EXPERIMENTAL INVESTIGATION OF "LATENT LEARNING" IN MICE

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Abstract

To investigate the "latent learning" phenomenon, 114 male albino mice (age 90 to 110 days) assigned seven groups (4 experimental groups and 3 control groups) were made to run 2 mazes arranged specially for the purpose (one trial per day). The mazes varied only in length. Latent learning, either in the form of sudden drop in error rates or in the form of interference (negative transfer) was shown in all experimental groups. Also, a special kind of negative transfer (we call it "delayed interference") was shown in group 6

The topic of "latent learning" was introduced in 1929 by H.C. Blodgett for the first time in an article entitled "The effect of the introduction of reward upon maze performance of rats". It was the focal point of controversies among two belligerent camps in the psychology of learning. In Blodgett's experiment, 3 groups of hungry rats ran in a 6 allayed maze (rats belonging to the first group obtained food from the goal box in all trials and reduced their errors in a regular manner. Those from the second group received food from the eighth trial onwards and the rest just after the third trial. As can be seen in figure 5, the errors of both groups 2 and 3 dropped to the level of the first group (reinforced in every trial) almost immediately after these two groups were reinforced. As Deese and Haulse' (1967) put it:

«... since this type of learning apparently took place during non-reinforced trials, but became evident only in the presence of food, it was called latent learning». (Persian translation, page, 71)

one year later, Edward, c. Tolman examined the topic of latent learning (Tolman and Honzik, 1930) and reported:

«Honzik and myself repeated the experiment (or rather he did and 9 got some of the credit) with the 14-unit T-mazes and with larger groups of animals, and got similar results». (Tolman, 1948). Until 1951, of the q experiments conducted on latent learning similar to those of Boldgett, Tolman, and Honzik experiments, 7 supported Tolman's results whereas the other 2 produced contrasting results (Hilgard, 1956). According to Mac Coroquoudale and Meehl (1954), of the 48 experiments reported during the past 23 years-from 1929 to 1952 or is classifiable into 5 categories, the ration of positive to negative responses was 30:18. In any case, the wide support of «latent learning» phenomenon caused some difficulties for the reinforcement theory supporters. As Melon (1950) puts it:

«It is worthy of note that latent learning experiment may, under ideal conditions, disprove reinforcement theory, but failure to demonstrate latent learning does not prove reinforcement theory».

Thus, the latent learning phenomenon proved to be

an assured and convenient victory for cognitive theory Supporters. Among explanations of latent learning, the «Cognitive maps» hypothesis set forth by Tolman is the more famous. Tolman believed that during the nonreward period, the animal forms a cognitive map which is used only after the first reward.

«The substitution of the food at the end of the maze, a highly demanded goal-object, led the rat to use its cognitive map, to take the turns which led from one unit to the next».

(Hilgard Bower, 1975, Pp. 136)

«Cognitive map» points out to the knowledge that the animal gains, regardless or the absence of rewards. In one sense, cognitive map is synonymous with «schema» and «cognitive structure» which is the common core of cognitive theorists. Cognitive map, is certainly a metaphor, not something as precise as an intervening variable. But it is highly explanatory. This could be the reason why it has been so widely used in theorizing in personality, psychopathology, social psychology, and so on. Also in information processing theories encoding into short-term and long-term memories alters the contents to cognitive plans.

The goal of this experiment is to investigate the «latent learning» phenomenon and «cognitive map» hypothesis. In these experiments, latent learning was studied by special arrangements common in studying interference (negative transfer); and general conditions of latent learning experiments were repeated. Then, by changing the plans of mazes, the cognitive maps hypothesis was examined.

Method

Materials:

In the present study two six-branch mazes (A+B) were used (figure 1 in the index). The plan of maze B was identical to Blodgett's maze. Maze A was planned randomly, using coin-flipping to determine the right or left turns as correct responses. These two mazes were identical in all aspects except in plan. They were mad of 6 mm wood. The start box was covered with a piece of hard-board after the mice were put in it, but the goal-box had a glass covering. One-way wooden doors were used to check any possible return attempts to the boxes. All the maze alleys were covered with transparent plastic.

Lodging enclosures were different from the feeding boxes. The animals were held in metal cylindrical containers 60 centimeters in diameters and a height of 40 centimeters. Feeding boxes were made of cardboard in different sizes (A) 25x30, B) 35x35, and c) 30x40 Cms) all, 40 Cms high. The differences in size were aimed to neutralize the possible effect of the feeding places as a secondary reinforcement-a condition necessitated by the nature of the experiment. To neutralize the effect of lodging enclosures, the subjects were put in different lodging boxes alternately. Feeding and lodging enclosures had no covering during all stages of the experiment.

Subjects:

114 male albino mice (ages 90 to 110 days) were fed for 8 days before they were randomly assigned to 4 experimental group and 3 control groups. The daily food ration for each of the subjects consisted of 16 grams of ground bread given individually and once per day. Water was always available in both feeding and loading enclosures. But food was accessible only in the goal box and only on the basis of experimental arrangements. None of the subjects was maze-familiar, i.e. none had any previous experience with any maze.

Procedure:

Subject were randomly assigned to 7 groups, 4 of which containing 18 subjects each, and the remaining 3 groups each with 14 subjects. For the purpose of identification, groups were numbered from 1 to 7. Groups 3, 4, 5, and 6 served as experimental groups and groups 1, 2, and 7 as control groups. Each group had one daily trial and received its food ration once a day and on the basis of special experimental arrangements. Each daily trial took place almost 24 hours after any previous trial.

Group number 1, consisting of 18 subjects, ran maze B during all of the trials and always found food in the goal box and remained there for 90 seconds after which they were transferred to the feeding box where food and water was available. The subjects remained in the feeding box for 2 hours on average, and finally were transferred to the lodging enclosure.

Group number 2, containing 18 subjects, ran maze B but never found food in the goal box. They remained in the goal box for 90 seconds, then were transferred to the feeding box and their daily food ration was supplied almost one hour after they were transferred to the feeding box8 Almost 2 hours later, these subjects were transferred to the lodging box.

Group number 3, consisting of 18 subjects, ran maze B for all the trials, Experimental arrangements for this group were exactly the same as group number 2 for the first 3 trials and similar to those of group number 1 for the rest of the trials.i.e. they found no food in the goal box for their first 3 trials and one hour after being transferred to the feeding box, they were supplied with their daily ration. But from the fourth trial on wards, these subjects found food in the goal box as well as in

the feeding box, and 2 hours later, they were transferred to their lodging enclosure.

Group number 4, consisting of 14 subjects, ran maze B. The experimental arrangements for this group were precisely the same as group number 2 for the first seven trials, and similar to those of group number 1 for the rest of the trials. i.e. they found no food in the goal box during their first seven trials. They received food approximately one hour after transferring to the feeding box.

Group number 5, consisting of 18 subjects ran maze A for the first 3 trials and then ran maze B for the rest of the trials. in maze a, upon reaching the goal box, they found no food there, remained in the goal box for 90 seconds, after which they were transferred to the feeding box with no food in it. After about one hour, these subject received food in the feeding box and after nearly 2 hours, they were transferred to the lodging enclosure.

Group number 6, consisting of 14 subjects, ran maze A for the first seven trials and maze B for the rest of the trials. The experimental arrangements for these subjects were exactly the same as the first 3 trials of group 5 for their first seven trials, and from the seventh trial onwards, the same as those mentioned for group number 5 from the fourth trial onwards.

Group 7, consisting of 14 subjects, ran maze A in their first seven trials, and maze B for the rest of th trials. But in every trial upon reaching the goal box and receiving food, stayed there for 90 seconds, after which they transferred to the feeding box, received their daily ration of food and two hours later were transferred to the lodging enclosure.

No. of Subjects	groups \ trials	1	2	3	4	5	6	7	8	9and onwards
18	one	+ B	+ B	+ B	+ B	+ B	+ B	+ B	+ B	+ B
18	two	- B	- B	- B	- B	- B	- B	- B	- B	- B
18	three	- B	- B	- B	+ B	+ B	+ B	+ B	+ B	+ B
14	four	- B	- B	- B	- B	- B	- B	+ B	+ B	+ B
18	five	- A	- A	- A	+ B	+ B	+ B	+ B	+ B	+ B
14	six	- A	- A	- A	- A	- A	- A	+ B	+ B	+ B
14	Seven	+ A	+ A	+ A	+ A	+ A	+ A	+ B	+ B	+ B
114										

Table A. Summary of experimental arrangements*

(*) Signs mean receiving of rewards and (-) signs mean non-reward conditions.

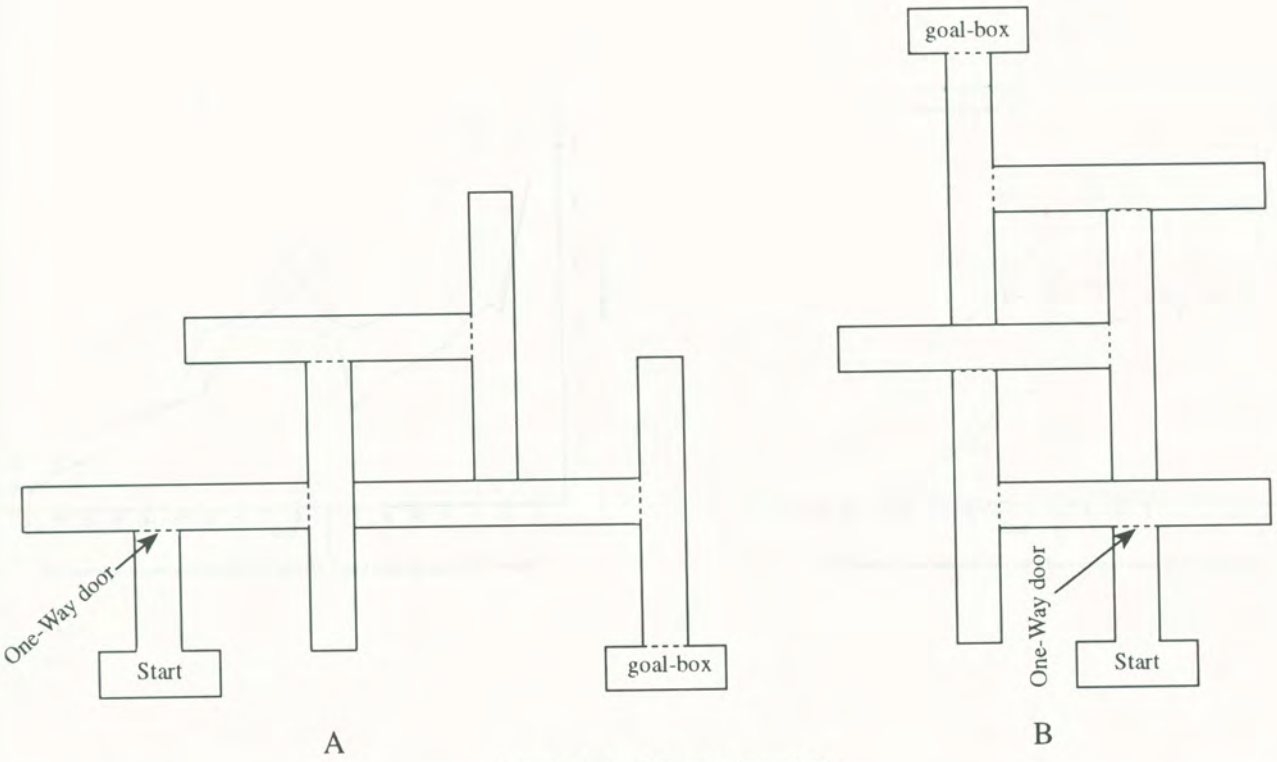
In these experiments learning criterion used was the same as that of Blodgett (1929), and Reynolds (1945); i.e. any wrong turn and any later returns to the wrong alley was considered as one error. A turn was considered as an error only if some parts of animal's body, except its tail, passed through half of the wrong corner, but if the animal turned the wrong corner and, before its second half of the body passed the corner, it returned back, it was not considered an error.

Results

Table B shows mean errors of the subjects and figures 1 to 4 show the same data graphically.

Trials \ Groups	One	Two	Three	Four	Five	Six	Seven
18		3.16				.35	.42
17		3.22				.71	.85
16		3.16				.92	1.21
15		3.27				1.14	1.5
14		3.38				1.57	1.64
13		3.33		.42	.44	1.85	1.85
12		3.22		.71	.77	3	2.07
11		3.16	.50	1.07	1.00	3.14	2.94
10	.38	3.22	.83	1.57	1.38	3.71	3.28
9	.72	3.22	1.05	1.92	1.55	4.28	3.50
8	.94	3.16	1.27	3.64	1.88	3.21	4.21
7	1.38	3.11	1.66	3.85	2.33	3	1.64
6	1.83	3.27	2.11	3.64	3.55	3.14	2.14
5	2.27	3.11	2.44	4	3.61	3.57	2.42
4	2.88	3.11	3.77	3.21	3.83	3.64	2.64
3	3.16	3.50	4.11	4.85	4.22	3.64	3.14
2	3.66	3.77	4.55	5.07	4.22	3.21	3.42
1	5.55	5.88	6.44	6	6	5.42	5.28

Table B. Mean errors for each Trial for seven groups of subjects.



Plan of the Mazes A and B

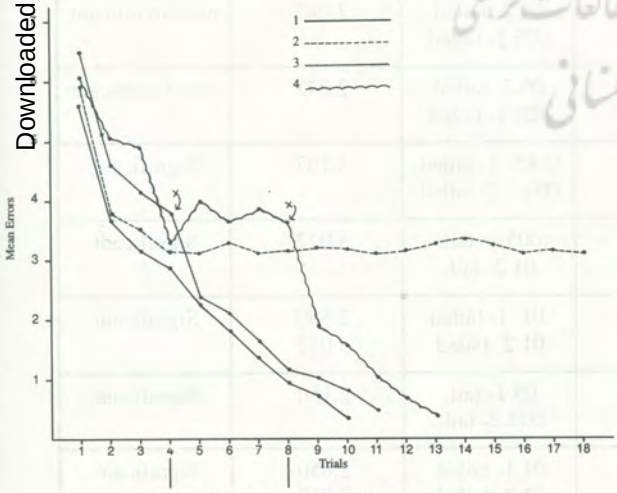


Figure 1. Error means for group 1 (always rewarded), group 2 (always no reward) for groups 3 and 4 first time of rewarding shown with an (X) sign

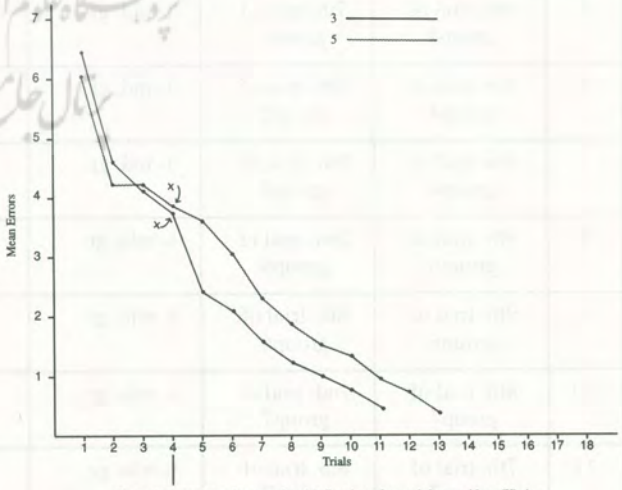


Figure 2. Error means for group 3 and 5. first time of reward shown with an (X) sign

Figure 3. Error means for group 4 and 5. first time of reward shown with an (X) sign

Figure 4. Error means for group 6 and 7 - (X) Sign Shows the first time subjects received reward.

No.	$\bar{X}_1$	$\bar{X}_2$	Test	Calculated Statistic	Level of Significance	Critical t in the Table	Significant or non-significant
1	5th. trial of group3	5th. trial of group1	t- ind. gr.	t = .43	.05 2- tailed .25 1- tailed	2.042	non Significant
2	5th. trial of group5	5th. trial of group3	t- ind. gr.	t = 2.95	.05 2- tailed .025 1- tailed	2.042	Significant
3	4th. trial of group3	4th. trial of group4	t- ind. gr.	t = 2.17	.05 2- tailed .025 1- tailed	2.042	Significant
4	4th. trial of group3	4th. trial of group5	t- ind. gr.	t = .32	.05 2- tailed .025 1- tailed	2.042	non-Significant
5	9th. trial of group4	7th. trial of group1	t- ind. gr.	t =1.45	.05 2- tailed .025 1- tailed	2.042	non-Significant
6	8th. trial of group4	8th. trial of group2	t- ind. gr.	t =1.02	.05 2- tailed .025 1- tailed	2.042	non-Significant
7	9th. trial of group6	9th. trial of group4	t- ind. gr.	t = 7.37	.0005 1- tailed .001 2- tailed	3.707	Significant
8	9th. trial of group6	2nd. trial of group6	t- rela. gr.	t =3.16	.005 1- tail. .01 2- tail.	3.012	Significant
9	9th. trial of group6	8th. trial of group6	t- rela. gr.	t =3.75	.01 1- tailed .01 2- tailed	2.650 3.012	Significant
10	8th. trial of group7	2nd. trial of group7	t- rela. gr.	t =2.24	.05 1- tail. .025 2- tail.	2.160	Significant
11	7th. trial of group7	8th. trial of group7	t- rela. gr.	t = 5.55	.01 1- tailed .01 2- tailed	2.650 3.012	Significant

Table C. Summary of Statistical Analyses

Conclusions and discussion

By looking at table B and figures 1 to 4 a reduction in error rat of the subjects in the second set of the trials, despite the kind of experimental arrangements grasps the observers' attention. The mean reduction is 1.82, which is larger than the daily reduction of group 1 (always rewarded group, which the reduction of error is .61). As it was mentioned, the mice were not familiar with the mazes. So one probable reason for these error reductions could be the animals' familiarization during the first trial with the mazes. The figure given in Blodgett's 1929 report shows the Possibility of error reduction by 1 unit without any rewarding of the subjects (figure 5 in the index). Such a reduction is observed from Toman and Honzik (1930) report with almost 2 to 3 units (see figure 6 in the index).

Another explanation for observed reduction may be the use of the learning criterion, in this case Blodgett's criterion. By this criterion, each repeated return to the wrong corner is considered as one error. The number of these returns on the first day is more than of the following days. And almost all of the subjects ran a wrong alley repeatedly on the first trial. In later trials, however, the animal does not usually return to the right alley which causes a considerable reduction in the errors of the following days, compared pared to those of the first day. It seems that distinction between two kind of errors (1: choosing a wrong corner, and 2: returning from the right corner to the wrong one) and collecting the measures related to these two kinds of errors would clarify the point. In the present study (like those of Blodgett's and probably of other studies) such a distinction has not taken place. We suggest that other investigators use several maze learning criteria, rather than only one, so that the animals' behavior in the maze could be examined from more varied aspects.

Group 3 subjects found food for the first time in their fourth trial in the goal box and in the fifth trial reduced their error by 1.33 on the average. As can be seen from table C, there is no significant difference between mean error of the fifth trial of groups 3 and 1 (group 1 was always rewarded) (see table 3). Also, group number 3, after receiving food in the goal box (on the fifth trial), reduced it's errors significantly in comparison with the fifth trial of group number 5 (table C, No. 2), where as such a difference could not be seen between the two groups on the fourth trial (table D). Furthermore, error mean of group number 3 on the fourth trial showed significant difference with that of group number 1 (table C, No. 3).

In Summary, tests 1, 2, 3, and 4 (table C) show that: 1) *in case of group number 3, latent learning did take place: 2) this latent learning was due to the formation of the maze map in the animals' mind during the time they ran in the maze without receiving any reward.* In other words, group number 3 that was rewarded after non-reward period in the maze B, was able to reduce its error rate as much as group number 1 that was constantly rewarded, because they formed the cognitive map of the maze during non-reward period (table C, No.1). On the other hand, group No.5 that was rewarded for the first time in maze B and spent their non-reward period in maze a (different from maze B) showed no significant error reduction (table C No. 1, 2, 3, 4). Error reduction in group number 5 on the fifth trial as compared to that of the fourth trial was .22, whereas the same comparison with group number 3 showed a reduction of 1.33 (more than six times as much). *These findings are fully compatible with Tolman's explanations of latent learning.* The only difference between groups 3 and 5 is in the plan of the maze they ran during non-reward period, and on the basis of cognitive map hypothesis, it is clear that having access to the «optimal map» was possible for group 3 only, or as Tolman puts it: «They had been building up a map and could utilize the latter as soon as they were motivated to do so». (Tolman, 1948)

Group number 4 was rewarded for the first time in its 8 th trial and in the next trial reduced its error rate to the amount of 1.72 and became significantly similar to group 1, i.e. to the level of the group that was rewarded consecutively (table C, No.5). While in its previous trial (8th trial), group 4 had no significant difference with group 2 that was not rewarded at all (table C, No.6). If we compare groups 4 and 6 on their ninth trial (i.e. the first trial after the rewarded trial) shows that error mean for group 4 is significantly less than those of group 6 (table C, No.7) In sum, it can be concluded that tests 5 and 6 of table 7 show that group 4 (the group that ran in maze B during non-reward period and was rewarded in the same maze for the first time), reduced its error rate significantly. In other words, subjects in group 4 were able to put in use what they had learned latently. Or we could say that *in the case of Group 4, as it was expected, latent learning took place.*

Group number 6, i.e. the group that ran maze A in the first seven trials without reward, and from the eighth trial onwards, ran maze B with reward, showed signs of negative transfer (interference). i.e. in the ninth trial showed a significant increase in its error rate compared compared with the second and eight trials. (table C, No. 8 and 9). In other words, relative to the previous trial (8th trial), group 6 had an average of 1.07 unit increase in its error rate and had almost the same amount error (1.06) as compared with the ninth trial of group 2

(always with no reward). *These latter findings imply the occurrence of negative transfer. The reason for such an implication is that group 6, had also a kind of latent learning but since this learning was related to a map (maze A map) other than the desirable map (maze B map), it caused disturbance in the performance of the animal in maze B. This is in complete agreement with the predictions of the cognitive map hypothesis.*

Group number 7 is the group[that was rewarded in all of the trials in maze A. Aglance to the numbers 10 and 11 of table C shows clearly the emergence of interference in the eighth trial (i.e. the first trial in maze) B), which is of course expected. *But this interference is different from that of group 6. For group 7, interference occurred in the eighth trial, i.e. in the first run in maze B, while for group 6, interference. took place in the ninth trial, i.e. in the second run in maze B (see figure 4).* That is to say, in the case of group 6, interference has shown itself with a delay of one trial. Here, we are seemingly encountered with a special kind of interference who may be called «delayed interference». The animal does not us what has learned about the maze as long as it is not rewarded, but, when it receives the first reward in the eighth trial uses its latent learning in the next trial (interference). Once, in an address to the APA, on the occasion of his presidency of APA, Tolman put it as follows:

«during latent learning the rat is building up a «condition» in himself, which I have designated as a set of hypotheses, and this condition-these hypotheses-do not then and there show in his behavior. S's are presented, but the corresponding R's do not function It is later, after a goal has been introduced which result in strong apatite, that the R's or as I would prefer to say, the B's, appropriate to these built-up hypotheses appear». (Cited from Reynolds, 1945).

References

Blodgett, H.C. (1929) The effect of the introduction of reward upon the maze performance of rats. *Univ. Calif. Pub. Psycho.*, 4, 113-134.

Deese, J. and Hulse, S.H. (1967) *The psychology of learning.* New York: Mc-Graw-Hill Book company (3rd. ed.).

Hilgard, E.R. (1956). *Theories of learning* (2nd ed.) New York: Appelton-Century-Crofts.

Hilgard, E.R. and Bower, G. (1975). Theories of learning (5th. ed.) New York: Appelton-Century- Crofts.

Mac corqudale, K., and Meehl, P.E. (1954). E.C. Tolman. in W.K. Estes, and others. *Modern learning theory.* New York: Appelton-Century.

Melton, A.W. (1950). Learning. *Ann. Rev. Psych., 9-30.*

Reynolds, B. (1945). A repetition of the Blodgett. experiment on latent learning. *J. Exp. Psycho., 35, 504-516.*

Tolman, E.C., and Honzik, C.H. (1930). Introduction and removal of reward and maze performance in rats. *Uni. Calif. Pub. Psy. 4, 257-275.*

Tolman, E.C. (1948). Cognitive maps in rats and men. *Psycho. Rev., 55, 189-208.*

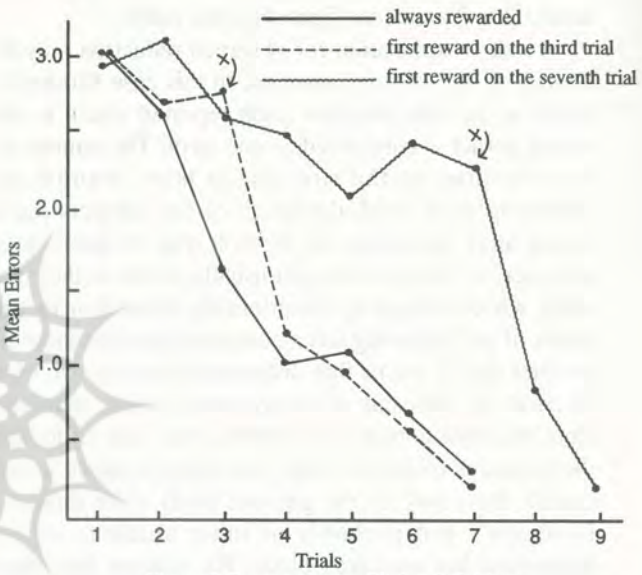


Figure 5. Error meams for Blodgett's Subjects. (X) Sign shaws the first time of receiving reward. (adapted from Blodgett, 1929).

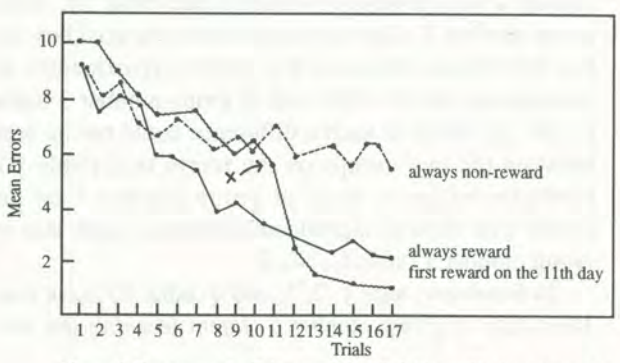


Figure 6. Error means for Tolman and Honzik Subjects. (X) singn shows the initiation of receiving reward. (adapted from Tolman and ttonzik, 1929).