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The influence of preoperative learning on the recovery of a successive brightness discrimination*

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The recovery of a successive two-choice brightness discrimination following posterior neodecortication is significantly impaired if the reinforcement contingencies of the postoperative task are the reverse of those learned preoperatively. These results replicate a simultaneous two-choice brightness discrimination.

Of the many possible mechanisms that may mediate behavioral recovery following neurological insult, two have received some recent attention and specification with regard to the recovery of learned brightness discriminations following neocortical insult. One of these has been outlined by Cooper and his associates (Bauer & Cooper, 1964; Goodale & Cooper, 1965; Bland & Cooper, 1970; Cooper, Blochert, Gillespie, & Miller, 1972) and suggests that the recovery process is essentially a relearning process. The second has been detailed by Meyer (1972) and suggests that the recovery process may be a reaccessing process. The two notions differ inasmuch as one, the relearning position, suggests that what is occurring pre- and postoperatively is essentially the same basic process, while the other notion, the reaccessing position, suggests that the pre- and postoperative processes are qualitatively quite different. In this latter instance, postoperative behavioral recovery occurs because the preoperatively learned behavior was spared by the neocortical damage, with the recovery process representing a reactivation or reaccessing of the spared behavior patterns. Both of these postulations have amassed a certain amount of empirical support, but much of this support is quite indirect and none of it provides a direct test of the two positions.

Recently, however, LeVere and Morlock (1973) directly tested the relearning and reaccessing concepts with a procedure where the two positions would make opposing predictions. The experimental design was quite straightforward and simply involved preoperative training of two matched groups of rats on a simultaneous two-choice brightness discrimination and, subsequent to posterior neodecortication, retraining one group of rats on the original brightness problem while retraining the other group on the reversal of the original brightness problem. The logic was that if the Ss were recovering the discriminative behavior through a process of relearning, i.e., establishing new and independent memory engrams, then it should matter little whether the rats were retrained on the original brightness task or on the reversal of the original brightness task. However, if the animals were not relearning postoperatively and if the preoperative experience was somehow involved in the recovery process, as suggested by the reaccessing notion, then the animals trained on the reversal of the original brightness discrimination should be significantly impaired during postoperative training. This was argued because in the reversal group which was learned preoperatively was the antithesis of the behavior required postoperatively. The results indicated that the postoperative reversal group was, in fact, significantly impaired in their mastery of the reversed brightness discrimination. LeVere and Morlock (1973) thus concluded that a strict interpretation of the relearning position was somewhat untenable.

However, in deference to the data suggesting the viability of the relearning conceptualization, it would seem appropriate to attempt a systematic replication before wholeheartedly espousing the conclusions of LeVere and Morlock (1973). The present report describes this replication using a successive brightness discrimination procedure instead of the simultaneous task used by LeVere and Morlock. The successive task was chosen because, while it is obviously a learned visual

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behavior, it is just as obviously conceptually different from the simultaneous task in a number of ways. Of these, perhaps the most important is the fact that in the successive brightness discrimination procedure reinforcement is not correlated with any particular visual discriminative cue but rather depends upon the visual cues in relation to the spatial aspects of the training situation.

METHOD

Subjects and Apparatus

The Ss for this experiment were 28 male hooded rats between the ages of 90 and 100 days.

Pre- and postoperative discrimination training of the Ss was accomplished in a Yerkes-type two-choice Y-maze apparatus using back lighted panels as the discriminative cues. The details of this apparatus have been previously presented by LeVere and Morlock (1973).

Procedure

Each rat was preoperatively trained on a successive brightness discrimination task which required the animal to enter the left goal area when the rear panels of both the left and right goal areas were illuminated and to enter the right goal area when the rear panels of both the left and right goal areas were dark. Each animal was trained for 10 trials each day until reaching a criterion of nine first-choice correct responses on any series of 10 trials. With these exceptions, all other training procedures were identical to those described by LeVere and Morlock (1973).

On the day following criterion performance, each animal was subjected to a bilateral posterior neodecortication. The intended extent of the lesion corresponded to that described by Horel, Bettinger, Royce, and Meyer (1966) and by LeVere and Morlock (1973) and was to include all neocortex posterior to a line passing through the bregma and becoming tangential to the rhinal sulci. All lesions were performed by the aspiration technique as described by LeVere and Morlock (1973). Following surgery, all animals were allowed a 14-day recovery period.

For postoperative retraining, the animals were divided into two groups matched by a computer program which considered all possible pairings between individual Ss and the number of trials required by the Ss to reach successively more stringent criteria. One of the two matched groups was then retrained to a criterion of nine correct choices out of 10 trials on the original successive brightness discrimination problem. The other group was retrained to a similar criterion but with the reinforcement contingencies of the original successive brightness discrimination task reversed. That is, this latter group was trained to go to the right when the rear panels of both goal areas were lighted and to go to the left when the rear panels of both goal areas were dark. Aside from the reversal procedure experienced by the one group of Ss, the postoperative training was identical to the preoperative training procedure.

When each animal completed postoperative training, it was sacrificed with an overdose of sodium pentabarbital and perfused with physiological saline followed by 10% buffered formalin. Histological analysis then proceeded in accord with standard procedures as detailed by LeVere and Morlock (1973).

RESULTS

Histological

Histological examination showed that two of the Ss had sustained bilateral damage to the hippocampus and that three other Ss indicated some sparing within the dorsal lateral geniculate nucleus (LGN). These animals were eliminated because, in the first instance, Kimble (1968) has suggested that rats sustaining hippocampal lesions are deficient on successive discrimination tasks and, in the second instance, LGN sparing would suggest the possibility of an incomplete neocortical lesion. In both cases, the inclusion of these animals could lead to incorrect conclusions concerning the hypothesis in question. Of the 23 Ss which remained, 9 were in the group receiving postoperative training on the original successive brightness discrimination, while 14 were in the group receiving postoperative retraining on the reversal of the original successive brightness discrimination. Comparing the lesions sustained by these 23 Ss, it was found that there was little difference between the two experimental groups. The mean destruction sustained by the nonreversal group was 48.27% of the cortical surface (SD = 7.3%), while the reversal group sustained an average of 47.96% cortical damage (SD = 9.77%). The slight 0.13% difference between the two groups was, of course, nonsignificant as indicated by the t statistic ($t = 0.082$, $df = 21$, p = n.s.).

Behavioral

The behavioral results are presented in Fig. 1. As can be seen from the figure, the average trials to criterion for the two experimental groups was essentially identical during preoperative training. This is of interest primarily to indicate that the elimination of some of the Ss on histological grounds did not disrupt the match of the two treatment conditions. Postoperatively, however, the two groups were not identical. The rats postoperatively retrained on the preoperatively learned successive discrimination problem reattained criterion in approximately the same number of trials postoperatively as was required preoperatively ($t = 0.572$, $df = 8$, p = n.s.). In contradistinction, the rats postoperatively trained on the reversal of the preoperative successive brightness discrimination were significantly impaired relative to their preoperative acquisition ($t = 5.263$, $df = 13$, $p < .001$, two-tailed related measures). Moreover, and more importantly, the postoperative learning of the rats retrained on the reversal of the original successive brightness discrimination were significantly inferior to the rats retrained on the nonreversal discrimination ($t = 2.241$, $df = 21$, $p < .05$, two-tailed independent measures). A similar conclusion is reached when the postoperative acquisition scores are evaluated with an analysis of covariance using the preoperative acquisition scores as the covariate ($F = 4.561$, $df = 1/20$, $p < .05$). Thus, while postoperative reacquisition approximates preoperative acquisition when rats are required to master similar habits, postoperative acquisition of a visual behavior at odds with the preoperatively learned visual behavior

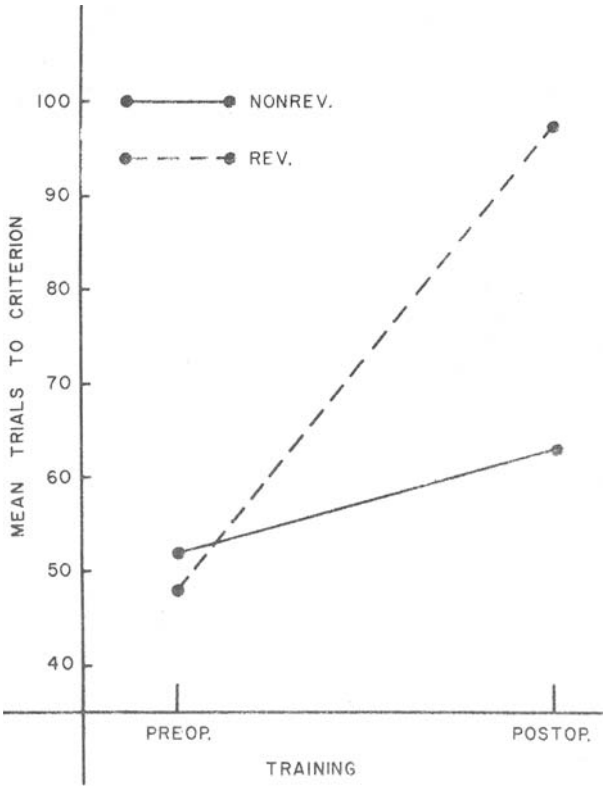

Fig. 1. Mean trials to criterion during preoperative training (PREOP) and postoperative training (POSTOP) for the group postoperatively retrained on the original successive brightness discrimination (NONREV) and the group retrained on the reversal of the original successive brightness discrimination (REV). Criterion performance was nine first-choice correct responses out of any series of 10 trials.

appears to be significantly retarded—a result which is difficult to align with the notion that recovery of function is the learning of new and independent memory engrams.

DISCUSSION

The present data would thus appear to replicate in detail the results reported by LeVere and Morlock (1973). Consider first the nonreversal treatment condition. The present results indicate that bilateral posterior neodecortication is effective in disrupting a successive brightness discrimination habit but that the hooded rat is able to reattain criterion performance in essentially the same number of trials as that required for preoperative mastery. These data are then compatible with the data related to the simultaneous black-white discrimination for hooded rats trained to a criterion of nine correct choice responses out of 10 successive trials (Horel et al, 1966; Lashley, 1935; Thompson, 1960; LeVere & Morlock, 1973). It may be noted, however, that this result is not in complete agreement with the data presented by Thompson and Malin (1961), who report negative savings when striate lesioned albino rats were retrained on a successive brightness discrimination. But the albino rat also indicates negative savings on a simultaneous brightness discrimination following striate lesions (Meyer, Yutzey, & Meyer, 1966), so that the failure of the present data to correspond to the Thompson and Malin (1961) result may most probably be attributed to a species difference.

Turning to the reversal treatment condition, the present data also accurately parallel the results reported by LeVere and Morlock (1973). That is, while preoperative original learning of the successive discrimination task was comparable, by experimental design, in both the nonreversal and reversal treatment groups, the Ss postoperatively retrained on the reversal of the original successive brightness discrimination were significantly impaired. And, it is important to note that this impairment was detectable with respect to not only the reversal group's *preoperative* acquisition but also, and perhaps more importantly, with respect to the more conservative comparison between the *postoperative* performance of the reversal and nonreversal groups.

Since the behaviors required of the individual when mastering a successive black-white discrimination are conceptually quite different from the behaviors required when the individual is mastering a simultaneous black-white discrimination, the present results provide some degree of generality to the concept that behavioral recovery may involve behavior patterns established prior to the neurological damage.

In a general sense, then, the present results argue against any conceptualization that recovery of function following brain damage represents the establishment of new and independent memory engrams. What is recovered postoperatively, according to the present data, is clearly not independent of the behavior patterns which were established prior to the neurological damage. This should not, of course, be interpreted as suggesting that postoperatively the striate lesioned rat is incapable of learning or even that learning plays no part in postoperative restitution of function. Rather, what is suggested here is that whatever the postoperative recovery process is, it is not simply a rerun of those processes occurring when the behaviors were initially established prior to neurological insult.

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