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An Experimental Study of the Effect of the Introduction of an Intellectual Factor in a Problem of the Motor Learning Type

Ernest Vernon McClear
Loyola University Chicago

AN EXPERIMENTAL STUDY OF THE EFFECT OF THE INTRODUCTION OF AN INTELLECTUAL FACTOR IN A PROBLEM OF THE MOTOR LEARNING TYPE

BY

E. VERNON McCLEAR, S.J.

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VITA AUCTORIS

Ernest Vernon McClear was born in Detroit, Michigan, on October 20, 1909. He completed his grammar school training at St. Mary Academy, Royal Oak, Michigan. He attended the University of Detroit High School, graduating in 1927. He received his A.B. degree from the University of Detroit in 1931. In 1934, he received his M.A. degree in Greek from Xavier University, Cincinnati, Ohio. During the following two years he studied philosophy and psychology at West Baden College of Loyola University. During the scholastic year 1936-1937, he taught the classics at St.Ignatius High School, Chicago, Ill. During the scholastic year 1937-1938, he held a Fellowship in the Department of Psychology at Loyola University, Chicago, Illinois.

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CHAPTER I

INTRODUCTION

Psychology, like every other science, has its definite subject matter. As a complete science it should endeavor to discover the ultimate principles which underlie the conscious life of man. Again, as in the other sciences so too in psychology a division of labor makes for efficiency. As natural philosophy utilizes the natural sciences of physics and chemistry as sources of data, as a complete ontology bases its laws upon the data gathered by all the natural sciences, so too a complete psychology needs an experimental as well as a philosophical branch. We must have a "psychology of fact," as well as a psychology of ultimate causes. As Lindworsky says:

> Experimental psychology...is closely related to philosophical psychology. The experimental psychologist must have solved at least a part of his task before the philosopher can even begin his; that is to say, at least some of the primary facts of mental life must be determined, observed, and described, before conclusions regarding the ultimate causes of such facts can be arrived at. It may be presumed that the two sciences will not attain an exact knowledge until the conclusions of the philosophers are made more widely applicable and more secure by the support of the facts discovered by experimental psychology. Experimental psychology is, therefore, an indispensable auxiliary science to philosophy. (12:4)

In this day of positive science it is unnecessary to defend the existence of experimental psychology. It is, however, necessary to remember that experimental psychology is a science with a definite purpose and a definite function. Willingly do psychologists admit that a break has occurred between psychology and philosophy. Many, forgetting the purpose of an experimental science, hope to make that break absolute, to set experimental psychology up as a complete science independent of all philosophy. To treat experimental psychology thus would be to degrade it; it would become an incomplete whole instead of the complete and essential part it truly is. The purpose of experimental psychology is to discover the relationships which exist between phenomena. For this purpose it is eminently fitted, the method of experimentation being ideally suited to the exact determination of facts. Once the facts have been carefully observed and catalogued and the directly accessible connections between facts have been stated, the task of the experimentalist is at an end. Then, either the experimentalist becomes philosopher, which, alas, he frequently does without the necessary philosophical background, or, more reasonably, the facts are presented to the philosopher to be used as building blocks in the edifice of truth.

Experimental psychology, like all the experimental sciences, derives its chief value from its ability to control conditions. Repetition of an experiment and variation of conditions enable the experimentalist to discover the true nature of the phenomenon under consideration. Thus it is possible to discover the various factors which enter into the learning process and to discover the factors which differentiate the learning process

of the animal from that of man. It is necessary here as elsewhere, however, to present the facts as facts, and to await a complete array of facts before drawing a final conclusion.

A conclusion based on an incomplete examination of phenomena is very likely to be erroneous. For example, it is quite evident to even the superficial observer, that the learning processes of men and animals are at times very similar, perhaps identical. Attending strictly to this observation and basing our studies upon it, it is possible to conclude that both men and animals learn by "cue reduction," and that men learn more efficiently than animals because they are able to pack far more into a "cue" than is the brute. Such a discovery tells us something about the learning process in general and gives us some distinction between human and animal learning, but is by no means a complete explanation either of the learning process or of the distinction between the two modes of activity. Our attention has been fixed on the similarities in the two processes, with a consequent neglect of important differences. The observation that the learning processes of men and animals are at times alike must be balanced by the further observation that at times these learning methods differ, and differ greatly.

This empirical, even casual, observation is a necessary prelude to experimentation, for all experimentation is based, to some extent, upon hypothesis. There would be no reason to experiment if we already knew the complete answer. But it is equally true that there would be no occasion for experimentation unless we at least suspected the answer. Unless we suppose that there are factors to be isolated we cannot arrange an adequate experimental procedure. In the present experiment we intend to study the

effect of certain intellectual factors in human motor learning. The experiment assumes, therefore, that such factors exist. What are the grounds for this assumption? Observation, which leads to the conclusion that man's intellectual ability assists him in the solution of problems.

Everyday experience forces upon us the conclusion that man has the power of comparison. Two golf balls may be separated from a tray containing many objects and labelled "alike" because of their superficial resemblance. These same two balls may be called "different" if it be observed that one has round dots while the other has square dots. Qualities of the two are compared, a process which supposes the power of abstraction, the ability to separate mentally and attend to one or more features of an object to the exclusion of the rest, an ability manifested whenever one uses a simile. We attend to a part of the total impression of both objects and note the relation which exists between the parts. This power of abstraction, as Lindworsky notes (12:155), is a different function than that of pure sensory apprehension. The knowledge of relation is not only an irreducible conscious content, but also an experience which cannot be reproduced by sensational means; it is of a different category than are sensations and images or their complexes. Cognitive relations are essentially distinct from these latter and belong to that higher class of experience designated by the term "thought." Although the terms of the relation are frequently sense objects, although the relation is necessarily expressed by a word or sign, still the knowledge of the relation between the terms is immaterial and abstract. The ability to perceive an abstract relation must be classed as an intellectual power.

Intellect is broadly defined by Maher (13: 231) as "the faculty of thought," including under thought such specific abilities as attention, judgment, reasoning, and the formation of general ideas, all of which acts exhibit a distinct supra-sensuous element. Garrett's enumeration of the peculiar powers of man (3: 120) will be seen to parallel this definition. Commenting on the puzzle experiments of H.A. Ruger, Garrett states that "the ability to formulate general principles, evolve concepts, and educe relations of a symbolic kind would ... seem to be strictly a human accomplishment." This, if it be so, and experimental results point to this conclusion, is sufficient justification for an experiment in the learning field which still gives room for the play of peculiarly human abilities.

Although it is evident that the perception of relations plays an important part in man's peculiarly intellectual acts, it is not so clear what effect is exercises in the solution of motor problems. What effect, if any, would the perception of a relation between two similar motor problems have on the solution? That effect the present experiment will endeavor to discover. Specifically, the present experiment aims to create a situation where a definite relation exists between two problems, both of which can be solved by "trial-and-error learning," and to determine whether or not the relation between the two problems will be perceived, whether this relation so perceived will have any effect on the learning and, if so, what effect. To bring out clearly the effect of abstraction and the perception of unity amidst diversity, it seemed best to present two problems where some of the elements were identical but where also a relation of opposition could possibly be perceived, and to determine, by means of a

control, what effect the noted relation had upon the learning.

To this end the following experiment was devised. A stylus maze, which will be described later, was learned by the subject, chiefly by the "trial-and-error" method. When this maze had been mastered, a second maze which had a definite relation to the first was introduced. This second maze was the mirrored image of the first, being so mirrored that the horizontal moves were reversed while the vertical paths remained the same. It was to be supposed that if the first maze had been mastered and the relation of the second to the first were grasped, the task of the subject would be much simplified and the "trial-and-error" procedure of the first maze abandoned for a supposedly superior intelligent mode of procedure. Since there is some positive transfer of training in maze learning, as has been noted by Webb (20) among others, it was necessary to have a control group learn a maze of equal difficulty with the mirrored maze after their mastery of an unrelated maze. Thus the amount of transfer could be determined and, all things else being equal, the amount of improvement in excess of that due to transfer of training could be attributed to the perception of the relation between the mirrored maze and its counterpart. The mazes will be described later and the experimental procedure more fully explained.

Of several possible techniques a stylus-maze problem seemed best suited to the purposes of this experiment. In the first place, the maze experiment affords a wealth of objective results, since it is possible to judge learning on the basis of either trials, time, or errors. Then, too, the stylus-maze experiment provides a thought-provoking parallel to animal-maze experiments, especially in view of Perrin's conclusion that the human

learning process in the maze is the same for both stylus and "life-sized" mazes (16:220-221). A third reason was the fact that the initial difficulty in the stylus-maze was approximately equal for all the subjects, since this maze provides a situation previously unfamiliar to the learner. This seemed to lessen the chance of individual differences in experience jeopardizing the results. Again, since the subjects were not hand-picked but were selected at random, the fact that Husband (7) and Perrin and Gould (4) find the correlation of maze learning with intelligence to be very slight was another favorable portent for the reliability of the experiment. Finally, the conclusion of Peterson (17) that trial and error appears to be the universal method of procedure in learning of the problem-solving type and his agreement with Thorndike that thinking and reasoning are in no useful sense the opposites of automatism, custom or habit, served as a challenge to construct a problem which would investigate further the effect of thinking and reasoning in a motor-learning problem.

In conclusion we may say that it is not the purpose of this experiment to contrast human powers of learning with those of brute animals. We are content to determine here whether, even in a simple motor task, man's efficiency is improved by his ability to understand the relation which exists between two problems and to base his action upon this understanding. The logical conclusions from the facts reported in the experiment may be drawn by philosophers. This experiment rests with its factual findings.

CHAPTER II

BACKGROUND

An examination of current psychological periodicals reveals a wealth of maze experiments. For the most part, however, the mazes are animal mazes and the experimenter is concerned with animal learning. The results of these experiments may be of value to the student of human learning or may apply only to the animals used in the experiments. The only maze results which can, without assumption, be applied to human learning, are those obtained from the study of human reactions in the maze. Fortunately, during the past twenty-five years various experimenters have used the maze technique in their study of human abilities.

Maze experiments on human learning have chiefly utilized the stylus maze. According to Knotts and Miles (10:417), investigators of the history of the stylus maze, the first publication concerning such a case is that of Perrin in 1912 (15) in which he mentions a pencil maze to be traced by a blindfolded subject. It is certain that Perrin played an important part in the evolution of the stylus-maze experiment. He followed up this first article with a monograph in 1914 (16) in which he describes an experimental study of the human learning process. It is in this monograph that he describes his experimental comparison of the "life-sized" and the "pencil" or "stylus" maze, from which comparison he was able to conclude that the

human learning process was the same process in the two types of maze, and thus to justify the use of the stylus-maze results for the purpose of comparison with the results of animal-maze experiments. Here, too, he describes exactly his experimental procedure, his instructions to the subjects, his method of scoring errors, and the criteria for learning, all of which have been adopted to some degree by subsequent experimenters. The experiment led him to the conclusion that the human adult does not learn complicated segments of the maze unconsciously but must employ conscious processes of discrimination, memory, and other human abilities. He found too, as others have subsequently found, that the learning process in the maze is divided into two chronological stages; that of the first few trials in which the subject notes the general scheme of direction, and the second, of longer duration, during which the subject studies the separate segments as separate problems. Again, as was to be expected in a problem of this kind, he found that the rational processes of the subject were seemingly futile and that the subject was forced to prolonged exploration for the solution of the maze. He notes the fact that cues were disregarded, that ideas were acted on uncritically until proved false through trial and error, and very logically explains the meagre attempts at reasoning as due to the lack of past experience applicable to the maze problem.

In the course of the same experiment Perrin rotated his mazes 180 degrees and found that the subjects learned them with very little difficulty. A mirrored maze, too, proved easy for his subjects. It is to be noted, however, that in the case of both the rotated and the mirrored maze Perrin's subjects were told of the nature of the change. Later experiments, notably

those of Higginson (5) and Scott (18), show that neither the rotation of the maze nor the use of a mirrored reversal result in striking improvement if the change is made without the knowledge of the subject.

In 1916, Perrin collaborated with Gould in another maze experiment (4). In their report the experimenters note the definite effect of chance discovery on maze learning, and raise the question whether the maze is a fair test of any type of learning. The fact that chance is an unmeasured and probably fluctuating factor forces them to the conclusion that there is no exact correlation between intelligence and efficiency in maze learning. The very fact that the subject must resort to the plodding procedure of trial and error handicaps a subject with a fertile mind who spends much time in testing his theories. Although intelligence does frequently defeat its own purpose in maze learning, the experimenters conclude that it is equally true that stupidity correlates with poor maze records. This fact is seemingly due to the inability of the stupid subject to analyze his maze experiences.

Since these first publications of Perrin, various experimenters have made use of the stylus maze, with, as Knotts and Miles note (10) differences in patterns and no consistent practice with regards to the length of the true path or the ratio of the length of the true path to that of the culs de sac.

In 1917 Webb took up the problem of transfer of training in maze learning (20). In his experiment all subjects learned maze A and were then divided into groups, each of which learned a different maze. This division was designed to investigate the dependence of transfer upon the character

of the second problem. The transfer effect was measured by the difference between the original learning and the "transferred learning." It was shown that the total effect was a positive transfer according to all three criteria of trials, time, and errors. There was also, however, a negative element, the inhibition set up by the first problem. A positive correlation was found between the degree of transfer and the difficulty of the second problem, and also between the degree of transfer and the similarity of the two maze patterns. A positive correlation was also found between any two of the three criteria of measurement. The conclusions of this experiment have been called in doubt by Higginson (5), who points out the difficulty of determining reliably the actual degree of similarity between physically dissimilar maze patterns. This difficulty Webb thought he had overcome by having nineteen individuals rank the mazes according to their similarity to maze A, judging the similarity according to relative position of the true pathways and the culs de sac, the direction of the course of travel, and the relative difficulty of mastery. Although Higginson's objection invalidates the conclusions as to the correlation between the degree of transfer and similarity of pattern, it does not affect Webb's conclusion that the total effect is a positive transfer.

As noted earlier, Peterson (17) concluded from his maze experiments that trial and error was the universal method of procedure in learning of the problem-solving type. The simple motor problem which his subjects solved probably offered little opportunity for the exercise of a higher ability.

In 1926, Koch and Ufkess (11) conducted an experiment in maze learning

with blind and seeing subjects. Two of their conclusions are worthy of note. First, they report that "the intelligence of the subject determines, in part, the ease with which he masters the maze " (p.131). Their second conclusion was that "blind subjects tend to be less successful, on the average, in maze learning of the stylus variety than are normal subjects" (p.131).

Three years later Knotts and Miles (9) obtained opposite results from a similar experiment. They found that "the blind show median scores indicating somewhat better success than the sighted in number of trials, total errors, and total time for both mazes." They found, too, that, although learning curves are of the same character for both raised finger mazes and stylus mazes, the raised maze, which affords direct cutaneous contact, is much easier for both blind and seeing subjects than is the stylus maze.

This conclusion that the high-relief maze is more easily mastered than a stylus maze of the same pattern was not a new discovery. It had already been indicated by the results of experiments of Husband (6) and Nyswander (14).

Interesting from the point of view of the present experiment is the work of T.C. Scott. Seeking to determine the effect of retention and recognition of maze patterns, he performed an experiment, reported in 1930 (18), in which he employed not only similar patterns, but also mirrored reversals and even identical patterns. The subjects in this experiment learned one maze per day, and were given twenty-four hours of rest before beginning the succeeding maze. Scott's results agree in general with those of earlier investigators, but bring some new points to light. From the

quantitative results obtained from the relearning of the same or a similar maze, he concludes that it is evident that a pattern is retained in memory and aids in the relearning of a similar maze, especially if no third problem intervenes. He notes, too, that this retention in memory of a maze pattern may, under some conditions, prove a handicap in learning a maze with similar elements. Interesting is a third conclusion, namely, the fact that "frequently the pattern functions entirely non-consciously. The subject does not recognize the fact that he is relearning the same or a similar maze." (p.206) Subjects may make fine scores without realizing that they are working a maze similar to the first. The fact that Scott used a finger maze of only twelve moves and of comparatively simple pattern may account for some of his results. It may explain how the help derived from learning a maze nine of whose moves were identical with those of a second maze and the help derived from learning a maze which was the mirror reversal of the second were about the same. It may account, too, for the surprising fact that out of thirty-seven subjects who learned a maze and were then given its mirror reversal, only one subject recognized the relation of the two, and of two others who suspected the relation, only one seemed to profit by his suspicion. In Scott's experiment the few subjects who recognized identical mazes or were aware of some similarity seem to have had this recognition aroused purely by kinaesthesis, recognition being based entirely on motor findings. Scott also noted that recognition came suddenly and seemed similar "to what has sometimes been called 'insight'."

In 1931 R.W. Husband (7) did further work on the problem of transfer in maze learning. He found that greater profit is derived by the learner

who passes on to a similar task than by the learner who undertakes one somewhat different, a conclusion in agreement with earlier findings in this field. Later, the same experimenter (8) tested the result of previous instruction on maze performance. He found that an instructed group learned with greater speed, although, as was to be expected, not all profited equally from the instruction and some made poor scores through carelessness or lack of insight. In this experiment Husband endeavored to relate maze performance to intelligence, using as his norm the total time consumed in learning, this norm being adopted in view of the results of the 1931 experiment.

In 1936 Scott (19) tested the effect of minor variations of maze patterns and found evidence to support the view that long moves in the middle of the maze decreased the difficulty of the pattern and that short moves, especially in the last part of the maze, resulted in increased difficulty.

Higginson (5) recently studied human learning with a rotated maze. He rotated the FosterA maze four times with each of fifteen subjects. He attempted to show that the high degree of transfer of training between two similar mazes depends upon the discovery of the relation of similarity. An interesting sidelight is the fact that no one made a striking improvement on any of the four rotations; the average of thirty-three trials for the first position was reduced only to twenty-five for the second position and to eighteen for the third and fourth.

This brief resume of the experimental work on human maze learning gives some background for the present experiment. We see that the maze experiment

is not something new and untried, that mirrored mazes have been used in previous experiments in human learning, sometimes as a distraction or merely to measure the retention of learned material, sometimes with the knowledge of the subject, but at least in one instance (18) without the knowledge of the subject.

We find that there is a positive transfer from one maze to another, the amount of which must be determined in our experiment by the use of control groups. We note, too, that both Webb (20) and Scott (18) found that an inhibition was set up by the first problem. This inhibition, presumably greater when the problems are more similar, would be very high between two mazes so closely related as are our mirrored mazes. However, we need not attempt to measure this negative element. If the mirrored mazes prove harder to master than the second unrelated mazes, this inhibition may partially account for the greater difficulty. If the mirrored mazes prove easier, in spite of the inhibition, so much the greater is the effect of the perception of relation.

This experiment differs from that of Scott (18) by the fact that herein we use a stylus maze instead of the less difficult finger maze and, secondly, here our specific object is to determine whether or not the subject will recognize the relation which exists between the two mazes and, if so, what effect such recognition will have on maze performance.

CHAPTER III

THE EXPERIMENT

This experiment was conducted in the psychology laboratory of Loyola University, Chicago. It ran intermittently from November10, 1937 until April 10, 1938. The time of experimentation was fairly evenly divided between a morning period which extended from ten o'clock until noon and an afternoon period which began at two and ended at four.

Subjects

The subjects were, for the most part, college sophomores. All were unacquainted with the maze experiment and inexperienced in laboratory methods. Volunteer subjects were accepted without any attempt at selection. It is the opinion of the experimenter that the subjects used in this experiment represent a cross-section of the student body. The scores of only forty-eight subjects appear here. These were the subjects who completed the experiment under exact experimental conditions. Twelve other subjects were used in the preliminary work of perfecting the technique of the experimental procedure.

Apparatus

The apparatus used in this experiment consisted of a blindfold, a

stop-watch, a stylus, four mazes, and a clamp to hold the mazes to the table.

A folded piece of cleansing tissue under a pair of sun-glasses was found to be a comfortable and effective blindfold.

The stylus consisted of a six-inch metal rod, three-sixteenths of an inch in diameter, notched near the end and ending in a smooth round knob. The handle of the stylus was covered with close-fitting rubber tubing.

Each maze was constructed of two pieces of plywood, each piece one-quarter inch thick. The maze pattern was cut with a jig-saw out of a piece of plywood nine inches square. This piece was then permanently attached to a ten-inch base of the same material. The width of the maze path was one-quarter inch. The finished product was a smooth-surfaced maze ten inches square, with a half-inch ledge on all sides. The nine-inch upper surface contained the maze pattern, grooves one-quarter inch deep and one-quarter inch wide, beginning and ending in widened circular compartments. The smooth surface of the plywood gave a smooth bottom to the grooves. Since the sides of the grooves and the surface of the maze were also smooth, the danger of a subject locating his position in the maze through irregularities was avoided.

Since four mazes of different pattern were used in this experiment, a brief description of each maze will be given here.

Maze A (Plate I) was modelled on the Foster A maze. Except for very slight differences in length of path, the elimination of two turns in one cul de sac, and the addition of one unimportant cul de sac, this maze is a reproduction of the first two-thirds of the Foster maze. The maze was

shortened to enable each subject to learn two mazes during one experimental period without undue fatigue.

Maze A mirrored (Plate II) is the mirrored reversal of Maze A. Both patterns were cut in one operation and the mirroring effected by fastening opposite surfaces to the base. The mirroring is such that the horizontal moves are reversed, although the vertical lines remain the same as those of maze A.

Maze B (Plate III) was designed in an attempt to find a maze with a pattern entirely unrelated to that of maze A, but of approximately equal difficulty.

Maze B mirrored (Plate IV) was constructed from maze B in the same manner as A mirrored from A.

In the construction of mazes A and B two results were sought. The primary objective was to produce two mazes of entirely different pattern. This, we believe, has been done. The true path in maze A proceeds around the maze, beginning in the lower right hand corner and following fairly close to the sides of the maze to the left, reaching the goal in the upper right corner of the maze. The pattern in maze B proceeds from the center of the maze to lower right, to upper right, to lower right, to lower left, to upper left, to a goal in the center. There is little similarity between these two patterns.

A secondary objective was to make two mazes of equal difficulty. Since not much is known about the relative difficulty of patterns of various length and direction, it seemed best to construct a maze with an equal number of turns in the true path and an equal number of culs de sac.

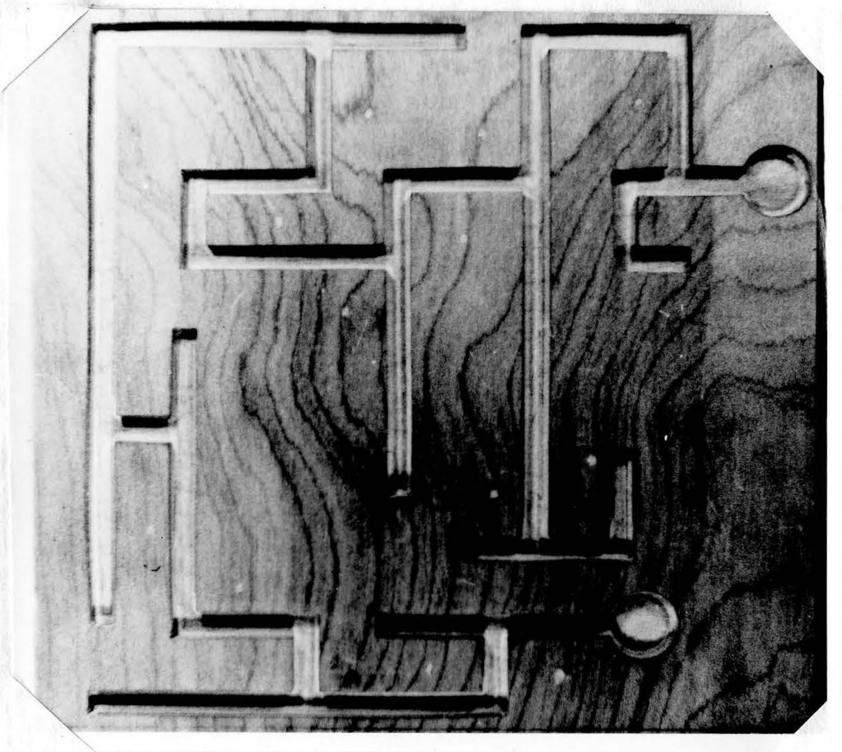

Plate I.
The starting box is in the lower right-hand corner, the goal in the upper right-hand corner.

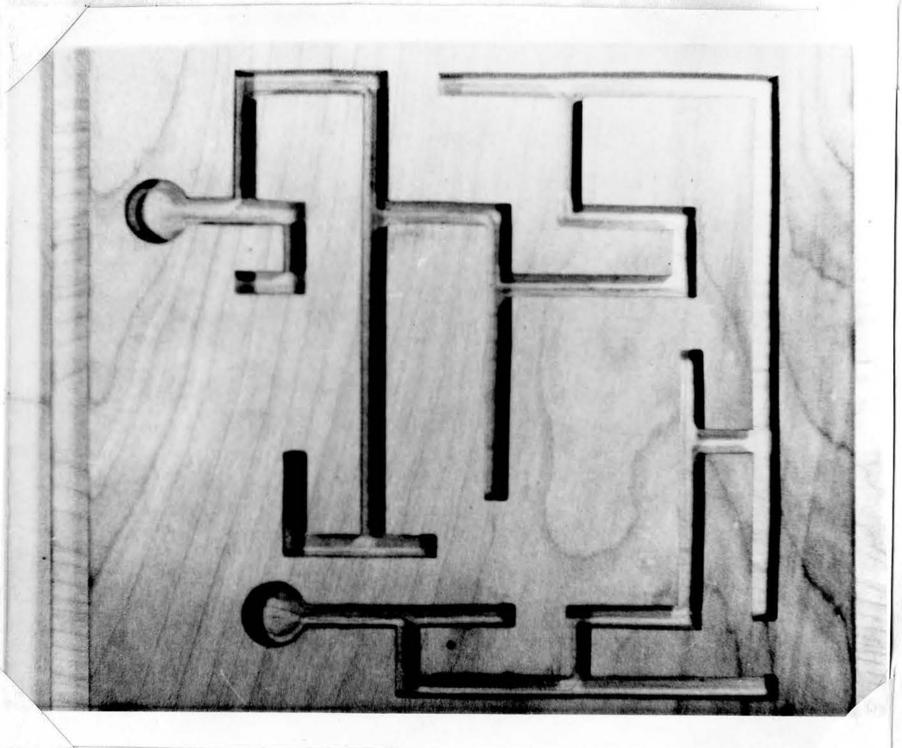

Plate II
Maze A mirrored. The starting box is in the lower left-hand corner, the goal in the upper left.

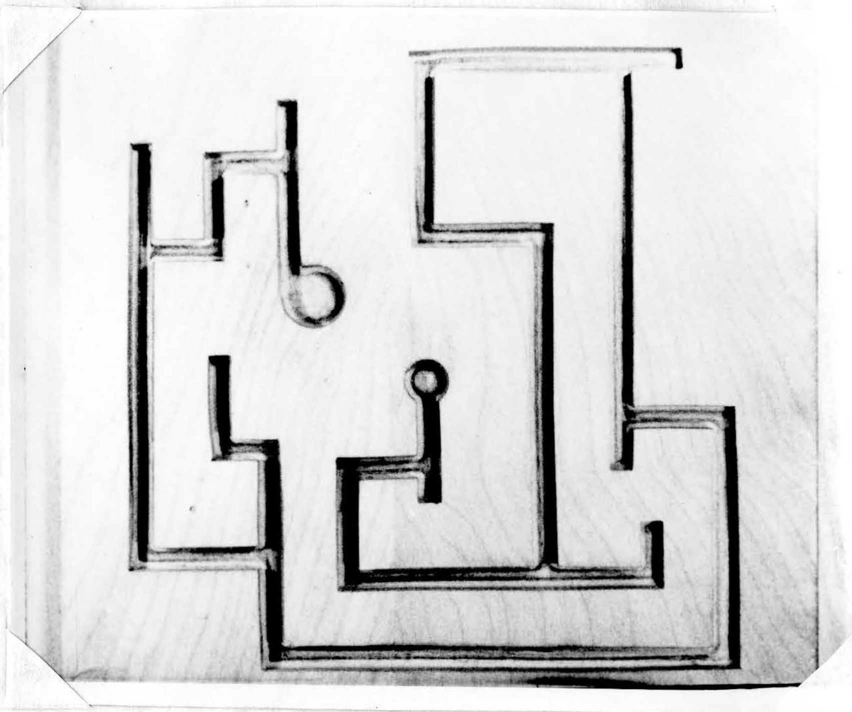

Plate III
Maze B. The starting box is in the center of the maze, the goal above the center and to the left.

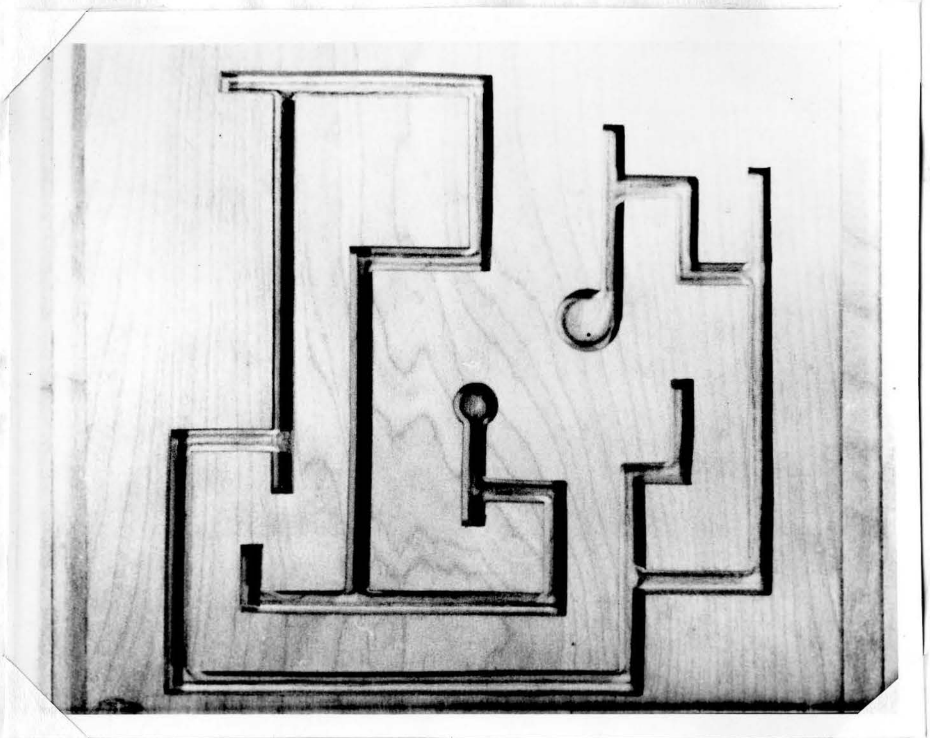

Plate IV
Maze B mirrored. The starting box is in the center, the goal above the center and to the right.

An attempt was made to counteract the difficulties arising from the involved reversals of direction in maze B by making the culs de sac of B more simple than those of A, and lengthening the moves in the central part of the maze. In spite of these changes, the results show maze B to be of slightly greater difficulty than maze A. Since the success of the experiment did not depend on the exact equality of the two mazes, no further attempt was made to equalize the two.

The following table gives the dimensions of the two mazes.

Table I

Dimensions of Mazes A and B

	Turns		Length of true path in inches	No. of culs de sac	Length of culs de sac	Moves in culs de sac
	R	L				
A	10	9	$30\frac{1}{2}$	7	$16\frac{1}{2}$	12
B	11	8	$40\frac{1}{2}$	7	8	10

Procedure

The twenty-four subjects of the control group performed their part of the experiment first, and this for two reasons. First, to determine the relative difficulty of the two mazes. Secondly, to determine whether two such mazes could be mastered successively without undue fatigue. The results obtained from this part of the experiment would show the amount of transfer

of training from one maze to an unrelated maze. To find the amount of improvement the twenty-four subjects were divided into two groups of twelve each, the first of which learned maze A followed by maze B, the second, maze B followed by maze A. A comparison of the scores for maze A learned first with those of maze A learned second should give us the amount of improvement due to training on maze B. The improvement due to training on maze A would be determined in the same manner. Further, it would be possible to make a direct comparison of the scores obtained from maze A learned after an unrelated maze with the scores from A learned after its mirrored image.

The procedure followed with the control groups was as follows:

The subject was seated comfortably at a table before a covered maze (A or B). In an attempt to establish an objective, experimental attitude on the part of all subjects, each was told informally that the experiment was not designed as a test of his abilities, but merely sought objective results on the learning process. He was given the stylus and cautioned to hold it perpendicular to the maze, in such a manner that the hand would not come in contact with the maze surface. The blindfold was then adjusted, the maze uncovered, the stylus placed in the starting box, and the following instructions read:

"You are now in the starting box. You are to move the stylus through the grooves until I tell you that you are out. Keep the stylus in the grooves and try to accomplish two things: first, reach the goal in a reasonable time, secondly and especially, learn to avoid wrong turns. Begin when I say 'Go'."

The instructions were read twice, a third time if the subject still failed to understand them. No further help was given. At the word "go" the subject began to follow the grooves of the maze. The stop-watch was started at the same time and ran until the subject reached the goal. Errors were scored according to Foster norms (2:159) whenever a subject entered a cul de sac, moved backward over the true path, turned a corner in a cul de sac, or turned a corner backward over the true path. A rest of about fifteen seconds was given between trials. When a subject had completed an errorless trial at slow speed, he was encouraged to increase his speed. The criterion for mastery was three consecutive errorless trials, one of which was completed in ten seconds or less.

When the first maze had been mastered, the maze was covered and the blindfold removed. The subject was given a five minute rest while the second maze was substituted.

The second maze was learned under the same conditions as the first. When the blindfold had been adjusted, the instructions were repeated and the trials began. Errors were counted and the time recorded for this as for the first maze. After the mastery of the second maze the subject was asked not to divulge to others the nature of the experiment. We have no reason to believe that anyone failed to maintain secrecy.

The experimental section of twenty-four subjects was also divided into two groups. One group learned maze A followed by A mirrored, while the other group learned maze B followed by B mirrored.

It was the intention of the experiment to measure the effect on learning of the definite relation which exists between each maze and its mirrored

image. To determine whether or not the relation was explicitly perceived, it was found necessary to vary the procedure slightly for this second group. The first maze was learned exactly as the first maze of the control group. During the learning of the mirrored maze, however, the subject was asked after the third trial to estimate the relative difficulty of the two mazes. This request afforded the subject an opportunity of stating the relation, if he had perceived it; it gave him no clue if he had not. The subjects' remarks in response to this question were noted. No other direct questions were asked during the learning of the maze. Volunteered remarks were noted, but were not solicited. Only after the mirrored maze had been mastered was the subject again asked to compare the two. His comparison and the reasons advanced to support his judgment were again noted. Each subject of the experimental group, too, was asked to keep secret the nature of the experiment.

One possible improvement in the procedure became evident after the experiment neared completion. We had obtained our results by comparing the scores for maze A learned after B with those of maze A mirrored learned after A. In this way we found the amount of improvement due to the new factor of relatedness between the mazes. As the experiment now stands, this direct comparison supposes that maze A and maze A mirrored are of equal difficulty. Although we have no reason to doubt the validity of this supposition, we would have preferred to compare identical mazes. This would have been done if the experimental group had learned the mirrored maze first and the original second. Then it would have been possible to compare scores made on the same maze when learned after an unrelated and after a

related maze.

CHAPTER IV

RESULTS

This chapter will be divided into two parts, the first of which will list the quantitative results, the second, the information gathered from the introspective reports of the subjects. Interpretation of these results will be left, for the most part, to the concluding chapter.

Quantitative

The twenty-four subjects of the control group learned the mazes first. Twelve learned the A maze followed by the B maze, and the other twelve learned the B maze first. Since the success of the experiment depended on a similarity of conditions in all parts of the experiment, the subjects of the control group were required, as those of the experimental group could be later, to learn the two mazes consecutively. Three subjects, one in group one (A - B) and two in group two (B - A), were unable to complete the learning in one period. The records of these were not used.

In the records here presented the following abbreviations will be used: in the control group the first maze learned will be followed by the numeral 1, and the second, by the numeral 2, e.g., A - 1, B - 2; in the experimental group the first maze will be designated by the simple letter (A or B), and the second maze by the letter M, e.g. A - M, B - M. The maze designated by the letter M is in each case the mirrored image of the first.

It had been the intention of the experimenter to use the records of the control group to determine the amount of transfer from an unrelated maze, and to use only one mirrored maze with the experimental group. However, the results obtained from the control group caused a modification of this procedure to seem advisable. Glancing at the results of the first control group (TableII), we find that B - 2 is easier than A - 1 according to all three criteria. The results of the second group (Table III) show an even greater improvement for A - 2 when learned after B - 1. Comparing the records of A - 2 with those of A - 1 and the records of B - 2 with those of B - 1, we find that there has been a positive transfer from the first maze in each case. The relative difficulty of the two mazes remains in question. If we look to the results of the first learned mazes (A - 1 and B - 1), we find that maze A is the more difficult, requiring more trials, more time, and more errors than B. However, A - 2 and B - 2 give results in seeming contradiction to this first finding. B - 1 is much more difficult than A - 2 according to the time and error scores. Again, a comparison of the composite scores of A - 1 and A - 2 with those of B - 1 and B - 2 (Table IV) invites the conclusion that B is more difficult than A.

Our final conclusion on the basis of these scores would probably be that maze A is more difficult than maze B, but that there is a much greater degree of transfer from B than from A. The experimenter then faced a predicament. If he used only mazes A and A mirrored with the experimental group, he would be taking advantage of the fact that there is only a slight transfer from A (if he compared the improvement of B - 2 over B - 1 with that of A - M over A). If he used B and B mirrored, he would take advantage

Table II

Table of Individual Scores in Terms of Trials, Time, and Errors for the First Unit of the Control Group

	Maze A			Maze B		
Subj.	Trials	Seconds	Errors	Trials	Seconds	Errors
1	19	752	190	17	369	104
2	35	1001	331	24	673	185
3	40	1078	196	19	537	134
4	40	1618	407	18	1113	336
5	17	1106	207	22	1321	331
6	32	649	194	24	921	377
7	43	1073	363	19	599	256
8	26	1196	249	25	1044	349
9	32	1031	389	31	983	449
10	43	576	175	29	553	210
11	21	599	190	20	539	183
12	17	750	106	13	496	90
Total	365	11429	3097	261	9148	3004
Mean	30.4	952.4	258.08	21.7	762.3	250.3
S.D.	9.69	327	93.79	4.91	287.6	111.8
P.E.	1.89	63.7	18.28	.95	56.08	21.8

Table III

Table of Individual Scores in Terms of Trials, Time, and Errors for the Second Unit of the Control Group

	Maze B			Maze A		
Subj.	Trials	Seconds	Errors	Trials	Seconds	Errors
21	23	651	246	28	402	149
22	27	442	133	13	257	100
23	24	529	245	22	350	155
24	39	921	316	46	1175	287
25	25	957	204	34	938	385
26	31	841	222	11	152	43
27	35	1842	746	27	597	190
28	20	928	283	24	428	84
29	23	529	163	15	755	253
30	21	482	103	26	372	42
31	30	1339	210	11	189	39
32	10	1048	174	18	568	180
Total	308	10509	3035	275	6183	1897
Mean	25.6	875.7	252.9	22.9	515.2	158
S.D.	7.21	390.1	154.3	9.90	295.6	103.4
P.E.	1.4	76	30	1.93	57.6	20.1

Table IV

Comparison of the Composite Means of Mazes A - 1 and A - 2 with Those of B - 1 and B - 2

	Trials	Seconds	Errors
A	26.6	733.8	208
B	23.6	819	251.6

of the fact that B learned second is almost as difficult as when learned first.

In the light of these findings, the experimental procedure was revised. The experimental group, too, was divided into two sub-groups, one of which would learn mazes A and A mirrored, the other, B and B mirrored. This division would make possible the direct comparison of the results of both A and B when learned after a related and an unrelated maze and would also enable us to contrast the amount of improvement of A - 2 over A - 1 with that of A - M over A, and the improvement of B - 2 over B - 1 with that of B - M over B. If the mirrored mazes produced improved scores according to both of these comparisons, it could justly be maintained that the relationship between the mazes of the experimental groups had resulted in greater efficiency.

Accordingly, twelve subjects learned maze A followed by A mirrored (Table V) and twelve subjects learned mazes B and B mirrored (Table VI). The records of a thirteenth subject in each group were rejected, in one case because the subject was unable to finish both mazes in one period, in the other, because of the discovery that the subject had failed to understand the instructions.

It will be recalled that the general purpose of the experiment was to measure the effect on maze learning produced by the previous learning of a related maze. In our examination of this effect we will disregard for the moment the question of whether the subject recognized explicitly the relation between the two mazes. The general effect of the introduction of a related maze is best perceived in a comparison of the records of both A and B when learned after an unrelated and after a related maze. Comparing the means for trials, time, and errors (Table VII), we find that there is a significant improvement in the results of the second maze when this maze is preceded by a related one. The improved means for the A mirrored maze are especially significant. In spite of the fact that A - 2 was much easier than A - 1 and the previous learning of the A maze resulted in only a slight improvement in B - 2, a comparison of the scores of A - M with those of A - 2 reveals a significant gain for the mirrored maze, the critical ratio of the difference being above four for criteria of trials and errors and almost three for the less important time scores. A comparison of B - M with B - 2 shows a significant gain for the mirrored maze here also, the critical ratio of the difference being above four for all three criteria and above six for the significant error scores.

Table V

Table of Individual Scores in Terms of Trials,
Time, and Errors for the First Unit
of the Experimental Group

	Maze A			Maze A Mirrored		
Subj.	Trials	Seconds	Errors	Trials	Seconds	Errors
41	20	1003	169	13	377	59
42	25	612	111	15	521	116
43	25	667	155	13	254	50
44	23	742	170	14	401	60
45	21	726	154	11	315	54
46	25	877	160	10	152	9
47	26	664	216	18	357	34
48	24	406	102	6	83	9
49	28	713	193	11	283	49
50	15	575	197	9	212	42
51	16	477	107	12	219	92
52	27	1348	353	18	700	150
Total	275	8810	2087	150	3874	724
Mean	22.9	731.4	173.9	12.5	322.8	60.3
S.D.	3.96	240	63.9	3.39	160.27	39.49
P.E.	.772	46.78	12.45	.660	31.24	7.699

Table VI

Table of Individual Scores in Terms of Trials, Time, and Errors for the Second Unit of the Experimental Group

	Maze B			Maze B Mirrored		
Subj.	Trials	Seconds	Errors	Trials	Seconds	Errors
61	21	833	177	24	587	141
62	34	1247	384	23	596	157
63	18	835	260	14	335	70
64	25	704	253	20	390	94
65	30	1800	370	17	711	173
66	17	815	96	13	346	34
67	13	326	49	10	205	23
68	12	476	29	7	234	12
69	17	1086	292	17	466	52
70	27	1161	219	22	871	189
71	23	563	174	9	283	63
72	31	770	159	14	334	86
Totals	268	10616	2460	190	5358	1064
Mean	22.3	884.6	205	15.8	446.5	88.6
S.D.	7.141	379.1	116.3	5.394	196.1	57.91
P.E.	1.391	73.90	22.67	1.051	38.24	11.28

Table VII

Summary of Comparative Scores of Groups of Twelve Subjects for Two Mazes Learned After an Unrelated and a Related Maze

	Mean A-2	Mean A-M	Difference	P.E.d	C.R.
Maze A					
Trials	22.9	12.5	10.4	2.4	4.3
Seconds	515.2	322.8	192.4	65.5	2.9
Errors	158.0	60.3	97.7	21.5	4.5
Maze B					
	B-2	B-M			
Trials	21.7	15.8	5.9	1.27	4.6
Seconds	762.3	446.5	315.8	67.8	4.6
Errors	250.3	88.6	161.7	24.5	6.6

As a further indication of the amount of improvement in maze learning caused by the introduction of a related maze, it is possible to compare the transfer of training found in the control groups with the improved scores of the experimental groups. To do this we compare the improved averages of A-2 and B-2 over A-1 and B-1 with the improvement of A-M over A and B-M over B. A comparison of these results (Table VIII) shows a universal gain in efficiency when the learning proceeds from a related maze. It will also

be noted that here, too, the gain is greatest in the error column.

Table VIII

A Comparison of the Increase in Efficiency in a Maze When Learned after an Unrelated and a Related Maze as Determined by the Percentage of Improvement of the Mean for the Second Maze

	Mean	Mean	Average Gain	Percentage Improvement
		Maze A		
	Maze A-1	Maze A-2		
Trials	30.4	22.9	7.5	21
Seconds	952.4	515.2	437.2	45
Errors	258	158	100	38
	Maze A	Maze A-M		
Trials	22.9	12.5	10.4	45
Seconds	734.1	322.8	411.3	56
Errors	173.9	60.3	113.6	65
		Maze B		
	Maze B-1	Maze B-2		
Trials	25.6	21.7	3.9	15
Seconds	875.7	762.3	113.4	12
Errors	252.9	250.3	2.6	1
	Maze B	Maze B-M		
Trials	22.3	15.6	6.5	29
Seconds	884.6	446.5	438.1	49
Errors	205	88.6	116.4	56

Summing up the results thus far tabulated, we find that mazes A-M and B-M were not only more easily learned than A-2 and B-2, but that maze A-M was much easier when learned after A than after B, and maze B-M easier when learned after B than after A. If it be true that there is more transfer of training from maze B than from A we might expect an improved score for maze B-M, but could hardly expect lower averages for A-M, since this maze is learned after maze A which affords less transfer than B. The only constant factor which could account for the better scores in the mirrored mazes is the new element of relatedness.

Finally, it is possible to contrast the records of those who explicitly recognized the relation between A or B and the mirrored maze with the records of those who did not. Of the twelve subjects who learned mazes A and A-M, six explicitly recognized the relation between the two: three on the first trial, one on the third, one on the sixth, and one on the tenth. Four out of twelve recognized the relation between B and B-M: three on the first trial, and one on the fourth. As can readily be observed from Table IX, those who explicitly recognized the relation made slightly greater improvement in the mirrored mazes than did those without explicit knowledge. This gain is again most noticeable in the error averages.

Graphs of the learning curves of the various groups are not presented. The element of chance, which enables one subject to make an excellent score on his first trial and a poor score on his tenth, another subject to make good scores from the beginning, and a third to make steady progress from a poor score to a good one, reduces the value of this graph in maze learning. Furthermore, in this experiment the graph illustrates no

important point, especially in view of the fact that those who discovered the relation between the related mazes made this discovery on different trials and, as a group, made scores only slightly better than the scores of those who did not.

Table IX

A Comparison of the Gain in Efficiency on the Mirrored Maze of Those who Explicitly Recognized the Relation with the Gain of Those without Explicit Recognition

	Mean	Mean	Average Gain	Percentage Improvement
Subjects who recognized:		Maze A		
	Maze A	Maze A-M		
Trials	23	12	11	47
Seconds	736	298	438	59
Errors	162	37.5	124.5	76
Subjects who did not recognize:				
	Maze A	Maze A-M		
Trials	22.6	13	9.6	42
Seconds	732	348	384	52
Errors	186	83	103	55
Subjects who recognized:		Maze B		
	Maze B	Maze B-M		
Trials	19.5	13.5	6	30
Seconds	944	399	545	57
Errors	194	75	119	61
Subjects who did not recognize:				
	Maze B	Maze B-M		
Trials	23.7	17	6.7	28
Seconds	855	470	385	44
Errors	210.5	95.5	115	54

Qualitative

The introspective reports were requested primarily to determine whether or not the relation between the mirrored maze and its counterpart was perceived. The reports satisfied this requirement but gave little additional information. As was mentioned in the account of the procedure, the subjects were questioned only during the learning of the mirrored mazes, when they were asked at the completion of the third trial, and again at the end of the experiment, which of the two mazes they considered the more difficult. Those who recognized the relation between the two mazes stated this fact and little else. Of those who did not recognize the relation, some assigned reasons for the greater ease or difficulty of one maze, others did not. Volunteered remarks were recorded whenever they occurred. The most significant statements will be summarized here.

Those who discovered the relation did so at different times. To some recognition came on the first trial, as is clear from the following volunteered remarks at the end of that trial:

> "This seems like the other in reverse."
> "This is the opposite of the first one, but I can't get an image."
> "This is reversed."
> "I think this is the first one; only to the left."

One subject stated at the end of the third trial:

> "Just the opposite of the other one. I knew it on the first trial."

Some suspected a relation on the first trial and became certain later in the experiment. The remarks of two subjects will illustrate this:

First trial: "This seems opposite, but I am not sure."
Third trial: "It is opposite."

First trial: "The beginning and end is reversed."
Tenth trial: "The whole maze is reversed."

To some, even suspicion came later than the first trial, as is clear from the remarks of these two subjects:

First trial: "I have not the slightest idea where I went."
Third trial: "This seems opposite to the first, but I think there are some differences."
Fourth trial: "No, this is opposite."

First trial: "The first was harder."
Third trial: "I think they are opposite."

Of those who failed to discover the relation between the two mazes, the majority thought the second maze easier after three trials. Typical of the remarks of those who could assign no reason for the greater ease, are these:

"It's just easy."
"This is easier. I don't know why."

The reasons advanced for the greater ease of the second maze were often conflicting:

"This is much less complicated."
"More turns in this, but it's easier."
"The lines are longer in the second, but there are not so many turns."
"This is easier. The lines are straighter."

Although all agreed at the completion of the experiment that the second maze was the easier, not all thought so during the earlier trials. One subject who judged the second easier at the end of the third trial had reversed his judgment at the end of the fifth trial and concluded at the end of the experiment that the second was easier because it had "a simpler

more direct path." Others, seemingly influenced by the inhibitory effect of the first maze, at first found the second more difficult, only to reverse their opinion as the learning progressed.

The few remarks which indicate the manner of learning point to a preponderance of kinaesthetic imagery:

> "I was guided at times by the distance of the true path from my body."
> "I learned the series of left and right turns, but I had no picture of the maze."
> "I learned to lean the stylus to right or left."

Besides these introspective reports, a few incidental observations seem worthy of note. In spite of the fact that all subjects were told that they were not undergoing a test, a few could not overcome the idea that they were being compared with others. As a result a few were nervous, fearing poor scores. These, in general, did poorly. A smaller number accepted the test as a challenge, determined to make a record. These were much more successful. Impatient subjects, even those of high intelligence, frequently made poor scores because of this trait. Even when these subjects had almost mastered the maze, their haste to complete a trial in which an early mistake occurred would cause several unnecessary errors. In their haste they would try to substitute action for the little thought necessary in their task. Again, those who appeared most intelligent did not always do best in this experiment. These were not satisfied with the necessary, but slow, trial and error learning, but sought to put in practice half-formed theories, thus wasting time and running up their error score. Finally, the effect of chance was striking; a subject confronted with two paths, especially near the end of the maze, could take

one and find himself with knowledge of the true path, or take the other, and find himself retreating from the goal, confusing himself more with every backward turn. The element of chance should not be disregarded in any conclusion drawn from a maze experiment.

CHAPTER V

CONCLUSION

The results of the present experiment justify one general conclusion, namely, that the introduction of a relation into a motor learning problem has a definite positive effect on the learning. The comparison of the results of both the A and the B maze when learned after an unrelated and after a related maze shows that better scores are made when the second maze is related to the first. The experiment legitimately presumes that a mirrored maze is of the same initial difficulty as its counterpart. The results of the control groups indicate what scores are to be expected on either maze when learned after an unrelated maze. A comparison of these scores of the second mazes of the control groups with the scores of the mirrored mazes of the experimental group should indicate whether or not the introduction of a related maze results in significant improvement. The improvement of these scores of the mirrored mazes of the experimental group, as recorded in Table VI, is significant in every instance.

It will be noted, however, that the scores for the first mazes of the experimental group are better than those for the same mazes of the control group. Whatever the cause of this difference, whether it be an unconscious improvement of technique, an increased familiarity with the experiment on the part of the subjects, or an accidental grouping of more adept subjects,

the fact that these first mazes of the experimental group proved easier indicated the advisability of finding some comparison which would supplement the comparison of the second mazes of the control group with the second mazes of the experimental group, and, at the same time, take into account the difference in difficulty of the first mazes. This further comparison, that of the improvement of the second mazes of the control group over the first with the improvement of the mirrored mazes over their counterparts, brought out the fact that there was a decidedly greater improvement in the mirrored mazes of the experimental group (Table VIII). Thus, each comparison resulted in consistently better scores and more improvement for the mirrored mazes, according to all criteria.

To what factor must these better scores be attributed? Can the results be explained by chance? The critical ratios of the difference found in the direct comparison of the second mazes are consistently high enough to rule out chance. The possibility of chance accounting for the results is further lessened by the corroborative results of the second comparison.

Can the improvement in the mirrored mazes be explained by a similarity between the related mazes? Investigators have discovered that the more similar the mazes are, the greater is the transfer. This transfer in similar mazes can adequately be accounted for by mere sense memory and motor habit. In the present instance, however, mere sense memory and mere motor habit would not explain the improvement, since no two consecutive moves of the second maze are the same as those of the first. The mazes are analogous rather than similar.

Seemingly, the only factor which can account for the greater ease of the mirrored mazes is the relation between these and their counterparts, and the only reason the subjects made better scores on the mirrored mazes is that, either explicitly or implicitly, they knew the relation which existed between the related mazes.

Of the entire twenty-four subjects of the experimental groups, the ten who explicitly recognized the relation between the two mazes made slightly more improvement on the mirrored mazes than the fourteen subjects who were without explicit knowledge (Table IX). The difference is hardly great enough to justify an absolute distinction between the two groups. Rather, these results would seem to bear out the conclusion of Scott (18:206) that "frequently the pattern functions entirely non-consciously." The relation between the two mazes had a positive effect even though explicit knowledge of that relation was lacking. Some of the subjects made excellent scores without recognition, making more improvement in the mirrored maze than others who pointed out the relation. The average improvement of the subjects who failed to recognize the mirroring was much greater than can be explained by mere transfer of training. It may possibly be explained by what we may call "implicit knowledge."

By "implicit knowledge" of the relationship between the two mazes, we mean a knowledge which would have become explicit had the subject centered his attention on a comparison of the two mazes. In the learning of the second maze, the attention of the subject was centered on the problem at hand, and only in the dim background of attention were the guiding images of the first maze. Although the subjects knew, in many instances, the

proper sequence of moves in the second maze, they did not attempt to assign a reason for this knowledge and consequently failed to compare the second maze to the first.

Three factors probably go far to explain the failure of the fourteen subjects to attain to explicit knowledge of the relationship. The first of these is the fact that maze learning was a new experience for the subjects. Even though these subjects may have noticed analogous sequences of moves in the two mazes and used this observation to good advantage in the second maze, their lack of knowledge of the various possible patterns could have led them to conclude that analogous sequences of moves were necessarily found in all mazes. Thus, they would fail to attend to the analogies as such, and fail to compare the second maze with the first. A second factor is that of individual differences in kinaesthetic imagery. Many who learned the mazes did not realize that the lines were straight. These were handicapped by the absence of visual sensations which ordinarily supplement kinaesthetic sensations of this type. Subjects so handicapped would have an inaccurate knowledge of the first maze and would consequently be unlikely to note a relation between that maze and any other. The third factor, related to the second, was the incomplete character of the imagery. The images of the first maze, predominantly of an unfamiliar, non-visual type, had probably not been integrated into one complete image of the total pattern. It is probable that in many instances the first maze had been mastered by segments, without full attention to the serial position of individual segments in the maze. In the second maze, the subject, encountering the corresponding segment and learning quickly to make the

analogous moves, failed to attend to the relationship existing between the two segments because he was unaware that they occupied an identical position in the two mazes.

Although this experiment was devised to examine the effect of the introduction of a relation in motor learning, and for that alone, a few wider observations made during the course of the experiment seem worthy of note here.

Seemingly the mazes were learned by sections, one difficult segment at a time engaging the attention of the subject. The difficulties were not solved in the order in which they occurred in the maze, the subjects generally concentrating first on the section they found most difficult. Usually more difficulty was experienced in the central part of the maze than in the beginning or the end. The end of the maze was usually mastered first and the beginning next. The persistent errors, however, occurred nearer the end than the beginning, indicating that although the section of the maze which immediately precedes the goal makes a vivid impression, forward association is greater than backward.

It was noted, too, that long moves were more easily remembered than short moves. A turn which occurred immediately after a long move was more easily remembered than one after a short move. This fact may, perhaps, partially account for the fewer recognitions of maze B mirrored, since maze B began with a very short vertical move, A with a longer horizontal move.

Two other factors probably interfered with the recognition of B mirrored. In view of the fact that six of the ten subjects who recognized

the mirroring did so on the first trial, early impressions of the second maze assume great importance. It seems that the more trials take place without recognition, the greater is the interference set up by the new task and more remote the possibility of comparing the second maze with the first. Likewise, the further the subject proceeds in the maze, the greater the effect of interference. Thus, the first few moves of the mirrored maze are of special importance. Important, then, is the fact that the first move in maze B ended in a cul de sac so short that many failed for several trails to recognize it as such. The same difficulty occurred in the mirrored maze. Maze A, on the other hand, had a longer, more easily learned cul de sac at the end of this first move. A final and very important difference in the beginnings of the two mazes is the direction of the first move. The first move of maze A was horizontal, that of maze B, vertical. As a result, the subject beginning the A mirrored maze immediately moved in a direction opposite to the direction of his first move in the previous maze. The subject learning B mirrored lacked this clue, since his first move duplicated the first move of the B maze.

Summarizing the definite results of the experiment, we find that the introduction of a relation into a motor learning task results in improved scores, an indication that man can do better work, even in a motor task, through the proper use of his intellectual powers. We found, too, that the relation between the mirrored mazes was at times perceived. Finally, the results would seem to indicate the inadvisability of concluding ignorance from the absence of explicit knowledge, since the subjects who failed to recognize explicitly the relation between the mazes made progress in the

second maze inexplicable except in terms of "implicit knowledge."

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The thesis, "An Experimental Study of the Effect of the Introduction of an Intellectual Factor in a Problem of the Motor Learning Type," written by Ernest Vernon McClear, S.J., has been accepted by the Graduate School with reference to form, and by the readers whose names appear below, with reference to content. It is, therefore, accepted in partial fulfillment of the requirements for the degree of Master of Arts

Rev. Charles I. Doyle, S.J.	October, 1938
Alexander Schneiders, Ph.D.	November, 1938