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ON SOME FACTORS INFLUENCING MECHANIZATION IN PROBLEM SOLVING

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PREFACE

Human behaviour is usually characterized as being highly original, adaptive, and variable. This fact cannot be denied, and is usually accentuated by studies in Comparative Psychology. The human can undertake a great variety of behavioural and cognitive activities when compared with infra-human species.

Notwithstanding this outstanding feature of Homo Sapiens, it still remains true that in certain situations, and under certain conditions, Man's behavioural and thought processes are marked by stereotypy. This characteristic of behaviour has been labelled perseveration, habituation, and rigidification. The investigation reported in this paper is oriented toward an understanding of this particular behavioural phenomenon.

HISTORICAL INTRODUCTION

For the past decade or so, the attention of theoretical and experimental psychologists has been focussed on the problem of habituation or perseveration of behaviour and thought in problem solving situations. This upsurge of interest stems primarily from a comprehensive monograph published by Dr. A. S. Luchins (1942) on the phenomenon of Einstellung, defined as "the set which immediately predisposes an organism to one type of motor or conscious act" (Warren, 1934, cited by Luchins, 1942). In his monograph, Luchins set forth experimental evidence that this special kind of mental set can and does play an important role in an individual's problem solving behaviour.

The problem essentially is this: Why do individuals blindly repeat a particular response when the objective situation demands a shift to a more adequate response? In other words, why do habits persist in situations in which they are no longer adaptive?

Dr. Luchins's work stems from some unpubl-

ished experiments undertaken by Zener and Duncker between 1925 and 1930 at the Berlin Institute (Maier,1936, cited by Luchins, 1942; Wertheimer, 1945). Essentially, subjects were habituated to solve certain types of problems in the same way. Then, when a test problem was given, Zener and Duncker found that an obvious and simple solution of the test problem was usually overlooked because the characteristic method of solution, set up in the preceding problems, was used in the test problem. Control groups tended to solve the problem in the obvious and simple manner.

The problem solving behaviour of the controls would be expected on the basis of the Law of Least Action, formulated by D. K. Adams as follows: In a learning situation, the behaving organism will satisfy its needs as economically as possible (D.K. Adams, 1931, cited by Hilgard, 1948). The fact that an organism will prefer short-cuts in problem solving and learning situations has been demonstrated time and again in animal and human experimentation. The general problem now becomes obvious: Why does the behaving organism use a complex method of solution, rather than a short-cut, even when the situation itself demands the use of

the simple and more direct method?

Luchins sought some understanding of this phenomenon - which he called Einstellung - when he undertook a vast experimental survey covering thousands of subjects from all age and scholastic levels. His procedure was essentially as follows: Groups of subjects were presented with a series of six Einstellung (E) problems involving simple arithmetic but only solvable in a somewhat complex manner. We can indicate this solution by the formula B-A-2C. This series of set-inducing problems was followed by two critical test (C) problems which could be solved either by the long method or the relatively simple and direct method exemplified by formula A plus C. Problem number nine, on the other hand, could be solved only by the simple method; it was, in effect, an extinction problem designed to disrupt the tendency to repeat blindly the long method and bring about the more direct solution of the last two problems, numbers ten and eleven, both of which were critical test problems. These arithmetic problems were presented in such a manner that the subject was required to juggle three water jars and an indefinite amount of water in order to obtain a definite amount of liquid. In this

model experiment, the measures of Einstellung or degree of mechanization are the number of Einstellung (complex) solutions on problems seven and eight; the time required by the subject to solve problem nine; and the number of Einstellung solutions on problems ten and eleven.

The results from thousands of observations indicated a high degree of mechanization. For example, in one study of college freshmen, there were 77% E solutions on the first two critical problems (C1C2) and 63% on the last two criticals (C3C4). (These particular figures are reported for comparative purposes, since the subjects of the investigation reported in this paper were also first year college students.)

Luchins concluded from his experimental evidence that habituation creates a mechanized state of mind, or a blind attitude towards problems; one does not look at the problem on its own merits but is led by a mechanical application of a used method. The subjects blindly repeated a response "because they have been narrowed down and have lost the possibility of a free genuine view of the task". Luchins further postulates that the effect is created by special factors

in the situation, rather than resulting from a general fundamental tendency of the human being.

In a later investigation, Luchins and Luchins (1950) attempted to prevent mechanization in problem solving with the use of new experimental methods. In one variation they even concretized the tasks by introducing special jars and an actual supply of fluid in place of the abstract symbols previously employed. Their results were, however, not very successful. The hoped-for weakening of the Einstellung tendency was vitiated, they feel, by the carry-over totthe experiment of attitudes toward arithmetic in particular and problem solving in general.

two recent PH.D theses have dealt with the impact of stressful conditions on the phenomenon of Einstellung or "rigidity".

Robert A. Harris (1950) has studied the effects of stress on rigidity of mental set in problem solving situations. The general hypothesis was: Emotional stress will result in rigid problem solving behaviour. Harris defines "rigidity" as "the inability to shift to a new method of solving a problem when a previously successful method of solution on the same kind

of problem is found to be no longer appropriate". Using a modification of Luchins's technique, employing, however, the arithmetical water jar problems, Harris presented his subjects with a series of four set-inducing problems followed by one critical and one extinction problem. The time taken by the subject to "discover" the correct solution of the extinction problem was used as the measure of rigidity. Various techniques were utilized in an attempt to raise the subject's level of tension or stress by creating a threat to his self-esteem: (1) The experimenter's attitude was formal, rejecting, aggressive, abusive, or critical; (2) A test atmosphere, involving an evaluation and comparison of individual abilities; (3) Failure in a test situation, involving an unsolvable problem; (4) A personality test interpretation technique, wherein the subject is told he possesses "strong, unconscious, neurotic tendencies".

The results of qualitative observations established the fact that ".....subjects in the experimental group were performing under considerably more stress than were the subjects in the control group". These emotional stressful conditions, furthermore,

directly account for the greater rigidity of mental set for subjects in the experimental group. However, there was no difference between the number of E responses on the critical problem. That is, "the stress group subjects did not tend to establish the set any more readily than the non-stress subjects".

Emory L. Cowen (1950) has studied the influence of varying degrees of psychological stress on problem solving rigidity. Rigidity is defined again as "the tendency to adhere to a previously practiced method of problem solution when that method no longer offers the most direct and efficient means of solving the problem". The general hypothesis is: Rigidity increases under increasing degrees of psychological stress. Again stress refers to experimentally produced atmospheres: (1) Mild frustration resulting from failure to solve a problem; (2) A "threat expected - threat received" situation; (3) A "threat expected - praise received" situation. The threat expectancy conditions stem from the results of a personality appraisal "test". Some time after taking this test one group of experimental subjects were told of maladaptive features of their personalities (threat received) while another group of experimental subjects were told of outstand-

ing characteristics of their personalities (praise received). In measuring rigidity, Cowen used a modification of the water jar arithmetical technique.

The results of the experiment indicated significant differences between the control, frustration, and threat received groups in the direction of a greater degree of rigidity stemming from increased stress. A mild peripheral stress elicits greater rigidity than does a non-stress situation, whereas a "central personality threat situation" elicits reliably more rigidity than does either of the former situations. There were also fewer evidences of rigidity in the group receiving praise in contrast to the group receiving threat after establishment of a threat expectancy.

Sydney Pally (1950) has also studied the effect of self-esteem threat upon the "rigidity of thought processes". The hypothesis is identical with that of Harris, and Pally defines rigidity as "the inability to break a mental set, to shift to a new solution".

Failure in a test situation, specifically designed test instructions, and the role assumed by the experimenter all were used to induce threatening

or stressful conditions. The usual water jar tasks were administered privately and individually. Measures of rigidity were: (1) The number of Einstellung solutions of the critical test problems; (2) The time taken to solve the extinction problem; (3) The number of individuals who solved all critical test problems by the Einstellung method.

Pally concludes that, other things being equal, individuals operating under self-esteem threat do react in a more rigid manner than individuals who are working under non-threatening conditions.

Richard Christie (1950) has studied the effects of frustration upon rigidity in problem solution. He was concerned with the following problem: If an individual has adopted a set method of solving problems, will frustration tend to increase his tendency to persist in this method of problem solution in situations which appear similar to ones where the solution has worked in the past but which in actuality are different? Christie used water jar arithmetical problems and an unsolvable task to induce frustration.

Results significant at the .00005 level of confidence were obtained when the acid test was a

comparison of the actual number of E solutions attempted on the extinction problem between high and low frustrates. Christie concluded that an increase of tension induced by frustration tends to increase Einstellung and leads to non-adaptive perseverative behaviour. One reason for this failure to adapt is the tendency to view new situations as being similar to past ones.

Rokeach (1950, cited by Cowen, 1950) used the Luchins water jar method and four experimental groups in testing the hypothesis that the more time the subjects were given between exposure of the problem and writing the solution, the fewer rigid solutions would be attempted. The experimental variable in this investigation was a specific time interval. Rokeach found that there were increasing evidences of rigidity of approach in the groups allowed the smallest amount of time for reflection. Time pressures cause the formation of restricted perceptual structures manifested by behaviour rigidity.

Luchins (1942) also studied the influence of a time pressure on the tendency of subjects to adhere to an inappropriate problem solving tendency. He found that when time pressures were increased, indiv-

iduals tend to cling to a complex method of solution even when a more direct and time saving method is available. Einstellung experiments stressing speed produced the same results.

Cowen and Thompson (1950) have studied certain relationships between problem solving rigidity and personality structure. They indicate, on the basis of the Rohrschach technique, some of the personality factors which appear to be related to Einstellung rigidity. These are (1) limited productivity and imaginativeness, (2) inability to perceive complex relationships and to integrate constructively, and (3) a restricted range of interests and a narrower field of function.

Meer and Gebhard (1950) have studied cognitive rigidity as a function of the personality variable security-insecurity. These investigators were concerned with the fact of individual differences in Einstellung behaviour, even when the situational variables are held constant. Is it possible that such differences are due to personality traits or attitudes?

Defining rigidity as the inability to overcome a set when the situation demands it, and using water jar tasks and two groups of experimental

subjects (secure, insecure), they found that the only subjects incapable of solving the extinction problem belonged to the insecure group. Meer and Gebhard conclude that insecure individuals develop comparatively rigid sets when compared to secure subjects.

Many animal experiments have been performed in the study of perseverative behaviour. A typical experiment (Gilhousen, 1941, cited by Hilgard, 1948) shows how rats which have learned a path including a jump appear to prefer that path to other more economical ones after they have been overtrained on it.

The writer has also studied the mechanized behaviour of rats in a maze situation. Ten animals were introduced to a maze containing a long "zig-zag" path and a short direct path to the goal-box. Under conditions of food deprivation, the rats soon learned to run up the short path to the goal (food). After ten preliminary runs in this manner, each rat was forced by means of a harness to traverse the zig-zag path to the goal some fifty times. When the harness is later removed, the rats will, over a series of ten runs, persist in running the long path to a highly significant degree when compared to their running behaviour on

the preliminary runs. They choose this path despite the availability of the short path. The experiment reported in this paper is essentially the human analogue of this animal experiment.

A Note on the Origin of Method

The methodology employed by the writer is essentially derived from some preliminary work of Dr. A.S. Luchins (1942). Luchins performed several experiments with grade school children utilizing a paper and pencil maze technique. The first six mazes exposed to the children were solvable by following a long twisted zig-zag path (located sometimes to the left and sometimes to the right); in the next two mazes (critical test mazes C1C2) the goal could be attained by this zig-zag path or by taking a short straight path upwards from the entrance to the goal-box; in the ninth maze the goal was reached only through the straight path upwards but not through the circuitous one; the next two mazes (critical mazes C3C4) were solvable both by the twisted path and the direct straight path. This is the basic design of the experiment reported in this paper.

A Note on Conceptual Systems

The question now arises: Have learning

theorists evolved a satisfactory conceptual system to deal with the facts of Einstellung? The following are two conceptual and theoretical schemas into which the particular results of this experiment and the facts of Einstellung in general may fit. In the section entitled "Discussion of the Results" this fitting will be considered. The schemas are by no means disparate.

Firstly, Hilgard (1948, pp. 336) postulates that the original behaviour in a learning situation is not the running off of earlier habits in a new situation, but is a genuine attempt at discovering the route to the goal. Past experience is used, but in a manner appropriate to the present. This original adjustment on the part of the animal may be termed a "provisional try" to be confirmed or denied by its success or failure. A provisional try corresponds to what Tolman and Krech have called "hypothesis" behaviour.

Now, overlearned, fixated, and stereotyped behaviour can be made coherent with the theory of provisional try if a certain assumption is accepted. That is, after sufficient overlearning, the learner no longer tries, unless something dramatic again arouses his searching behaviour.

Tolman (1948) believes that in the course of learning something like a "field map of the environment" gets established in the animal's brain. The incoming sensory impulses are elaborated in the Central Nervous System into a tentative, cognitive-like map of the environment. "And it is this tentative map, indicating routes and paths and environmental relationships, which finally determines what response, if any, the animal will finally release".

These maps may be relatively narrow and strip-like or relatively broad and comprehensive. The differences between these two kinds of maps will only appear when the animal is later presented with some change within the given environment. Then, the narrower and more strip-like the original map, the less will it carry over successfully to the new problem; whereas the wider and more comprehensive it was, the more adequately it will serve in the new set-up.

In a strip-map, the given position of the animal is connected by only a single path to the position of the goal. In a comprehensive map, on the other hand, a wider arc of the environment is represented, so that if variations in the specific routes be intro-

duced, the wider map will allow the animal still to behave relatively correctly and to choose the appropriate new routes.

THE PROBLEM

We have noted that the phenomenon of mechanization in problem solving has recently been the target of fairly extensive psychological investigation. Many of these experiments have dealt with the special aspect of stressful conditions and their relation to stereotypy; others have considered the correlation of Einstellung and personality traits. Few investigations (with the outstanding exception of Luchins, 1942) have dealt with the mechanization as such, in order to determine why it occurs and under what general conditions it occurs. Hilgard (1948) has remarked on the fact that the peculiar loss of "docility" in problem solving situations has not been studied too extensively (pp. 339).

The purpose of this experiment was to gain some insight into the conditions of mechanization in problem solving. An attempt was also made to understand the conditions operating when an individual does <u>not</u> become mechanized. (There are always, it appears, a few individuals in this category). It was hoped that some general conditions could be outlined as a result of the investigation.

In addition, the writer sought to improve upon the Einstellung technique in two ways. Heretofore, experimenters dealing with the "stress-frustration" hypothesis have devised methods for inducing these states from the outside, as it were. The stressful and frustrating conditions were foreign to the actual experimental material. An attempt was made in this investigation to include the stressful and frustrating conditions in the very nature of the task itself. This, it was thought, would be a decided improvement over previous methods.

The water jar arithmetical procedure, furthermore, contains an unsatisfactory condition. The individual who has developed the habit of solving arithmetical problems by the "long" method can solve the critical test problems - using this method - in a matter of a few seconds. The subject, in other words, saves very little in time and energy by using the direct method. In fact, it would probably take him longer to stop, look, and discover the "short" solution. What is needed, therefore, is an experimental procedure designed to produce a clear difference between the long and short methods. If the short method were comparatively easy,

non-frustrating, and fatigue relieving, then it would be worthwhile for the subject to shift. The attempt to achieve just such a situation was made in this investigation.

Furthermore, if significant conditions of mechanization can be outlined, would it be possible to fit them into a contemporary learning scheme satisfactorily? This must be considered since, for scientific purposes, we require a conceptual framework in which we can think clearly and predict what behaviour will occur under given circumstances. Also, the definitive analysis of rigidity falls primarily within the province of learning theory. Learning theorists are concerned with the establishment of learning and the perpetuation of its lessons. Therefore they must determine the circumstances accompanying the appearance of rigid behaviour; they must clarify the meaning of terms; and it falls to their lot to uncover the origin of this behavioural phenomenon. In addition, they must state precisely the systematic impact of what it is they have studied.

In summary, the writer wished to gain further insight into the conditions of mechanization in problem solving, using a situation which would include frustrating and stressful conditions in the tasks

required of the subject, and it which a clear-cut difference exists between the set inducing problems and the critical test problems. If satisfactory conditions can be outlined, they will be examined in terms of contemporary learning theory.

EXPERIMENTAL APPARATUS AND DESIGN

A Note on the Clarification of Terms

Before describing the experimental tools and methodology, it would be useful to outline, in the interests of brevity and clarity, a single terminology and set of concepts to be used from this point on.

Those tasks requiring the roundabout, complex solution will henceforth be referred to as the Einstellung (E) problems. This method of solution will be known as the E method or E path. Tasks which can be solved by the complex or direct methods will be referred to as critical (C) problems. The direct solution will be known as the C method or C path.

The concepts "mechanization" and "Einstellung" will be used exclusively to describe the behavioural phenomenon under consideration in preference to "rigidity", "perseveration", etc.

The Experimental Apparatus

A series of eleven paper and pencil mazes was presented to each subject. Each maze consisted of a starting place marked by an arrow, three intermediary pathways, and a goal marked by an X. The C path

consisted of a direct route to the goal; the E path consisted of a comparatively long, zig-zag path to the goal; the third path, while long and twisted, was essentially a blind alley. (See appendix B for the complete series of mazes).

The E mazes consisted of one correct path - the zig-zag path, the C path being blocked just before the goal; the C mazes consisted of two correct paths, both the E path and the C path being open to the goal; the extinction maze had one correct path - the C path. The series consisted of six E mazes, two C mazes, an extinction maze, and lastly, two more C mazes. The second and third C mazes together with the extinction maze were of a slightly different "gestalt", the paths being narrower.

The essential part of the experiment consisted of presenting these mazes in a mirror tracing apparatus. All cues are thus obtained by looking at the reflection of the maze in a mirror directly facing the subject, since a shield prevented him from looking directly at the paper.*

*This procedure may be compared with that outlined in:
A.S. Luchins - An Examination for flexibility-rigidity of behaviour. Distributed by Franklin D. Roosevelt Hospital, Veterans Administration, U.S.A., 1950.

The effect of this apparatus was to reverse the left-right relations while keeping the front-back relations intact. It was postulated, therefore, that the subject would obtain considerable difficulty and perhaps frustration in tracing the zig-zag, oblique lines as required in the E mazes.

Subjects were chosen from a group of volunteers in the Freshman Class at McGill University. Subjects of both control and experimental groups were chosen in a random manner from the original list. That is, each volunteer had an equal chance of being chosen for each group. It was thought that freshmen and freshettes would be particularly suited for this investigation since they are completely naive with respect to (1) the Einstellung philosophy, and (2), the mirror tracing technique.

The Experimental Procedure

Each subject was individually and privately tested. While the measure of mechanization was the number of E responses on C1C2 and C3C4, the writer resorted to naturalistic observation to record much of the significant data. This is in line with Hilgard's remarks on the need for more experimental data obtained in this

manner, particularly in learning situations (Hilgard, 1948, pp. 352). Qualitative techniques utilized were (1) recording the comments of subjects, and (2), interviewing the subject on the completion of the experiment and asking pertinent questions regarding the particular results obtained.

Each subject sat at a table on which rested the mirror tracing apparatus. The writer, standing and directly facing the subject, read a standard list of instructions (see appendix A). The subject was instructed to find a non-obstructed path from the arrow to the X and trace that path with a pencil. That is, he was to find a path which was continuous from starting place to goal. At all times he was to get to the goal as quickly and with as smooth a tracing as possible. The number of errors committed by the subject were to be counted. These consisted of the number of times he went into a wrong path and the number of times he went outside the lines of the figure. In addition, he would be timed on each trial. The writer also mentioned that this type of test is usually included in an overall test of intelligence. Finally the subject was told that if he had any comments to make during the course of the experiment,

he was to kindly say them out loud since the experimenter was interested in knowing what he (or she) was thinking. (The writer also included in his remarks a few words on how the subject was to use the mirror).

The subject was then presented with the eleven mazes in proper sequence. The six E mazes were presented alternately: left-right, left-right, and so on. The writer stood by the side of the table and timed the subject on each maze. And should perchance the subject pursue the E path in the extinction problem and go right through the block without seeing it, the writer pointed out the block to the subject. That is, the block was made effective in all cases.

When the subject had finally completed the tasks, the writer urged him not to reveal the nature of the investigation. (Each subject stated that he or she had no prior knowledge of the details of the experiment). When the subject left the room, the experimenter sat down and wrote out whatever comments the subject had made during the course of the experiment, together with any other data which seemed to be of value.

The Experimental Design

The basic investigation consisted of the testing of two groups of twenty-two subjects each. (In the section entitled "Discussion of the Results" preliminary data from several related investigations will be discussed. These experiments are being continued at the present time).

Each subject in group one (experimental group) was presented with the series of mazes in the mirror tracing apparatus. On the completion of this set, each individual was promptly presented with another identical set of problems, being told, however, that this was part 'b' of the experiment. This latter set was to be traced naturally (non-mirror).

Each subject in group two (control group) was presented with the reverse order of events: (a) the series without the mirror, and (b), a set of mazes to be done in the mirror.

We are thus able to compare the number of E solutions of the C problems six ways, as represented diagrammatically in figure one:

FIGURE ONE

COMPARISONS OF E RESPONSES

	GROUP ONE	GROUP TWO
'a'	mirror	non-mirror
'b'	non-mirror	mirror

The question now arises: What will each comparison reveal? The problem can be treated systematically as follows:

A. <u>1a - 2a</u>

The subjects of the experimental group are tracing in the mirror as opposed to the controls tracing without the mirror. If stress and frustration are successfully produced through mirror tracing, the experimental subjects should become mechanized to a significantly greater degree when compared with the controls. This comparison should also reveal the efficacy of the mirror tracing situation for a study of Einstellung as opposed to the natural paper and pencil technique utilized by Luchins.

B. <u>1a - 2b</u>

Here both groups are tracing in the mirror,

group one as an initial experience and group two as a secondary experience following the tracing of a set of mazes naturally. Presuming that both groups will encounter difficulty with the mirror tracing, will the initial experience of group two create a significant difference between the degrees of mechanization evidenced by both groups? If so, what situational factors are interfering with a strict interpretation of the "stress-frustration" hypothesis?

C. 2a - 1b

Here both groups are tracing naturally, the subjects of group two doing so as an initial experience and the experimental subjects as a secondary experience following the tracing of a set of mazes in the mirror.

A general interpretation of the "stress-frustration" hypothesis would predict a greater degree of mechanization for the subjects in group one who have just passed through a stressful and frustrating experience. Will results be obtained in this direction? If not, what factors are operating to prevent such a result?

D. 1b - 2b

Here, both groups are tracing a second set of mazes. Since both groups have encountered the mirror

tracing, group one immediately before and group two now, will both groups show evidence of strong mechanization? If not, what situational factors can be shown to be playing a dominant role?

E. 1a - 1b

The "stress-frustration" hypothesis would predict a greater degree of mechanization in 'a', presuming again that mirror tracing is stressful and difficult. If results are obtained in this direction, can they be explained entirely on the basis of stress or are other factors playing important roles?

F. 2a - 2b

On the basis of the "stress-frustration" hypothesis, will the subjects tracing in the mirror (b) show evidence of strong mechanization when compared to 'a'? If not, why not?

THE EXPERIMENTAL RESULTS

TABLE ONE

NUMBER AND PERCENT OF EINSTELLUNG RESPONSES

FOR TWENTY-TWO SUBJECTS IN GROUP ONE

	male		female		total	
	N	%	N	%	N	%
C1*'	10	83.3	10	100	20	90.9
C2	9	75.0	10	100	19	86.4
EXT.	5(5)	41.7	10(7)	100	15(12)	68.2
C3	2	16.7	2	20	4	18.1
C4	1	8.3	2	20	3	13.6
C1*			1	10	1	4.5
C2			1	10	1	4.5
EXT.						
C3			1	10	1	4.5
C4			1	10	1	4.5

LEGEND: *'refers to first (mirror) set of mazes;
* refers to second (non-mirror) set.

EXT. refers to extinction problem; figures in brackets refer to number of individuals who traced through the block on this problem without seeing it.

Group of twenty-two college freshmen and freshettes made up of twelve males and ten females.

TABLE TWO

NUMBER AND PERCENT OF EINSTELLUNG RESPONSES FOR TWENTY-TWO SUBJECTS IN GROUP TWO

	male		female		total	
	N	%	N	%	N	%
C1*'	8	72.7	11	100	19	86.4
C2	3	27.3	9	81.8	12	55.5
EXT.	2(1)	18.1	5(3)	45.5	7(4)	31.8
C3			1	9.1	1	4.5
C4			1	9.1	1	4.5
C1*			1	9.1	1	4.5
C2			1	9.1	1	4.5
EXT.						
C3			1	9.1	1	4.5
C4			1	9.1	1	4.5

LEGEND: *' refers to first (non-mirror) set of mazes; * refers to second (mirror) set.

EXT. refers to extinction problem; figures in brackets refer to number of individuals who traced through the block on this problem without seeing it.

Group of twenty-two college freshmen and freshettes made up of eleven males and eleven females.

TABLE THREE

VALUES OF CHI-SQUARE OBTAINED IN A COMPARISON OF EINSTELLUNG RESPONSES FOR GROUPS 1a AND 2a

	1a	2a	chi-square	P
C1	20	19		
C2	19	12	3.93	less than .05
EXT.	15	7	4.45	less than .05
C3	4	1		
C4	3	1		

LEGEND: 'P' represents probability that observed difference results from chance factors.
The chi-square method for fourfold contingency tables is fully outlined in Q. McNemar (1949, pp. 200).
Yates's correction for continuity applied as outlined in Q. McNemar (1949, pp. 207).

Methodological Improvements

There can be no doubt that a situation has been achieved in which stressful conditions are involved in the very tasks required of the subject. All subjects found the mirror tracing quite difficult, their times on the first E maze ranging up to ten minutes. Much of the tracing was done very poorly; the subjects found it very difficult to keep within the lines of the figure and would be stumped time and again. A typical subject would shift in his seat and fidget, finally clamping his elbows on the table in order to concentrate on the task at hand. Some subjects began to sweat.

Conclusive evidence in this direction was obtained from the spontaneous comments of the subjects and from their answers to a few questions at the conclusion of the experiment. Experimental and control subjects referred to the mirror tracing as "frustrating", "difficult", "feeling of helplessness", "annoying", "aggravating", and so on. We can, therefore, label this situation as difficult and stressful and suggest the use of this method in future investigations along the line of the Harris, Cowen, and Pally papers.

The writer is quite certain that a situation has been achieved in which a difference between E and C paths does exist and is meaningful. We have noted the difficulty encountered in tracing the E path; The C path, on the other hand, can be traced in a matter of several seconds, and involves nothing more than a quick upward stroke.

Although the subject becomes adapted to mirror tracing over the set of six E mazes, fatigue sets in gradually. Many subjects would ask questions in the following vein: "When is it going to be over?"; "How many more do I have to do?". Therefore, switching to the C path in the C maze would not only conform to the instructions of getting to the goal as quickly and with as smooth a tracing as possible, but would also relieve stress and fatigue.

DISCUSSION AND ANALYSIS OF THE RESULTS

The Experimental Group

There can be no doubt that the mirror tracing problem solving situation results in a considerable degree of mechanization. The subjects do continue tracing the E path on the C problems, and the number doing so on C1C2 is fairly high. Of the twenty-two subjects tested, twenty traced the E path on C1 and nineteen on C2. Then, surprising as it may seem, fifteen subjects proceeded up the E path on the extinction problem, and, of these, thirteen did not see the block but traced right through it. These subjects then had the block pointed out to them by the writer. That is, the block was, in fact, effective in all cases. There was then little evidence of mechanization on C3C4.

Now, why is there such a high degree of mechanization when the C mazes offer a comparatively short and easy path? We can trace the development of Einstellung realistically in the following manner: The subject, as he begins tracing, becomes more and more involved with the difficulty he is encountering; he tries new methods of holding the pencil; he tries to

solve the "trick" in the mirror - he becomes, in effect, occupied solely with the improvement of his hand movements. At the end of six E mazes the subject is so much so involved that he literally does not see the open C path on C1. Even on C2, which is drawn in a slightly different form, the mechanized subjects are blind to the new possibility. They trace their lines into the goal-box right to the opening of the C path - and still a good number do not see it. Thirteen subjects continued right through the block on the extinction problem without seeing either the block or the open C path. Here is evidence of strong mechanization, but it is not a mysterious process. The conditions for strong mechanization have been described above. Analyzing the problem in another manner we can say: The subject starts out with a problem solving frame of reference - he has been instructed to get to the goal by choosing the correct path. He surveys the first problem and perhaps traces straight up the blocked C path before realizing his error. Finally he is tracing with some difficulty up the E path. As he passes from problem to problem his problem solving frame of reference changes gradually to a repetitive frame. This is aided by the fact that he becomes involved with the movements of his

hand in the mirror - what gradually becomes important for him is not the goal but the E path and the difficulty he is encountering there. This path becomes the prominent aspect of the situation for him. It stands out as a figure against the ground. Meanwhile, the goal itself fades into the background and recedes in importance for the individual. He, in effect, is mechanized.

The change in the frame of reference is brought out by comments in the following vein: "I was looking for tricks in the first few, but after a while I forgot about it".

Now we must ask ourselves: What conditions are operating when the subject does not become mechanized? (There were two such cases in this group). Here again, there is nothing mysterious about the matter. These subjects, upon being presented with each maze, paused, looked over the total figure, and satisfied themselves as to what the situation required of them before they began to trace.

This condition of inspecting the total figure also operated in most cases after the subject was blocked on the extinction problem. Here the subjects would comment as follows: "Now, Judy, let's stop and

look"; "There are two paths", and so on. Thus when the subject was presented with C3 he or she would pause perceptibly to survey the situation. This surveying behaviour directly accounts for the sharp drop in E responses on C3C4.

At the conclusion of the experiment, every mechanized subject was amazed at how he or she missed out on the C path in the C problems. In addition, each subject stated quite conclusively that he had not seen the open C path.

Comparison: 1a - 2a

In accordance with the "stress-frustration" hypothesis, the subjects in the experimental group (1) do attempt more E responses than the subjects in the control group who are tracing naturally. This is significant at well below the .05 level of confidence for C2 and the extinction problem. (The statistical procedure involved use of chi-square, Yates's correction, and fourfold contingency tables. This procedure is outlined in Q. McNemar, 1949, pp. 200-207). In addition, each figure for 1a is higher than the corresponding figure for 2a, for each C problem.

In the non-mirror situation, the individual has less reason to become involved with the E path,

and, as a consequence, less E solutions are attempted on the C problems. Some individuals broke the Einstellung and shifted on C2 because they noticed the C path opening at the end of C1, or because the different "gestalt" presented by C2 caused them to pause, survey the situation, and spot the open C path. In the mirror tracing situation there was little opportunity for this to occur. This situation is, therefore, more conducive to a study of Einstellung.

Comparison: 1a - 2b

Table two reveals that there was very little mechanization in the 'b' part of the control situation. In fact, only one individual showed evidence of mechanization. This is so despite the fact that these subjects are now tracing in the mirror.

What is interfering with the general interpretation of the "stress-frustration" hypothesis? It is nothing more than a high degree of expectancy. After having been blocked on the extinction problem or after having shifted on their own accord on the first set of mazes, the subjects, when presented with a second set, expect to encounter problems in which the C path will be open. Every individual recognized the similarity of the the second set of mazes to the first and waited for the

first problem with the open short path. This knowledge, that sooner or later they would be presented with a maze with two correct paths including an easy one, prevented the development of Einstellung again. This dominant attitude of expectancy prevented the subjects from becoming highly involved with the E path in contrast to the subjects of group one who encounter the mirror initially. This is so despite the fact that all subjects found the mirror tracing very difficult. Stress, therefore, is not an all inclusive rule but merely a situational factor which, under the right conditions, produces a high degree of mechanization, but which, under other conditions, can be made subservient to other situational factors.

Comparison: 1b - 2a

There was only one case of mechanization in the 'b' part of the first group and the reason is the same as outlined above. Each subject reported that he or she had waited for the first maze with the open C path. This watching behaviour confirms the methodological improvement of a clear difference between E and C paths - the situation the writer had hoped to achieve.

If the factor of subjective stress is carr-

ied over from 1a, then it is again subservient to a dominant attitude of expectancy.

Comparison: 1b - 2b

We have noted that only two individuals showed evidence of mechanization when presented with the second series of mazes despite the fact that one group is tracing in the mirror and one naturally, following an initial mirror tracing experience. Since mirror tracing is a stressful experience, this overall result points up the limited nature of the "stress-frustration" hypothesis.

The reason for solving the C problems by the E method on the part of one girl in group one and one girl in group two was that they just did not see and did not think. The writer could obtain no clearer statement since both girls were embarrassed by the results.

Comparison: 1a - 1b

The important fact here is that the feeling of stress resulting from the mirror tracing, if carried over to the second set of mazes, does not produce results according to a general interpretation of the "stress-frustration hypothesis because of the dominance of an attitude of expectancy.

Comparison:2a - 2b

Although the subjects in this group did not find the mirror tracing any easier than the subjects in group one, any feeling of stress resulting from this tracing was masked by an attitude of expectancy in determining the extent of mechanization.

Sex Differences

An overall perusal of the results indicates that girls consistently attempted more E solutions than did boys. The numbers involved are too small for statistical comparison but the tendency seems to be there. Apparently this result stems from the fact that boys remain relatively cool and collected in problem solving situations. Rather than a strict dichotomy, however, there is, in fact, a great deal of overlap. This tendency, however, might profitably be the subject of future investigation.

The Experimental Results and Learning Theory

We have noted how learning theorists must be concerned with the phenomenon of "mechanization in problem solving". Ultimately they must describe a conceptual system to handle the facts of behaviour stereotypy. We will examine the results of this experiment

in the light of contemporary learning theory in order to (1) better comprehend the results, and (2), study the utility of these systems. Perhaps they will prove adequate for describing the results of Einstellung experiments.

We will recall that Hilgard (1948) postulates that original behaviour in a learning situation is characterized by a genuine attempt to discover the route to the goal. This original adjustment, termed a "provisional try", corresponds to what has been called "hypothesis" behaviour. Stereotyped behaviour can be made coherent with the theory of provisional try if the following assumption is accepted: After sufficient overlearning (overperformance) the learner no longer tries, unless something dramatic again arouses his searching behaviour.

What happens in the experimental situation reported in this paper? We have described how, after sufficient repetitive activity in a problem solving situation, the subject gradually loses his problem solving frame of reference; he, in effect, no longer tries. Yet this repetitive activity was in most cases absent on C3C4 - after the subject had been blocked

on the extinction problem. Something dramatic - the discovery that he has traced right through a block and that the short path is open - again initiates searching behaviour. The subject pauses perceptibly when exposed to C3. This is a genuine attempt to find the correct path and is exactly what occurred when the subject was presented with the first E maze. Now it results in a shift in behaviour so that the individual traces the C path on C3.

Tolman (1948) has outlined a theoretical schema involving the concept of "cognitive map". This has been outlined on page 16. Using this concept we can theorize in the following manner: Through repetitive activity the subject becomes more and more involved and concerned with the E path, resulting in a narrowing of his cognitive map or grasp of the situation confronting him. The narrowness of this map is revealed when a variation is introduced in the specific routes to the goal. Those individuals who maintain a relatively broad and comprehensive map are able to "see" the change and alter their behaviour accordingly. To maintain such a map one need only survey each figure before tackling it. This is opposed to a "piecemeal" approach which encompasses but one aspect of the situation - the E path.

Those individuals who maintain such an approach and who are therefore victims of a narrow and strip-like cognitive map are unable to vary their behaviour according to the demands of the situation. The objective situation comprising goal, starting place, and three possible routes to the goal has been reduced for them to a phenomenal situation which consists entirely of one path.

Luchins (1942) has also noted this narrowing effect, particularly as a result of his experiments stressing speed and time.

> "Fear and nervousness are not exactly conducive to a critical attitude of solving problems; More likely, they so narrow the individual's mental field that he is blinded to a more direct method".

The condition of broad, comprehensive maps is then essential for adaptive behaviour in keeping with the variability of situational factors. The condition of narrow strip-like maps is essential to the mechanization of behaviour, and in theoretical terms accounts nicely for the inability of individuals to shift when the objective situation demands such a shift.

It is possible that this concept is related to the personality factors outlined by Cowen and Thompson and reported in the "Historical Introduction". They postulate that mechanization is correlated with the inability to perceive complex relationships; limited imaginativeness; a narrow field of function, and so on. Whether these are real personality factors playing an important part in the mechanization of individuals and thereby expressing more fully what is meant by "cognitive map" is not clear. Certainly, the results of this investigation point to the necessity of knowing the situational factors first; only then can the psychologist speculate in terms of personality function.

Further Investigation

Several problems arising out of this investigation are being studied and the preliminary results are available.

First, two improvements in the experimental procedure have been introduced. Previously, by presenting the E mazes in alternate order, it was felt that perhaps some sort of "alternate rhythm" was being set up which caused the individual to glance only to the

left and right, but not at the total figure. Secondly, it was desired to obtain a block on the extinction problem which would be effective in itself, thereby eliminating the interference of the experimenter.

Thus eleven subjects have been tested with the E mazes presented in random order and the block on the extinction problem drawn as a bright red line. The interference of the writer was eliminated except for three cases where the subjects thought the red line was a defect in the paper. The results, however, remain the same. In an initial mirror set of mazes there is a high degree of mechanization on C1C2 and a lesser amount on C3C4. In the second set of natural mazes there is no mechanization.

A further study of the conditions of mechanization and non-mechanization incorporates a large red block on all problems which require that one path be blocked. This block is one inch long and is drawn inside the lines of the path just before the goal. Thus the E mazes are signified by a very noticeable block on the C path. The C mazes, of course, contain no block. Preliminary results indicate a sharp drop in mechanization even when the mazes are presented in the mirror tracing apparatus. The absence of the large red

block on the C mazes is very noticeable. This "perceptual lack" causes the individual to pause and glance at the figure - the simple condition required to prevent mechanization. The results, therefore, are in accordance with the conditions of mechanization and non-mechanization outlined previously.

CONCLUSIONS

(1) Factors emanating from the situation in which the individual finds himself are invoked to explain "mechanization in problem solving". Stress, fatigue, inattention, and so on, lead to the development of a "piecemeal" attitude wherein only one aspect of the situation becomes important for the individual. The initial problem solving frame of reference gradually changes to a repetitive frame, and the individual falls into a mechanized state of mind.

(2) It follows, therefore, that a thorough study of situational characteristics should be undertaken before resorting to personality functions as explanatory concepts in Einstellung investigations.

(3) A simple yet fundamental condition of non-mechanization may be outlined as follows: The individual must pause and inspect the total situation before tackling a problem. He should first determine what the situation requires of him, so that he will be able to act intelligently with it according to its structural requiredness.

(4) An experimental set-up for the study of Einstellung has been designed which includes two marked improvements over the heretofore popular arithmetical technique. First, a clear-cut difference is established between long and short methods, so that the short method is relatively easy, non-frustrating, and fatigue relieving. Secondly, stressful factors are involved in the tasks required of the subject, rather than emanating from conditions foreign to the problem solving situation itself.

(5) It is suggested that the experimental tools and design reported herein will be useful for the continued study of Einstellung in the future, particularly in dealing with the "stress-frustration" hypothesis.

(6) The writer indicates how the general results of an Einstellung experiment may be handled theoretically in a satisfactory manner in terms of the concept of "cognitive map". In addition, certain results of the experiment fit neatly into Hilgard's theory of the "provisional try". Learning theorists, in short, <u>have</u> evolved theoretical systems to deal with the phenomena of Einstellung.

SUMMARY

A total of forty-four subjects, picked at random from a group of volunteer college freshmen and freshettes, were tested for Einstellung in a relatively new experimental situation. This consisted of exposing the individual to a series of eleven paper and pencil mazes presented in a mirror tracing apparatus. Each subject was tested individually and privately, and the writer resorted to naturalistic observation, including recording the comments of subjects, to outline a phenomenological situational analysis for the explanation of mechanization and non-mechanization under the same objective conditions.

In this analysis, emphasis was laid on situational factors as opposed to personality functions. The "stress-frustration" hypothesis was reduced to one factor which, under certain conditions, produces a high degree of mechanization, but which, at other times, can be made subservient to other situational factors. The results were then examined in the light of contemporary learning theory.

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APPENDIX A

EXPERIMENTAL INSTRUCTIONS

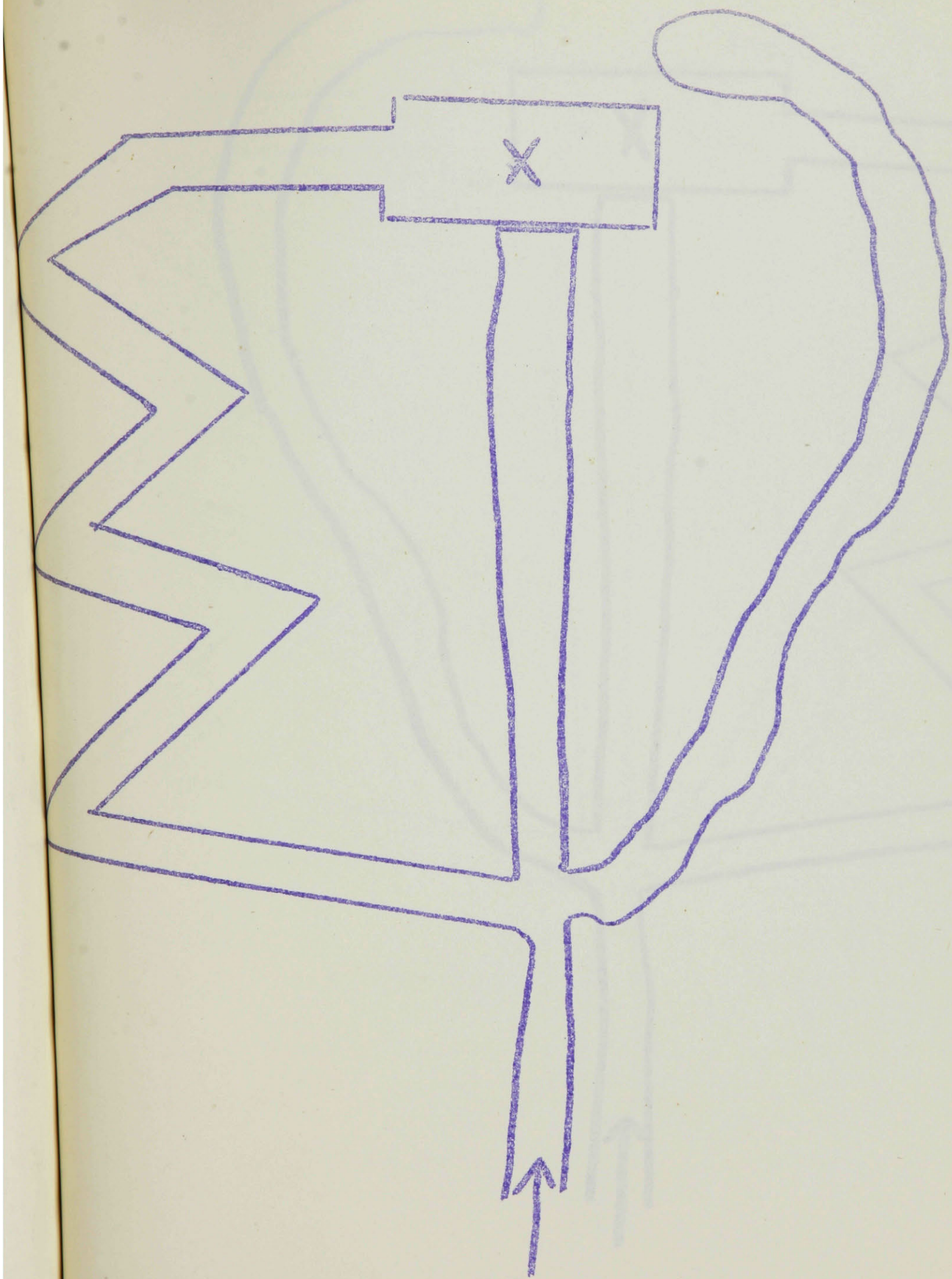
I am going to present to you a series of figures, each of which has a starting place marked by an arrow and a goal marked by an X. You are required to find a non-obstructed path from the arrow to the X and trace this path with a pencil. That is, you must find a path which is continuous from starting place to goal.

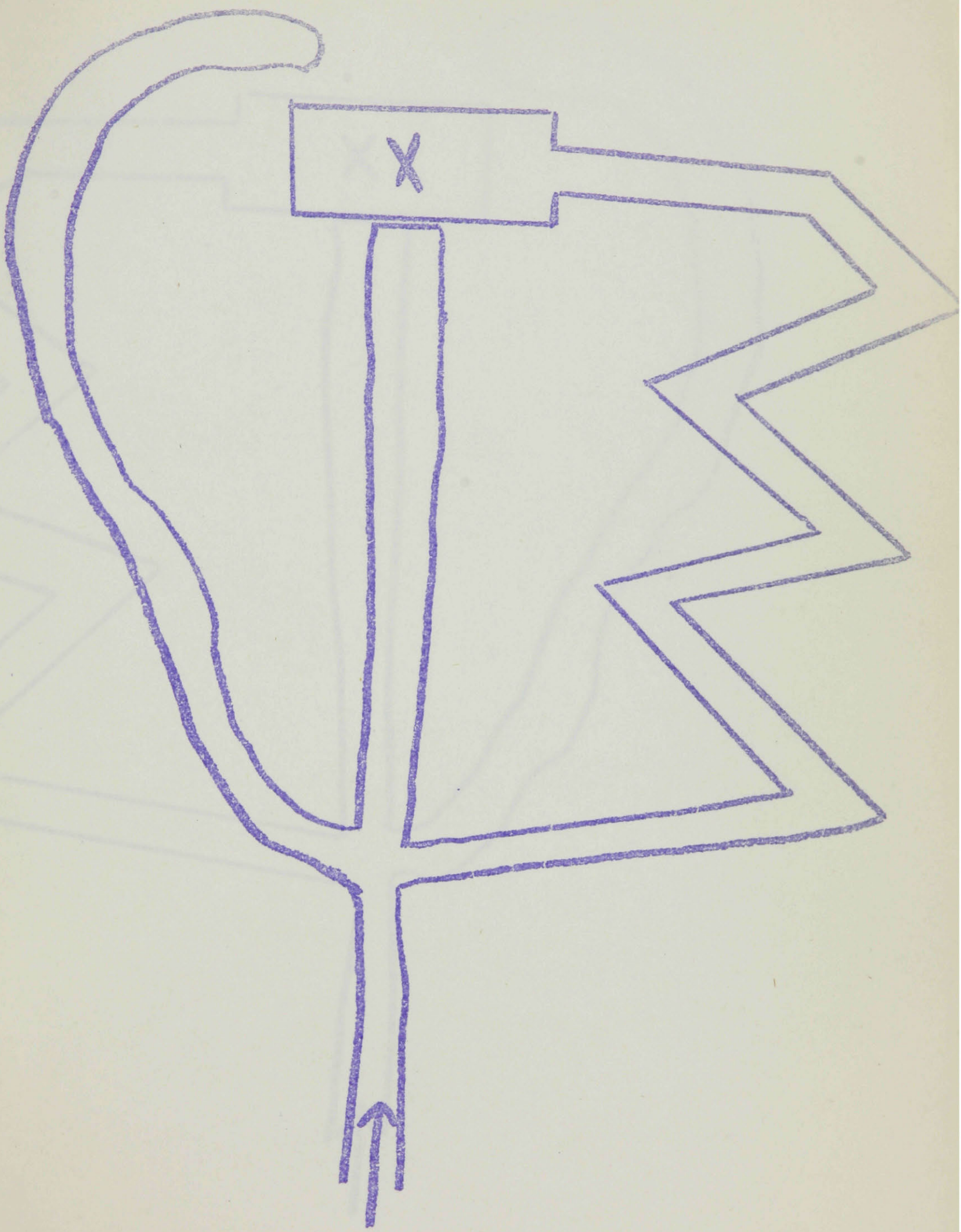
Now, this type of test is usually included in an over-all test of intelligence. I am going to count the number of errors you make, that is, the number of times you go into a wrong path, and the number of times you go outside the lines of the figure. And I am going to time you. In other words, you are required to get the correct path and with a smooth tracing movement go from the starting place to the goal as fast as possible. The faster and smoother you trace, the better score you will achieve.

If you have any comments to make during the course of the experiment on either how you feel or what you think of the experiment, I would like you to say them out loud because I am interested in knowing what you are thinking.

APPENDIX B

THE BASIC AND COMPLETE SERIES OF MAZES

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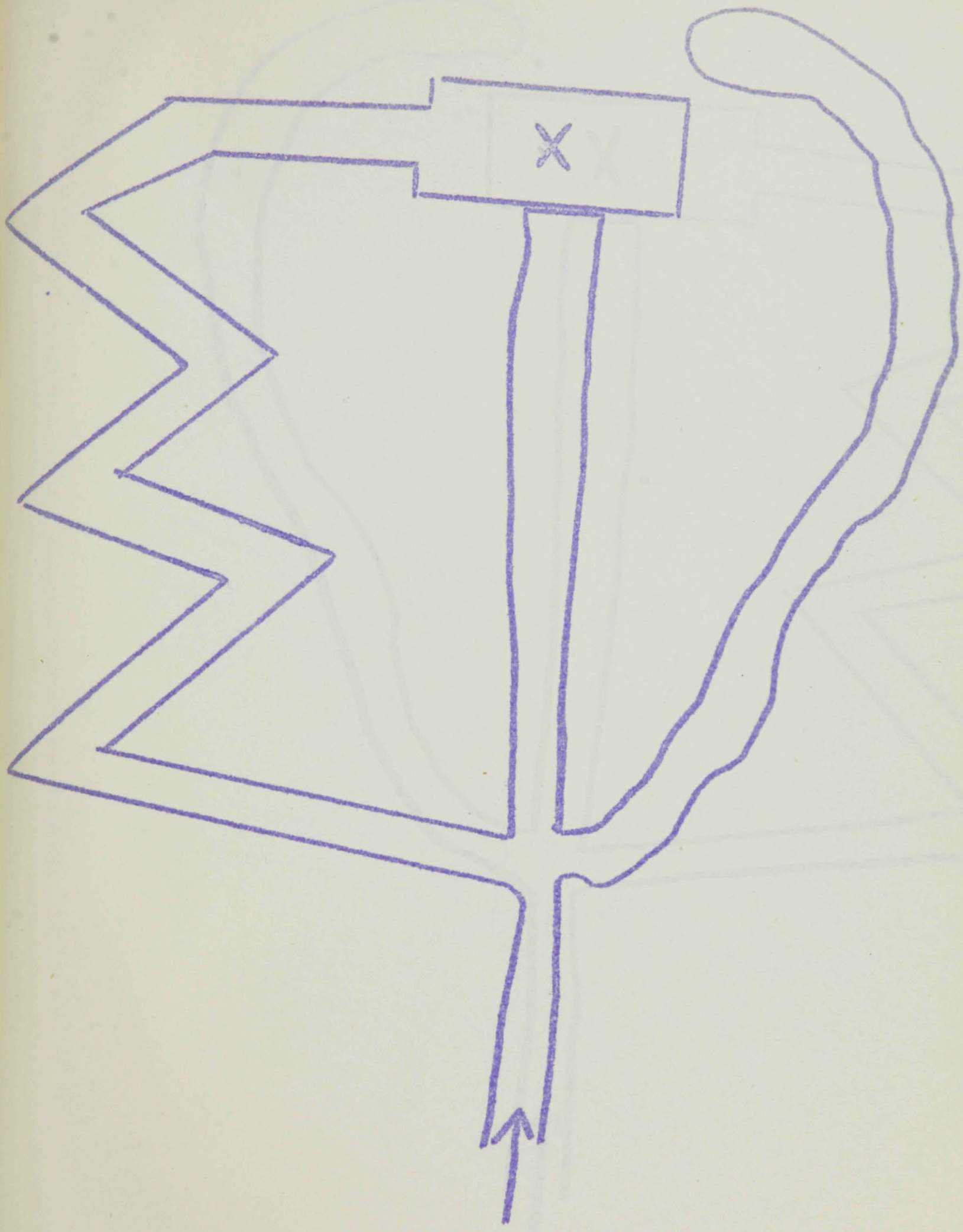

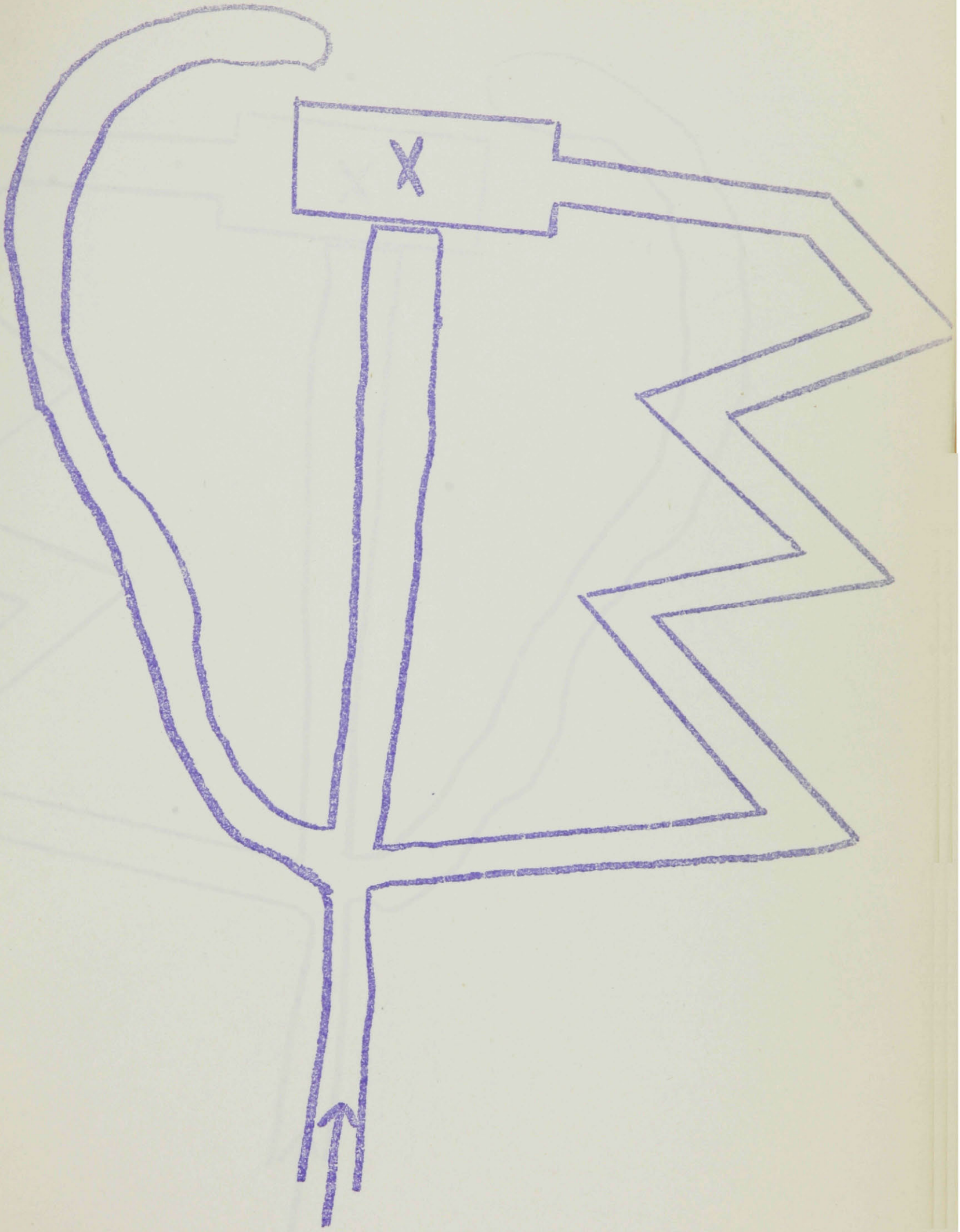
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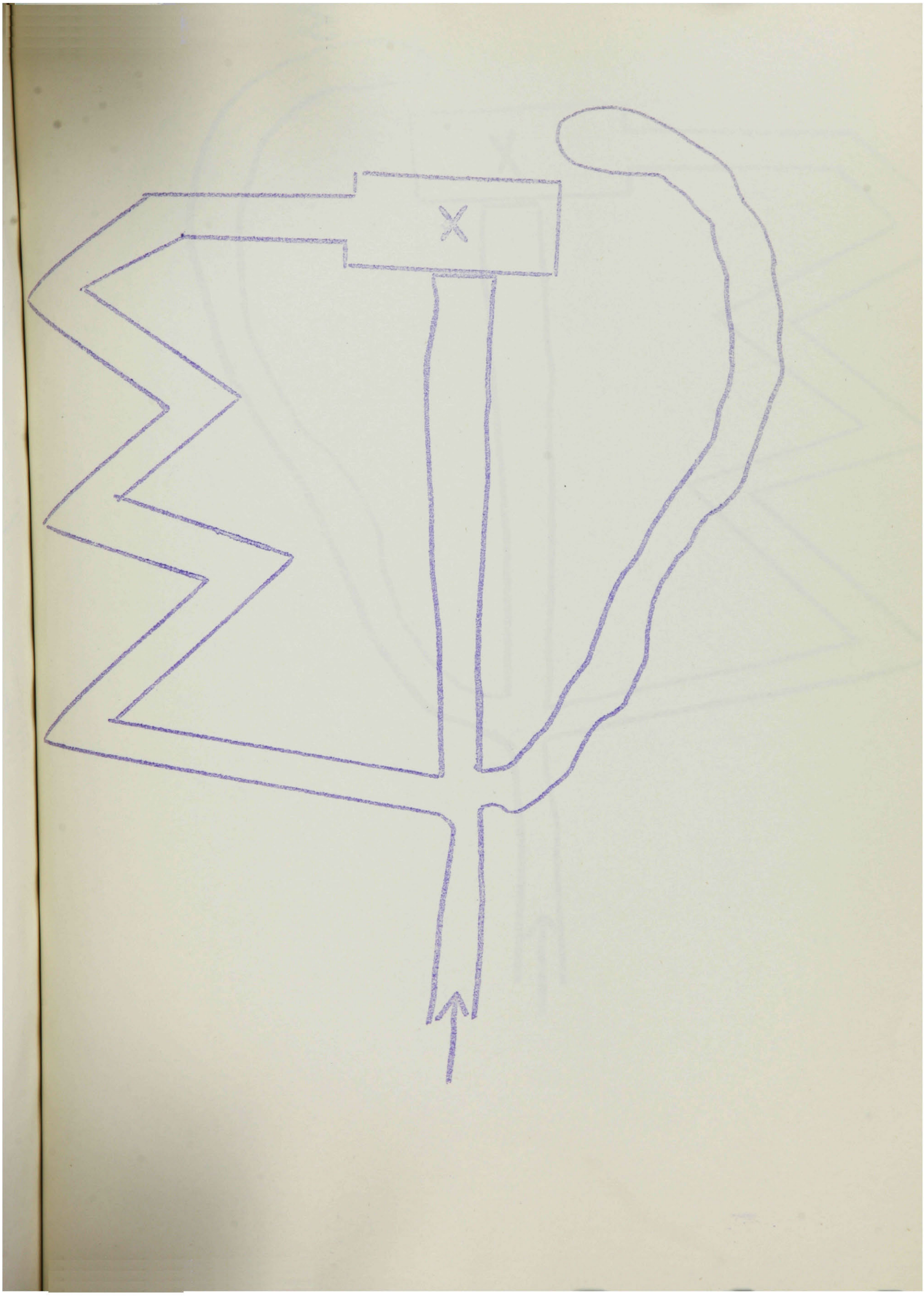

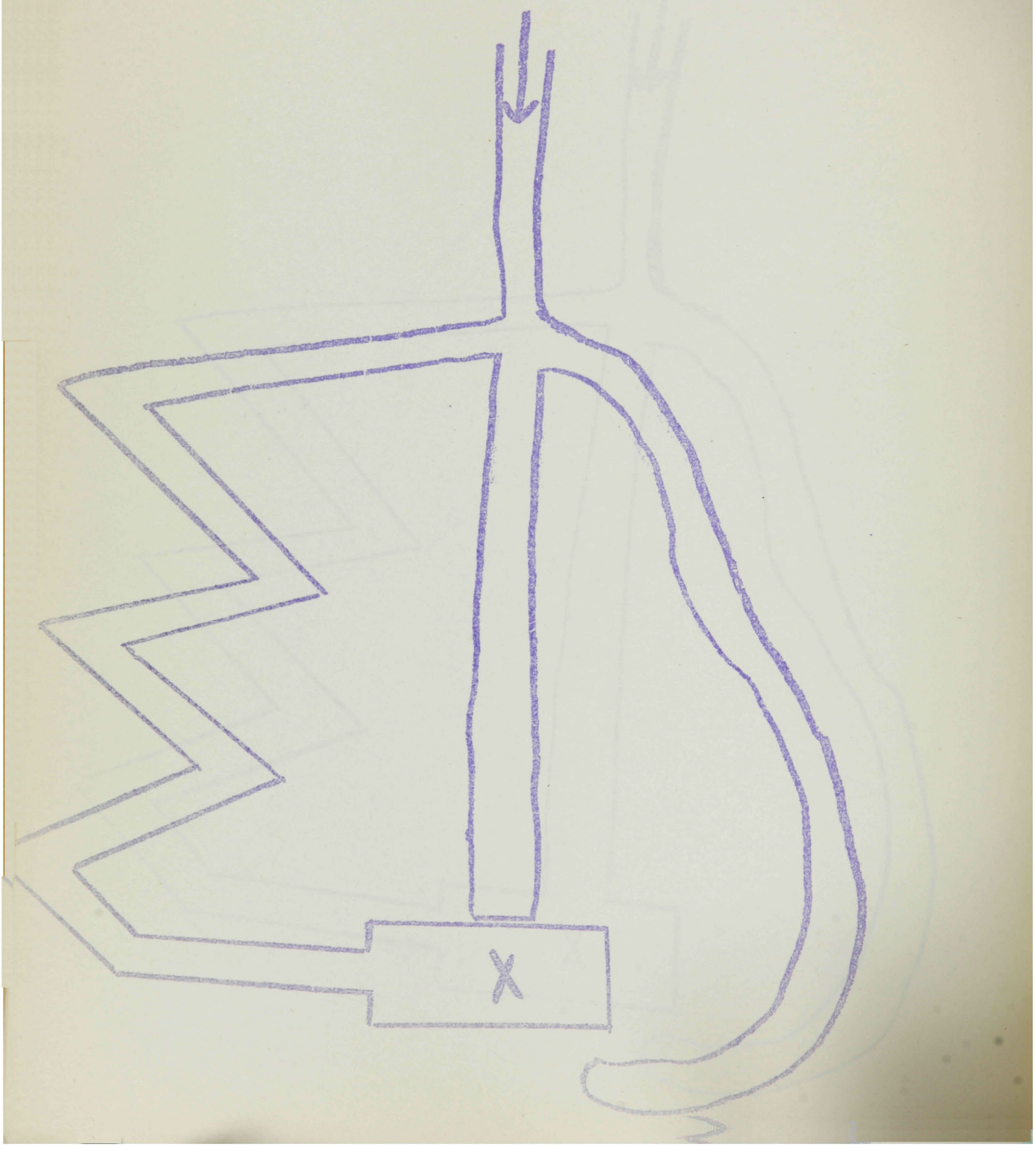
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