\overline{H}_1 + \overline{H}_2)$.

Now assigning values to the habit components, let $H_1 = 10$; $\overline{H}_1 = 1$; $H_2 = 12$; and $\overline{H}_2 = 2$. Substituting into $\mathcal{E}$ pos. - neg. = $(H_1 + H_2) - (\overline{H}_1 + \overline{H}_2)$, we get for

1. Bright trained - Bright correct:

   $\mathcal{E} = (10 + 12) - (1 + 2) = 22 - 3 = 19$

2. Bright trained - Dark correct:

   $\mathcal{E} = (1 + 12) - (10 + 2) = 13 - 12 = 1$

3. Dark trained - Bright correct:

   $\mathcal{E} = (1 + 12) - (10 + 2) = 13 - 12 = 1$

4. Dark trained - Dark correct:

   $\mathcal{E} = (10 + 12) - (1 + 2) = 22 - 3 = 19$

Note that, if there is transfer from training conditions, the performance of B - B will equal that for D - D. Further the difference in performance for the two groups trained on Bright will equal the difference in performance of the two groups trained on Dark. In accordance with the Perkins-Logan formulation, if there is no transfer from training, the hypothesis predicts no difference in the performance of the four groups and is thus not applicable to the present study.

Derivation of Stimulus-Intensity Theory.

The assumption with respect to habit and generalized habit are the same as in the Perkins-Logan's hypothesis. The added assumption postulated by Hull is that the stimulus-intensity component of reaction potential is a monotonic increasing function of absolute stimulus intensity. This component is assumed to be multiplicatively related to habit in the determination of reaction potential. Given the same conditions with respect to habit presented in the previous derivation and the additional stimulus-intensity component, the reaction potential to the positive and negative window in the discrimination problem is given by

$$\text{pos} - \text{neg} = \left[(V_1 + V_2)\, V\right] - \left[(V_1 + V_2)\, V\right].$$

Now let the stimulus-intensity component for the Bright stimulus (V_b) = 1 and that for the Dark stimulus (V_d) = 1. Substituting into the equation, we get for

1. Bright trained - Bright correct:

$$V = [22 \times 3] - [3 \times 1] = 66 - 3 = 63$$

2. Bright trained - Dark correct:

$$V = [13 \times 1] - [12 \times 3] = 13 - 36 = -23$$

3. Dark trained - Bright correct:

$$V = [13 \times 3] - [12 \times 1] = 39 - 12 = 27$$

4. Dark trained - Dark correct:

$$V = [22 \times 1] - [3 \times 3] = 22 - 9 = 13$$

Note that B - B and D - D are both superior to D - B and B - D, even when there is transfer of habit from training.

To extend the derivation further, it can be shown that Bright-correct conditions will be superior to Dark-correct when there is no transfer from training. Let the habit developed in the discrimination problem, $N = 12$, and the generalized habit, $\overline{N} = 2$, and $V_b = 3$, $V_d = 1$. Substituting into $V_{pos} - n_{eg} = (N \times V) - (\overline{N} \times V)$, we get for

1. Bright trained - Bright correct:

$$V = (12 \times 3) - (2 \times 1) = 36 - 2 = 34$$

2. Bright trained - Dark correct:

$$V = (12 \times 1) - (2 \times 3) = 12 - 6 = 6$$

3. Dark trained - Bright correct:

$$V = (12 \times 3) - (2 \times 1) = 36 - 2 = 34$$

4. Dark trained - Dark correct:

$$V = (12 \times 1) - (2 \times 3) = 12 - 6 = 6$$

Again note that Bright-correct is superior to Dark-correct, according to the stimulus-intensity theory.

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