ANTICIPATION AS A FACTOR IN MAZE ERRORS

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I. PRELIMINARY

Although much effort has been expended upon it, the problem of error elimination is far from having been satisfactorily solved. Many writers share the opinion of Hull (1) that "the question of how errors and unnecessary acts are eliminated is one of the most baffling theoretical problems that we have to face." Any experimentation which aims at an attack on aspects of this problem should have the virtue of providing material which may eventually lead to a formulation of the principles underlying these phenomena.

The present problem has arisen from certain results secured in an unpublished experiment carried out three years ago, which although incidental to the problem then in question, seemed to offer some significant data toward an explanation of error elimination. In this experiment rats were trained on the sectional maze built and used by Walton (10). The maze consists of eight similar units, each of which forces the rat to choose between making a left turn or a right turn when he enters the section. Removable glass plates at the ends of the pathways make it possible to have either the right or the left path the blind alley, as may be desired. The only variations from Walton's original setup were that in these experiments the maze and its floor-plates were supported by a wooden frame-work so that the maze was raised about 20 inches above the floor, and also that all the sections were laid end to end, making the effective direction the same throughout the maze. Environmental cues may be controlled very nicely in this maze as the various sections can be transposed, the floor-plates can be shifted about, the wire mesh section coverings can be rearranged, and finally the maze itself can be shifted about to different parts of the room.

A group of rats was trained in the maze with the succession of correct turns lllllll (i.e., the correct turns were all left turns). When they had mastered this problem they were required to learn the sequence rrrrrrr. Controls were trained first on the sequence rllrlrrl and then allowed to learn the rrrrrrr maze. The controls learned the second maze as rapidly as did the experimental group, showing that the capacity to discriminate the factor of regularity in a series of acts, if present in these rats at all, did not operate to increase the efficiency of the experimental group in learning this rrrrrrr maze.

TABLE 1

Showing the distribution of errors according to section of the maze, in the sequence RLLRLRRL

(N = 6)

	SECTION								TOTAL NUMBER OF ERRORS
	1	2	3	4	5	6	7	8	
1st five trials	21	19	20	14	15	13	20	19	141
2nd five trials	17	3	2	9	6	9	22	5	73
3rd five trials	15	10	11	10	10	12	22	6	96
4th five trials	10	1	10	2	2	5	29	1	60
5th five trials	8	0	9	1	0	4	29	4	55
6th five trials	3	0	10	1	3	3	29	1	50
Total number of errors	74	33	62	37	36	46	151	36	

This experiment when completed proved to be of interest chiefly with respect to the behavior of the controls in the "non-regular" maze—the rllrlrrl sequence. The control group in running this maze exhibited a long and serious plateau in its learning curve. In fact (although the animals were given only 30 trials each in this experiment) there was no good indication that they would ever have mastered this maze completely.

Table 1 is a tabulation of the errors made by this group, grouped for convenience into blocks of 5 trials each. The difficulty is seen to be a function of the seventh section of the maze—the next to the last point of choice before the food-box is reached. The correct choice at the seventh section is a right turn; that of the eighth, or last, a left turn. In this experiment the animals quickly established a habit of incorrectly turning left at the seventh section, a habit that became more strongly established as the number of trials progressed. In fact, only three times after the fifteenth trial did an animal *fail* to make an error (i.e., fail to turn left) in the seventh section. It would appear then that this error, instead of being performed less frequently and finally disappearing altogether as is the usual tendency where errors and useless acts are concerned, was becoming more firmly established with practice on the maze. This fact suggests that perhaps this error would persist as a permanent part of the behavior of these rats on this maze—i.e., that the maze would prove to be an insoluble one.

The performance on this maze also raises the question why there is this relative difficulty in the various parts of the maze, especially in the seventh section. The present paper is therefore an attempt to arrive at a solution of the problems mentioned directly above.

II. THE RLLRLRRL MAZE

In order to determine whether or not there was really a permanent plateau, and in an attempt to study in more detail this persistent error in the seventh section, another group of five rats was given an extended training on this same maze, until it became apparent that further trials would bring no further improvement. This condition was believed to have been reached when 100 trials had been given.

The rats used in the experiment were laboratory albinos of Wistar stock, about 100 days old when the experiment was begun. One run was given in the maze each day six days a week (except toward the end of the training period when two trials a day were frequently given), usually between two and four o'clock in the afternoon. The reward was a small piece of meat, usually hamburger, which the animal found in the food-box and was allowed to eat immediately. On concluding the day's runs, the animals were placed immediately in feeding cages and allowed to eat their daily ration for twenty or thirty minutes. Then they were put back into the living cages where there was no food and kept there until they ran the maze the following day. This insured a satisfactory hunger drive throughout the experiment.

Table 2 shows the distribution of errors, the trials being again grouped into sets five each. The last column of this table seems

TABLE 2

Showing the distribution of errors according to section of the maze, in the sequence RLLRLRRL

(N = 5)

	SECTION								TOTAL NUMBER OF ERRORS
	1	2	3	4	5	6	7	8	
1st five trials	20	11	17	16	11	18	13	17	123
2nd five trials	9	1	9	9	7	7	9	9	60
3rd five trials	3	1	4	4	3	4	9	5	33
4th five trials	5	1	5	8	2	9	10	6	46
5th five trials	4	3	5	9	2	8	10	0	41
6th five trials	7	3	9	6	1	5	18	5	54
7th five trials	9	2	12	12	0	6	20	9	70
8th five trials	4	1	15	11	3	7	16	7	64
9th five trials	7	5	10	9	2	7	20	8	68
10th five trials	7	4	12	5	4	5	21	5	63
11th five trials	2	0	12	3	4	4	16	6	47
12th five trials	4	1	12	1	1	5	19	3	46
13th five trials	2	1	11	4	0	2	21	0	41
14th five trials	1	0	7	3	1	1	22	1	36
15th five trials	3	0	10	3	5	4	20	2	47
16th five trials	3	0	11	4	3	2	21	1	45
17th five trials	1	1	8	1	0	0	22	1	34
18th five trials	0	0	10	1	0	0	20	1	34
19th five trials	0	2	17	2	5	4	22	4	56
20th five trials	4	4	9	3	2	3	20	1	46
Total number of errors	95	41	205	114	56	101	349	91	

to indicate that there is little promise of the rats' ever completely mastering this maze, as the performance on the third set of five trials was never bettered during the next 85 trials.

A table showing the individual performances on this problem would be much too voluminous to present here; moreover the writer feels that a short description of the individual differences in performance on this problem will serve the purpose as well as a table would.

The group consisted of five rats, A, B, C, D, and E. Three of the rats in the group, A, C, and D, were making errorless runs quite consistently from the tenth to about the twenty-fifth trial, rat D especially seeming to have solved the maze. From the twenty-fifth trial on, however, all three of the above rats began to make errors which persisted to the end of the experiment. Rats A and C made only one errorless run each from the twenty-fifth trial to the end of the experiment, while rat D would characteristically make 3 or 4 errorless runs and then make errors persistently for the next 10 or 12 runs, showing that he had not completely mastered the problem. The remaining two rats, B and E, did not make an errorless run during the entire experiment. The conclusion seems to be justified, therefore, that this group of rats was not able to master this maze, i.e., that this maze was an insoluble one in the sense that none of the group was able to run it consistently without error.

With regard to the distribution of errors, table 2 shows that this group repeated the results of the preliminary experiment; that is, there were more errors made in the seventh section than at any other point of choice in the maze. The next most difficult point of choice for this group, as well as for the animals in the preliminary experiment, was the third section, but in both experiments the difficulty of the third section was much less than that of the seventh, the ratio of errors in the seventh section to errors in the third section being about $2\frac{1}{2}$ to 1 in the preliminary experiment and about $1\frac{1}{2}$ to 1 in the present experiment.

Two different types of explanation appear to be plausible in accounting for the persistence of errors in this maze, especially the errors made in the seventh section. The first is that the performance in the seventh section appears to be about the same kind of behavior that Hunter (6) observed with his tri-dimensional mazes. Hunter trained rats on a sequence llrr using a tri-dimensional maze calculated to control sensory cues and found persistent errors at the second point of choice. That is, his rats tended with great regularity to run the llrr sequence in this fashion: lrrr. In attempting to account for this error, Hunter says (p. 523) that "the phenomenon is similar to that ordinarily discussed under the title 'retroactive influence of feeding.' I would rather regard the occurrence as an earlier appearance in the total behavior, of that type of response which leads immediately to food and the exit." The goal gradient theory of C. L. Hull, which will be discussed later in this paper, would also attempt an explanation of these phenomena in a similar fashion.

It is interesting to note here that Hunter was able to find persistent errors of this sort only with the tri-dimensional and temporal maze. He states (p. 534) that "the rat has shown his ability to master any complexity of bi-dimensional spatial maze. In the temporal maze he can master only with great difficulty, if at all, a combination as simple as llrr." Hunter seems in the above discussion to have ignored the sectional or the unit type of bi-dimensional maze with the possibilities of sensory control that are inherent therein, when he limits this sort of behavior to tri-dimensional and temporal mazes. The results which are reported in this paper indicate quite clearly that with a bi-dimensional unit maze of eight sections, and with the control of environmental sensory cues which such a maze affords, it should be possible to find several sequences which would prove to be insoluble to the rat. Two such sequences are reported in this paper, the rllrlrrl maze and the rrrrrrrl maze; other combinations may be readily elaborated from them.

The other sort of explanation which may be advanced to account for these results is one cast largely in terms of proprioceptive cues. This explanation would point out that errors are piled up at the third section to some extent as well as at the seventh, and would attempt to seek a cause which would account for both types of error. In the sequence rllrlrrl it will be noticed that in the seven instances where the animal passes from one section to the next, five of these cases involve an alternation from a left-hand pathway to a right-hand pathway, or vice versa; and the other two involve a repetition of the kind of pathway taken in the preceding section. It is quite possible that the rats in this group have formed an alternation habit; that is, that the responses involved in running a right-hand path set up cues leading to a choice of the left-hand path in the next section, and vice versa. Hunter (4) has described this sort of behavior more accurately as an "alternation after success" and has noted it as an easily established habit in raccoons as well as rats.

This sort of explanation would account for the fact of errors being persistent at both the third and seventh sections, without any recourse to a factor such as an anticipation of the turn leading to the food-box, because at these two points the animal may be said to be merely making an "alternation" (which in five cases out of seven is the correct response) instead of a "repeat" (which is correct in only two cases out of seven).

The possibility suggests itself that perhaps both these factors were operative in producing these results. That is, perhaps the establishment of an alternation habit accounts for the persistent errors at the third section and for a similar number of the errors made at the seventh section, while the factor of an anticipation of the turn leading directly to food accounts for the rest of the errors made in the seventh section, i.e., for the fact that errors were much more common in the seventh section than in the third.

However, the preponderance of errors in the seventh section may be held to be explicable in a simpler manner than that of invoking a factor of an anticipation of the last turn. It will be noted that when the rat comes to the third section he has traversed only one alternating pair of sections, while when he arrives at the seventh section he has traversed four such pairs. It may well be that this "alternation tendency" is more strongly established by the time the seventh section is reached, hence more errors at this point than at the third section.

This explanation being the simpler is to be preferred to one referring to a factor of anticipation. An anticipation of the turn leading to food may have been operative in the maze performance, but its presence cannot be proven because of the presence of other factors which offer a simpler explanation of the results.

It seems then that from the standpoint of being able to assign a satisfactory, unequivocal causal factor to the persistent errors present, the choice of the rllrlrrl sequence was a rather unfortunate one.

III. THE RRRRRRRL MAZE

In an attempt to show unquestionably whether or not this factor of anticipation[1] could operate in producing errors in maze running, another group of rats was trained on this same apparatus, this time using the sequence rrrrrrrl. This sequence will be readily seen to be a crucial one with respect to the two types of explanation advanced to account for the errors in the rllrlrrl maze. On the new sequence, if proprioceptive cues leading to the repetition of previous behavior units are the dominating ones in the maze-running behavior, we should expect to find the errors piled up at the last section (section eight) because of the fact that there are six "repeats" and only one "alternation" in this sequence. Hence running a right-hand pathway in one section should set up a strong tendency to choose the right-hand pathway in the next section, as this sort of behavior is correct six times out of seven.

On the other hand, if there is such a factor operative as an anticipation of the turn leading directly to food, it should in this sequence cause errors to accumulate in the seventh section and perhaps to some extent also in the sections directly preceding the seventh. Lumley (7, 8) working with human subjects on pencil and paper mazes, typewriter mazes, and other problems, found (*a*) that his subjects anticipated units further forward in the series in inverse proportion to the distance of these units from the point of choice, and (*b*) that as learning progressed the ratio of far anticipations to near decreased. If Lumley's results have a general validity and if the factor of anticipation operates in the manner that we have suggested above, then we should

[1] Anticipation, as used in this paper, is used in the same sense in which Lumley (7) has used the word. It refers to the experimenter's classification of the animal's response. That is, it seems to the experimenter as if the animal anticipates a turn which comes later in the series when he makes responses that are not appropriate but would be appropriate if given later in the series.

expect to find, in the present experiment, errors piled up to the greatest extent and persisting at the seventh section. To a lesser extent they should also be piled up at the sixth section, still less at the fifth, etc.

In this experiment albino rats were used, of the same stock as those used in the first experiment. Five animals were started on this maze, being from 80 to 100 days old when the trials started. One of the animals died after having run about 20 trials so that the results of this experiment are therefore limited to the performances of four animals. The procedure of running the animals was the same as that used in the first experiment, except that this group was given from two to four trials a day on the maze. Sections of the maze, floor plates, and coverings were shifted each day. Also the entire maze was shifted to a different part of the room twice during the experiment.

Table 3 shows the distribution of errors on the rrrrrrrl sequence presented in the same form as the data in tables 1 and 2. 100 trials were given each animal in this experiment, and since it appeared that further trials would not yield improved performance, the experiment was stopped at that stage. This point will be discussed later.

The table shows that in this experiment the seventh section is again the crucial one, the habit of turning left at this point becoming definitely established after a few trials and persisting with but minor fluctuations for the remainder of the experiment. The table also shows that left turns are made with lessened frequency from the seventh section back to the first. In fact, the results as a whole are the sort that are to be predicted if an anticipation of the turn leading to food is an actively operative factor.

Probably it would be more accurate to describe this anticipation as an anticipation of the character of the eighth section, rather than an anticipation of the turn leading directly to food. That is, the rat may be anticipating the fact that the right-hand alley of the eighth section is a blind alley as much as he is anticipating the fact that the left-hand alley of the eighth section leads directly to the food-box. In a maze, however, the designation of certain parts as blind alleys is a meaningless concept unless there is some sort of goal or end, or reward at the end of the maze, toward which these parts that we have designated as blind alleys bear some special relation. That is, there are no blind alleys in a maze at all unless there is also some part of the maze which rewards the animal for going to that part; those parts of the maze which hinder or obstruct the animal from reaching the goal thereby earn the designation of blind alleys, a designation which is justified only as long as they bear that sort of relation to the rest of the maze. It seems justifiable, therefore, to speak of this anticipation as an anticipation of the part of the eighth section that leads to food, since the food-seeking behavior of the trained rat implies the avoidance of blind alleys and other sorts of things that interfere with food-getting. The error scores show definitely the strong tendency of the animals to make the sort of response that leads directly to food before that sort of behavior is appropriate, that is, to act when they come to the seventh section (or often, to the sixth) "as if" they were in the eighth section.

Individual performances on this maze showed more uniformity of behavior than on the rllrlrrl sequence. One of the rats in this group had apparently solved the maze in the early part of the experiment, having made many errorless runs between the twentieth and the fortieth trials. At this point the maze was shifted in the room through an arc of 90°, and this animal at once began making errors which persisted for the rest of the experiment, showing that he had undoubtedly been depending upon some sort of environmental cue for the signal as to the proper place to turn left. The other three animals evidently were never able to utilize environmental cues for a satisfactory solution of the problem, as they were able to turn in errorless runs only once in a while and then never with any consistency. From the fortieth trial on, all the animals in the group were making persistent errors of the same sort and only occasionally did one of the group make an errorless performance.

Table 3 shows that the total number of errors made in each section for the 100 trials bears out Lumley's findings as to the nature of this anticipatory behavior. Errors are most frequent in the seventh section, are less frequent in the sixth, still less in the fifth, and less but about equal to each other in the fourth, third, and second. A good many of the errors in the first half of the maze occur during the first few runs and come as a result of back-tracking, a fact that many investigators have noted. The

TABLE 3

Showing the distribution of errors according to section of the maze, in the sequence, RRRRRRRL

(N = 4)

	SECTION								TOTAL NUMBER OF ERRORS
	1	2	3	4	5	6	7	8	
1st five trials	9	5	5	2	1	7	4	9	42
2nd five trials	4	3	1	1	3	4	8	12	36
3rd five trials	2	3	2	6	6	6	4	9	38
4th five trials	5	0	1	0	4	6	8	7	31
5th five trials	1	0	0	0	1	6	9	11	28
6th five trials	3	0	0	0	1	4	5	7	20
7th five trials	0	0	0	0	0	4	10	9	23
8th five trials	2	0	2	2	1	4	9	8	28
9th five trials	6	2	1	1	3	9	8	4	34
10th five trials	3	2	4	1	0	12	14	3	39
11th five trials	1	0	1	1	5	4	13	4	29
12th five trials	0	1	1	2	4	6	13	1	28
13th five trials	2	0	0	0	1	9	16	4	32
14th five trials	2	1	2	1	0	6	15	4	31
15th five trials	0	1	2	1	1	1	15	5	26
16th five trials	0	0	2	1	1	2	13	3	22
17th five trials	1	1	0	1	1	4	16	3	27
18th five trials	1	1	0	0	0	4	13	0	19
19th five trials	0	0	0	1	0	3	13	0	17
20th five trials	1	0	0	0	0	1	12	1	15
Total number of errors	43	20	24	21	33	102	218	104	

comparatively large number of errors in the first section is probably due to a tendency which appears occasionally for an animal to rush out "blindly" for several steps when released from the starting-box. This tendency has also been commented on by several experimenters. The large number of errors made in the eighth section is seen to be concentrated in the early trials, 75 per cent of them coming before the fiftieth trial. This shows that for a time the animals were evidently running the maze largely on the basis of repeating units of behavior. The response of running a right-hand pathway was offering cues causing a choice of the right-hand pathway in the next section, and so the animals were turning right at the eighth section instead of left. However, as soon as the animals began to anticipate this left turn, errors at the eighth section dropped off rapidly and, of course, errors at the seventh section increased rapidly. When the animals turned left too soon they would habitually keep on turning left at all succeeding sections, until finally a left turn would bring them to food. In other words, if a rat turned left at the sixth section, the chances were very good that he would also turn left at the seventh and eighth sections. The definiteness of this anticipatory behavior was nicely shown several times during the experiment by animals turning left at the seventh section and traversing it so rapidly and so "confidently" that they bumped their noses rather forcibly against the glass plate at the end of the blind alley.

Lumley's second generalization is also found to hold true for this experiment; that is, that "far" anticipations tend to decrease with respect to "near" anticipations as the learning series progresses. A glance at the error scores tabulated for section 5 and section 6 (table 3) shows that they fall off definitely as the trials progress, while the errors tabulated for section 7 reach a maximum at about the fiftieth trial and then continue at that level with but minor fluctuations for the remainder of the experiment.

The behavior exhibited on this sequence also bears out experimentally many of Hull's (1, 2, 3) theoretical implications, especially those relating to his "goal gradient hypothesis." It is not intended in this paper to regard Hull's hypothesis as a fundamental explanation of animal behavior. Many experimental facts could be cited that are opposed to certain of the principles of behavior to be deduced from this hypothesis. Nevertheless, the goal gradient hypothesis does provide us with a good descriptive account of the sort of behavior that we find under many problem conditions, including the situation provided by the present maze sequence. Hull's hypothesis, to state it briefly, is that (3, p. 26) "the goal reaction gets conditioned most strongly to the stimuli immediately preceding it, and the other reactions of the behavior sequence get conditioned to their stimuli progressively weaker as they are more remote (in time or space) from the goal reaction. This principle is clearly that of a gradient, and the gradient is evidently related somehow to the goal." Describing the behavior observed in the rrrrrrrl maze in terms of this principle, one would say that the response of making the turn which leads directly to food should become most strongly conditioned to the stimuli immediately preceding it, especially to the point of choice in the seventh section. Hence the tendency to turn left at this point would be stronger than at any other point in the maze preceding the eighth section, and would be progressively weaker at points of choice more and more remote from the food-box. An examination of table 3 indicates clearly that this is what has taken place in the present experiment.

The increasing strength of the tendency to turn left as more and more sections are traversed is shown clearly in figure 1, in which is indicated the total frequency of left turns for each section of the maze. It is interesting to note that the values of the ordinates of this graph resemble to some extent the left-hand half of a normal probability surface. In fact, if one throws out the first few trials in which back-tracking was frequent, the resemblance is quite striking.

One is tempted to speculate on whether the frequency of left turns would fall off in a similar fashion past the eighth section. That is, if a sectional maze were used with the sequence rrrrrrrlrrrrrrr, would the distribution of the frequency of left turns have its mode in the eighth section, with frequencies in the neighboring sections corresponding to a normal distribution? The data of figure 1 lead one to suspect that such might prove to be the case. If it were, the presentation of such results would involve highly interesting theoretical speculations. The writer intends to attack this problem in the near future, along with certain others that have arisen as a result of this paper.

Certain questions suggest themselves at this point:

1. Is this maze an insoluble one?
2. Why did not the behavior of the group reach a stage where all the rats were making errors at the seventh section on every trial?
3. How does this factor of anticipation function in terms of stimulus-response units?

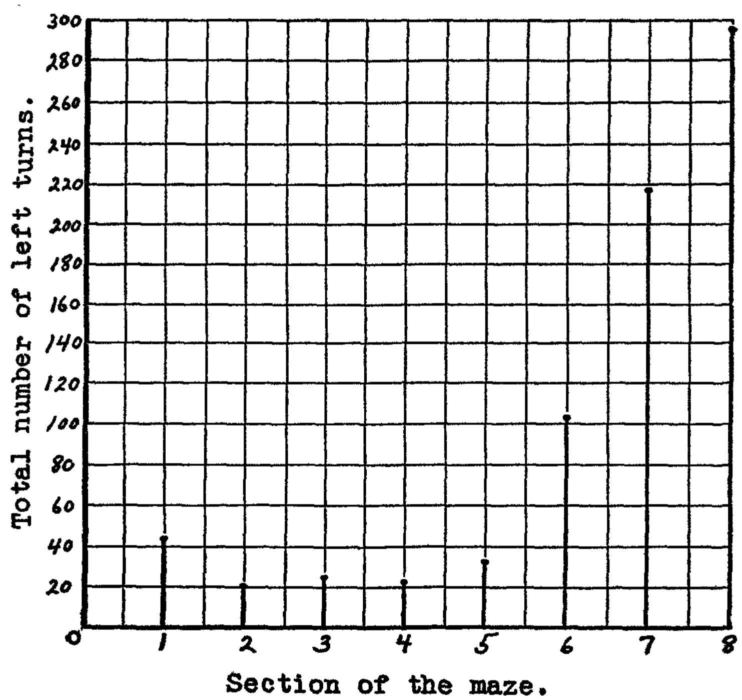

FIG. 1. SHOWING THE TOTAL NUMBER OF LEFT TURNS MADE IN EACH SECTION OF THE MAZE. (N = 4)

The only conclusive answer to the first question would be the accumulation of data covering the running of a large group of animals for several hundred trials, using this sequence. However, certain characteristics of the data gathered in these 100 trials make one feel rather confident of the results to be expected if an extended series were given. Table 3 shows that in the neighborhood of the fiftieth trial the rats were turning left at the seventh section about 70 per cent of the time, and also that this proportion was maintained with but minor variations for the remainder of the trials. There are, of course, two factors causing left turns at the seventh section, one of which we may designate as chance and the other as anticipation. The left turns due to chance are eliminated early in the series by training, while the left turns due to anticipation persist and show a tendency to be localized at a definite point in the maze, namely the seventh section. Table 3 shows that the only improvement in performance from the fiftieth to the one hundredth trial is in the elimination of most of the "far" anticipations, while no such tendency is shown for the "near" anticipations to be eliminated. This means that this factor of anticipation has become definitely localized in the seventh section, thus decreasing the variability of performance of this group of animals.

If this left turn may be described as an anticipation whose operation resembles somewhat that of a gradient, and if internal and external conditions are maintained, it seems reasonably safe to assume that this gradient will continue to be operative no matter how long the training series may be. If a rat did learn to run this sequence consistently without error and if it could be proven that environmental factors were not offering cues, then it would be necessary to attribute to the rat a more refined capacity for distance perception or quantity perception than that animal has been shown to possess.

With regard to the second question, Tolman (9), in describing the formation of serial response behavior, noted that the animal in a problem situation has often to learn to "hold in leash" certain responses and release them when (but not until) the environment becomes favorable for such behavior. Hull (1) asserts that there is a strong tendency for the organism's responses to be run off faster than the corresponding environmental sequence presents itself. It may be then that in this experiment the animals have learned to hold in leash this left-turning response until the proper environmental situation is encountered (i.e., the eighth section), but that it is a very difficult, perhaps an impossible, task for the rat consistently to hold in check this left turn until the proper time over an extended series of trials. This would offer a plausible explanation of the fact that errorless runs appear from time to time, as well as the fact that errors are distributed in the way that they are.

In answering the third question it seems hardly necessary to say that the fact that certain aspects of the behavior examined in this paper were labelled "anticipatory" does not imply in the least an identification with non-physical entities. It should not be too difficult a task to show by appropriate diagrams this anticipatory behavior as an instance of the familiar principle of conditioning. In fact, Hull (2) has attempted this very thing in his theoretical discussion and has shown how goal attraction, purpose, directing ideas, and anticipatory behavior can be described in terms of random behavior with subsequent conditioning, fixation, and elaboration. His diagrams also suggest the functioning mechanisms of these processes.

IV. CONCLUSIONS

As implied above, the fact that the groups of animals used in these experiments were small in number makes any generalizations from the data obtained indicative rather than conclusive. However, an examination of these data seems to warrant certain generalizations.

First, there are bi-dimensional maze sequences that give strong indications of being insoluble for the rat when the unit or sectional maze is used with the proper control of environmental cues.

Second, there appears definitely to be some factor (which for convenience we have called anticipation) present in the second of the experiments described above, which causes persistent errors to be made at the next to the last point of choice in the maze. This factor tends to cause the sort of behavior which leads the rat directly to the food-box to appear before such behavior is appropriate.

V. SUMMARY

Rats were trained on a bi-dimensional sectional maze in which environmental cues were assertedly controlled on the sequence

rllrlrrl. The rats failed to learn this sequence in 100 trials, persistent errors occurring at the seventh point of choice and to a lesser extent at the third point of choice. The fact of persistent errors at both the third and seventh points of choice pointed to the probability of the building up of an "alternation after success" habit, but the fact of many more errors occurring in the seventh than in the third section suggested the possibility that some other factor (such as an anticipation of the character of the eighth section) may have been operative.

Other rats were trained on the same apparatus with the sequence of correct turns, rrrrrrrl. They failed to learn this sequence in 100 trials, persistent errors occurring at the next to last point of choice, as was the case in the first sequence. In this sequence, however, behavior of an anticipatory nature is believed to have been definitely indicated.

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