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Performance as a Function of Drug, Dose, and Level of Training*

OAKLEY S. RAY and LYLE W. BIVENS

Psychology Research Laboratories, Veterans Administration Hospital
Leech Farm Road, Pittsburgh, Pa. 15206

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Abstract. Chlorpromazine (CPZ) at 1.0, 2.0 and 3.0 mg/kg and LSD-25 at 0.05, 0.10, and 0.15 mg/kg were administered to Ss given varying amounts of training on a discrete trial conditioned approach procedure. Both CPZ and LSD-25 showed significant dose-response effects, i.e., as dose increased, degree of behavioral depression increased. There was no relationship between the LSD-25 induced depression and the amount of training but CPZ showed significantly less effect on highly trained behavior than on moderately or minimally trained behavior.

The effect of a drug on an animal's performance as a function of amount of training preceding drug administration has not been clearly shown. It would seem that as the amount of training increases, there would be a decrease in the effect of a given drug and dose on the trained task. BINDRA and MENDELSON (1962) found, however, that with chlorpromazine (CPZ) at each of two dose levels the depressant effect of the drug increased as the amount of training increased. These authors replicated this finding in a second study (1963) and suggested that the obtained positive relationship between training and drug-induced decrement was due to a slowing of the animal's speed with which relevant responses were made.

SINGH (1964), on the other hand, has reported that the effect of CPZ on water rewarded lever-pressing is negatively related to the amount of training, i.e., as overtraining on the task increased the effect of the drug on performance of the task decreased.

Several of the procedural details of these experiments suggest that the reported results may not accurately reflect the relationship between drug effect and habit strength. The amount of training an animal has had in a task is best represented in HULL's (1943) concept of habit strength (H) which is related to the number of reinforced responses experienced by the animal.

In the BINDRA and MENDELSON studies the primary performance measure used to study drug effects was the number of responses in the

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Results

The measure of habit strength (H) used in this study was trials responded to. The session prior to drug administration was used as the control day and drug effects were studied as change from control in the percentage of trials responded to. To test whether an increase in H had

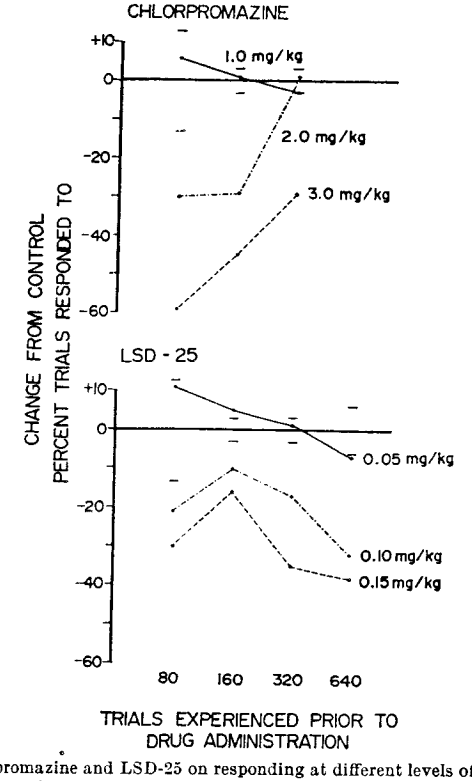

Fig. 1. Effect of chlorpromazine and LSD-25 on responding at different levels of training. Four *Ss* at highest and lowest doses of each drug and five *Ss* at middle doses; standard deviation of control day responding indicated by = —

occurred as a result of the number of trials presented the percentage of trials responded to on Group A's Control Day was compared to the percentage responded to on Group D's Control Day. Group A responded at the 87% level while Group D responded to 95% of the trials. This is significant at $p < .01$ which suggests that habit strength had increased.

Fig. 1 contains data for both drugs at all dose levels at each level of training. The data is plotted as change in percentage of trials responded to from control to drug day. The standard deviations for the four control days are indicated and can be seen to dimish rapidly from the first training level control day. Looking first at the effects of the different

drug doses on performance it is clear that at each training level for LSD-25 and at all but level III for CPZ there is an orderly dose-response effect. These dose effects were analyzed separately for each drug with the Kruskal-Wallis test. The LSD-25 dose response effect was significant at $p < .01$, while the CPZ data were significant at $p < .02$.

The principal concern in this experiment was the effect of the same drug doses on performance at different levels of training. To test for significance of the effects plotted in Fig. 1 the Kruskal-Wallis oneway analysis of variance was performed on both the CPZ and LSD-25 data. (A non-parametric test was necessary because of heterogeneity of variance among groups.) The analysis was performed across drug doses to analyze the effect of number of trials on the depression caused by the drugs. For CPZ the effect was significant at $p < .02$ but the LSD-25 effect was not significant. Three *t*-tests comparing differences between Groups A and D (80 and 640 trials) for each dose of LSD-25 were computed as a further test for a training effect. Only the effect obtained with the .05 mg/kg dose of LSD was significant ($p < .05$). Further support for the significant interaction between the CPZ depressant effects and the number of trials prior to drugging was obtained by testing the significance of the difference between the effects of the high and low doses at each training level. At Level I the difference was $p < .05$, at Level II $p < .10$ and at Level III the difference did not approach significance.

Discussion

These data corroborate those reported by Singh (1964) in that with the increasing amounts of training the depressant effect of CPZ on performance is diminished. Both the present study and Singh's seem to be in opposition to the CPZ-training level results reported by Bindra and Mendelson (1962, 1963).

The explanation of this apparent discrepancy may be in the measures used and the question asked. Although in their early study, Bindra and Mendelson (1962) utilize the concept of H they do not do so in their 1963 report. In the 1963 report they refer only to level of training performance and report their data according to three levels of training performance. Their analysis of their data fit well with Poslun's (1962) suggestion that the primary effect of CPZ is on the initiation of a response sequence, not on the carrying out of the sequence.

Their 1962 data was also reported in terms of number of responses during a fixed interval. Since the number of training sessions was not considered in grouping the *Ss* and there was no limit on rate of responding, it is possible that the *Ss* who learned to work rapidly early (Logan, 1960) were those finally placed in the highest training group. These fast responders would be expected on the basis of the 1963 analysis and

Poslun's data to show the greatest decrement following CPZ as they did. In neither the 1962 nor the 1963 study was there a test of the effect of CPZ on habits of different strength. These two studies of Bindra and Mendelson seem to be a clear demonstration of the greater effect of CPZ on fast responders rather than CPZ effects on habits of different strengths.

The use of a discrete trial paradigm in the present study made possible the control of level of habit strength and precluded any confounding with performance measures. Under these conditions CPZ was found to have a negative interaction with habit strength, i.e., as the number of reinforced trials increased the deleterious effect of CPZ on performance decreased.

LSD-25 showed clear dose-response effects (as did CPZ)—as dose increased performance decreased—but there appeared to be no effect on the decrement as a function of number of prior trials. However, since there was a significant difference between Groups A and D at the .05 mg/kg dose, there remains the possibility that the downward trend in performance with increasing habit strength seen in the LSD data is not spurious. Examination of this possibility will have to be carried out in future studies. It is possible that LSD-25 will interact with other behavioral control variables which held constant across the four training levels. There are suggestions from other research (Ray, 1965) that LSD-25 acts selectively to depress positively reinforced behavior at the same dose levels used here.

Bradley (1958) has shown that LSD-25 sensitizes *S*s to external stimuli, it may be that in this situation the *S* is therefore flooded with stimuli and is unable to adequately process the input information and thus make appropriate responses. It is easy to see that an effect of this type would not necessarily vary with the level of training.

LSD-25 does have a variety of autonomic effects. The observed effect could be due to a disruption of some basal physiological system—the duration of the effect depending on the dose level used. This system might block performance for a fixed period of time not related to the probability of behavior. It is not possible at this time to further clarify the obtained results.

Summary and Conclusions

It is clear that there is no single relationship between the effect of a drug on performance and the level of training of the behavior. It may be that CPZ is representative of tranquilizing-depressant compounds and that these agents will show decreasing effects on performance as training increases. It is difficult to uniquely categorize LSD-25 and all

that can be said is that each major class of psychoactive drugs will have to be studied individually to elaborate their effects on behavior at different levels of training.

References

Bindra, D., and J. Mendelson: Interaction of habit strength and drug effects. J. comp. physiol. Psychol. **5**, 217—219 (1962).

— — Training, drive level, and drug effects: a temporal analysis of their combined influence on behavior. J. comp. physiol. Psychol. **55**, 183—189 (1963).

Bradley, P. B.: The central action of certain drugs in relation to the reticular formation of the brain. In Jasper *et al.* (Eds.): Reticular Formation of the Brain, pp. 123—149. Boston: Little, Brown 1958.

Hull, C. L.: Principles of behavior. New York: Appleton-Century Crofts 1943.

Logan, F. A.: Incentive: How the conditions of reinforcement affect the performance of rats. New Haven: Yale University Press 1960.

Posluns, D.: An analysis of chlorpromazine-induced suppression of the avoidance response. Psychopharmacologia (Berl.) **3**, 361 (1962).

Ray, O. S.: The effect of psychotogens on approach and avoidance behavior. Int. J. Neuropsychiat. **1**, 98—103 (1965).

Singh, S. D.: Habit strength and drug effects. J. comp. physiol. Psychol. **58**, 468—469 (1964).

Oakley S. Ray, Ph. D.
Psychology Research Laboratories
Veterans Administration Hospital
Leech Farm Road
Pittsburgh, Pa. 15206, U.S.A.