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ROLE OF BLIND ALLEYS IN LATENT LEARNING

PHILIP K. JENSEN [1]

Michigan State University

Since Reynolds' demonstration that animals in a Blodgett-type experiment learn to avoid blind alleys during the exploration runs is central to an understanding of complex maze latent learning studies, two experiments were designed to investigate the extent of the role of blind alleys. Fifty-one rats were were used in a Buxton-Haney-type study, and a replication with the effects of blind alleys removed by the use of a multiple free-path maze. The results show a strong latent learning effect in the first case but no such effect in the second. Either cognitive or classical reinforcement theories have difficulties explaining the data. The simplest theory to apply is a probabilistic contiguity model.

Explanations of the latent learning studies classically have fallen into two groups: first, the cognitive theories such as those of Tolman, which have been summarized and defended by Thistlethwaite (1951); second, those of reinforcement theorists such as Hull, which have been equally well presented by Meehl and MacCorquodale (1954). A recent summary of the area has been made by Revenstorff (1966).

Thistlethwaite's (1951) review delineated four major types of latent learning experiments. Of these, the free exploration in multiple-unit maze studies, such as those of Buxton (1940) and Haney (1931), have provided the most consistent support for arguments against the plausibility of a Hullian reinforcement explanation. While these studies have been criticized as overly complex, the explanations offered in an attempt to account for their results have been less than convincing.

A central point for any theoretical explanation was provided by Reynold's (1945) demonstration that the blind alleys are used less and less as the period of exploration progresses. If a probabilistic contiguity theory is considered, it seems reasonable to suggest that the superior performance of experimental groups in the Buxton-Haney-type study is simply a continuation of their previously learned tendency to avoid the blind alleys.

To test this assumption, two studies were run. Experiment I was designed to maximize latent learning in a Buxton-Haney-type situation. Experiment II used a maze constructed of hexagonical units which permitted a close duplication of the first study but without the blind alleys. It was felt that cognitive or reinforcement theories should predict similar results in either study. On the other hand, if the appearance of latent learning in this type of situation is largely due to learning and avoidance of blind alleys, then latent learning should appear in the first study but not in the second.

Method

Subjects.—Fifty-one rats between the ages of 90 and 150 days were used. They included both albino and hooded males and females. The *S*s were assigned to the experimental and control groups in such a manner that age, sex, and breed were balanced.

Apparatus.—Two mazes were constructed of interlocking runways arranged in the pattern of hexagons as shown in Fig. 1. The larger maze consisted of seven such hexagons; the smaller used two. Blocks could be inserted into the alleys at the points shown. The mazes had no set starting box or goal box. The *S*s could be inserted or removed from any point. When food was present, it was in cups of the same width as the alleys so that *S*s were forced to climb over it in order to pass. Sliding doors were used to prevent *S*s from leaving a selected goal region during test trials.

With the insertion of appropriate blocks, the maze became a classical multiple-Y maze with starting box, goal region, and six blind alleys. Since the blocks were located 3 in. beyond the end of each blind alley, they were invisible until *S* had entered.

[1] Now at Drew University. The author would like to express his appreciation to M. R. Denny, for his assistance and consideration.

Requests for reprints should be sent to Philip Jensen, Department of Psychology, Drew University, Madison, New Jersey 07940.

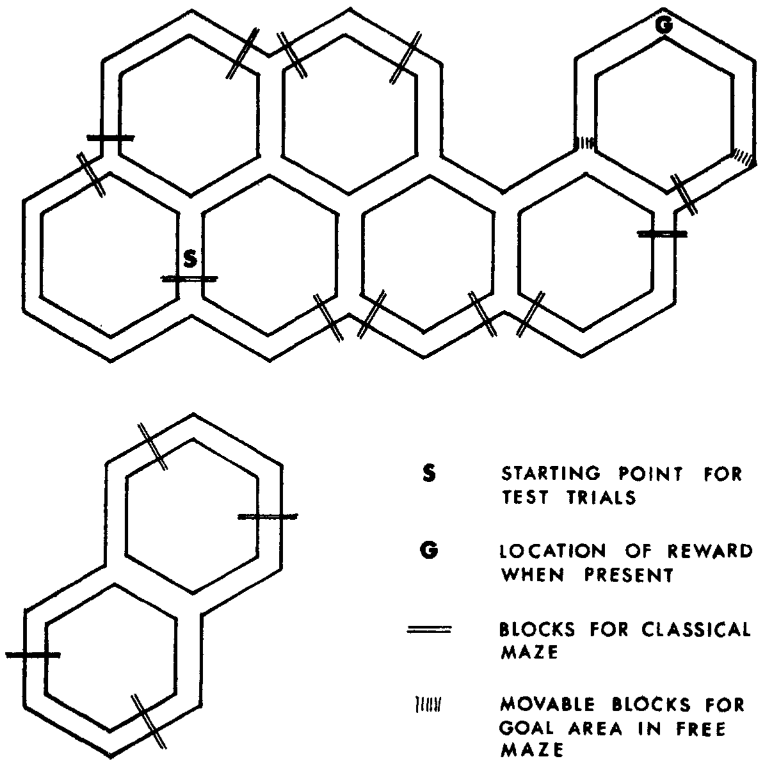

FIG. 1. The seven- and two-unit mazes with positions for blocks.

With the removal of the blocks, the maze was in its free form with no blind alleys and unlimited forward movement on what would prove to be, after the introduction of reward, true paths. The use of the hexagon pattern permits quite direct comparison of the free multiple true-path condition to the corresponding classical maze with its series of symmetrical choice points.

The smaller maze could also be varied between a classical and free form. It was used to permit acclimation of the rats in a highly similar but less complex environment.

Procedure.—Each *S* was taken through four stages: first, handling; second, an acclimation period in the small maze; third, a training period in which the experimental groups explored the large mazes while the control groups remained in the small mazes; finally, the test trials in which food was introduced into the large maze and the progress of all groups was recorded.

Handling.—The *S*s were placed on a 7 gm/day diet with unlimited water available in the home cage during the 7 days.

Acclimation.—In Exp. I, *S*s were placed in the small maze in its classical form with two blind alleys and a long path of eight straightways or stretches. This was the same length that the true path in the large maze would be. The *S*s, in groups of five or six, were randomly placed in the maze, permitted 20 min. of exploration, then removed from whatever stretch they happened to occupy. This procedure was repeated over a period of 4 days. The location of the blocks was varied with the blind alleys being in one position on Days 1 and 4 and the opposite of Days 2 and 3. In order to produce a partially reinforced food expectancy in the maze environment, a wet mash was introduced into the maze on Days 1 and 3, with the location of the two cups systematically rotated in 10-min. intervals through four positions. The quantity consumed was deducted from the 7-gm. home-cage diet.

In Exp. II, the same procedure was followed except that the maze was in the free condition. The two food cups were rotated through eight locations in periods of 5 min. each.

Exploration.—In Exp. I, *S*s were divided into an experimental group of 11 and a control group of 10. The controls were returned to the small classical maze for 3 hr. on 2 successive days. The position of the blocks was again reversed on the second day. The experimental group was placed in the large classical maze for the same time periods. The blocks and true path were in the positions which would be used for the test trials. No food was present in either maze during this period while the home-cage diet remained 7 gm. The *S*s were placed in the maze in groups of 5 or 6 with varied entry points and removal from whatever position was occupied at the end of the 3 hr.

In Exp. II, an experimental group of 15 and a control group of 15 were selected. They were placed in the appropriate small and large free-condition mazes. All other factors were the same as in Exp. I.

Test trials.—In Exp. I, the control and experimental animals received identical treatment. Food was placed into the large classical maze. (See Fig. 1.) The *S*s were inserted into the maze at the beginning of what was now the true path. The distance the animal travelled was measured in terms of the number of stretches entered. Retracing was permitted and scored in the same manner. Thus scores varied upward from the minimum of 8 which included the starting stretch. This method of scoring permitted comparison with Exp. II. Four trials were run each day over a 4-day period. The *S*s, as usual, were fed a full 7 gm. on return to the home cages.

Results

Since the scores were necessarily skewed, the Mann Whitney U test was employed. The scores used for comparison purposes were the medians for each *S* on a given day. Each day's data was treated separately, providing a series of four comparisons between control and experimental groups in each experiment. The results may be seen in Table 1.

In Exp. I, the latent learning effect was present at a significant level in each of the 4 days. In Exp. II, there is little evidence of a similar result. The experimental *S*s used more stretches than the controls on Days 1 and 3. Overall for the 4 days, the experimental *S*s' median of 14.0 was higher than the 13.5 of the controls.

The variation between animals decreased from Day A to Day D and was greater in the free-condition study than in the classical maze study. Thus some differences which are not significant are larger in absolute terms than others that are significant.

TABLE 1

MEDIAN NUMBER OF STRETCHES ENTERED PER TRIAL

Exp. and group	Day			
	A	B	C	D
Exp. I: Classical multiple-Y maze				
Control	16.5	11.5	10.2	9.6
Experimental	11.2*	9.2**	8.5**	8.5**
Exp. II: Free-cond. maze				
Control	14.8	16.0	11.2	13.0
Experimental	20.0	14.8	12.8	11.3

* $p < .05$.
** $p < .01$.

Discussion

The results in Exp. I agree closely with those of other studies of the Buxton-Haney type which demonstrated that the methods used were more than adequate to produce the latent learning effect. On the other hand, in Exp. II, using almost identical methods but with the blind alleys removed, no evidence of latent learning was found. The question raised is how these results fit into alternative theoretical models.

The results of Exp. II pose real difficulties for a position of the traditional cognitive type. If some form of place learning or cognitive map is operative, it should function equally well in the free maze. While the free-maze condition is more complex than the classical, it is still readily soluble for *S* once food has been introduced. During the test trials, the reduction of number of stretches entered was about the same for *S*s in Exp. II as for the controls in Exp. I. Likewise, the suggestion that the choice points are perceived differently by *S*s in the two conditions seems unsatisfactory since in both cases there is a food expectancy—albeit of differing strengths—conditioned to the maze cues and *S*s are operating under moderately high deprivation levels.

For classical reinforcement theorists, the results also pose problems. If secondary reinforcement is one of the operative factors in explaining Exp. I, it is just as present in Exp. II. In both studies there are discriminable choice points. A general drive such as curiosity would be reduced in both situations. None of these explain why the experimental *S*s in Exp. II fail to profit to at least some degree from their extended exploration of the maze. If all that is being learned is a simple avoidance of blind alleys, it would seem preferable to use an explanation which is more directly tied to the difference between a blind alley and a free path. Thistlethwaite (1951) pointed out the difficulty experienced in suggesting such mechanisms in free-exploration studies in his review.

At a descriptive level, what is being learned is not to enter blind alleys; at the theoretical level, the task is one of explaining differential response strengths at the choice points.

The most economical interpretation seems to lie in some form of a probabilistic contiguity model. The *S* basically does what he did last time in the same stimulus situation. In Exp. I, the last response made to the discriminable cues of the blind alley ends was an avoidance response. On the next approach to the same set of cues, the avoidance is made somewhat earlier since the specific cues in question are now more strongly conditioned to the response than they were on the first approach. This process repeats itself on subsequent entries into the blind alley. Eventually a situation results in which a simple glance down the alley from the entry point may increase the probability of a true-path response. In Exp. II, the last response made to all alleys was normally one of approach. In Exp. I, the test trials, with both food and removal from the maze, permit the experimental *S*s to profit from their differential response probabilities. In Exp. II, there are no differential response probabilities and thus no profit.

An examination of the first trials on Day A for Exp. I shows an anomaly. The 10 control *S*s used a median of 18.0 stretches, while the 11 experimental *S*s had a median of 22.8. Since the experimental group showed a marked latent learning effect on all 4 days, this reversal, although based on a small sample, is interesting.

If the effect is assumed to be real, one factor involved might be that during both acclimation and exploration stages, *S*s were always in groups. Only on the test trials were they placed in the maze by themselves. This change could confound the differences in experience and lead to the apparent disruption of performance in the experimental *S*s.

Herb (1940) showed that in a latent learning situation, the introduction of reward into a blind alley served to increase the overall frequency of cul entries. Herb's results suggest that the situation may not be as simple as the above analysis would have it appear. A minimal explanation would be that not only are individual blinds being eliminated but that generalization is quite strong between the various members of the group. A more elaborate interpretation could well move toward a mediational or concept model.

The sudden decline in the number of latent learning studies in the late 1950s seems to have been partly the result of the apparent explanatory power of the renovated Hullian position. The use of incentive reinforcement, the fractional anticipatory goal response, and secondary reinforcement in a variety of manners served to offer explanations for most of the literature in the area.

More recently, the evolution of statistical models has had the effect of emphasizing formal differences between theories rather than controversies of the older contiguity-reinforcement type. While such models tend to lean toward a contiguity position, it is often from a desire for simplicity rather than an underlying conviction. Simultaneously an experimentally induced erosion in the drive-reduction position has led to a steadily decreasing gap between the two sets of theories. The preference of many current theorists is for a weak definition of reinforcement with an emphasis on the specification of particular situational determinants.

The results of the two experiments reported above seem to suggest not only that the original decline of interest may have been somewhat premature, but that a reanalysis of the area with more attention to the specific features in different studies might well be rewarding despite the admitted complexity of the experimental situations.

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