PROBABILISTIC FUNCTIONALISM AND MALADAPTIVE BEHAVIOR

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CURRICULUM STUDIORUM

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INTRODUCTION

Tolman and Brunswik set forth a conceptualization of the perceptual process which Brunswik has characterized as "probabilistic functionalism". In their treatise they proposed that the cause-and-effect sequences, or "causal strands of the perceptual world", fall into two distinct categories: those that are relatively fixed and consistent and those that are uncertain and contingent upon circumstances. They point out that because of the ambiguity of many of its environmental signposts, the organism must interpret the cause-and-effect sequences in terms of probability based on experience.

This thinking has profound implications for understanding the perceptual processes in terms of their functional aspects rather than as mere passive registrations. In this study it is proposed that the application of Brunswik's principles to the realm of psychopathology might have value for both strengthening the assumptions underlying this view of perception and for gaining insight into new aspects of the maladaptive processes.

The first chapter will be devoted to elaborating Brunswik's position, tracing the relevant experimentation to its present state in perception and learning theory, surveying the work on perception in the area of psychopathology, especially in schizophrenia and finally, developing a rationale for the present investigation.

The experimental design is detailed in the second chapter. The discussion includes the formulation of the null hypotheses to be tested, a description of the sampling and testing procedure and an outline of the statistical techniques.

The experimental findings are presented and discussed in the final chapter. Following upon this the limitations of the study are indicated along with suggestions for further research. The report concludes with a summary of the findings and the conclusions reached.

The appendix contains a glossary of terms including operational definitions designed for purposes of this study.

CHAPTER I

REVIEW OF THE LITERATURE

This chapter attempts to trace the evolution of the research hypothesis of the present investigation. For purposes of clarity, this evolution may be seen in two sections. First, the theoretical framework for this study will be presented, tracing the relevant experimentation to its present state in perception and learning theory. This leads to the second section wherein the work on perception in the area of psychopathology, especially in schizophrenia, is surveyed. In this section an attempt is made rigorously to define "perception" extending the term to the maladaptive organism, and developing a rationale for the present study. The chapter concludes with a summary and statement of the basic problem.

According to Tolman and Brunswik,[1] an organism operates in an environment that is a

> [...] causal texture in which different events are regularly dependent upon each other. And because of the presence of such causal couplings, actually existing in their environments, organisms come to accept one event as a local representative for another event.[2]

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1 Edward C. Tolman and Egon Brunswik, "The Organism and the Causal Texture of the Environment", *Psychological Review*, Vol. 42, 1935, p. 43-47.

2 *Ibid.*, p. 43.

Any present perceptual experience consists of a total complex of cues. In the process of experiencing the perceiver learns to evaluate some of these cues as reliable, comes to consider others as ambiguous and partly confusing, and decides to dismiss still others as totally misleading.

Rarely, however, is univocal relationship experienced.

> Types of local representatives are, that is, not connected in simple one-one, univocal fashion, with the types of entities represented. Any one type of local representative is found to be causally connected with different frequencies with more than one kind of entity represented and vice versa.[3]

Thus, if an organism is to perceive an object meaningfully, it is forced to venture hypotheses, which will have a certain probability of being correct. The magnitude of the subjective probabilities involved, is related to the unique situations in which they occur, and to the purposes and values of the experiencing individual.

Quite often the perceiver thus faces a whole number of more or less incompatible, sometimes even contradictory hypotheses, each of these essentially a probability estimate of the significance of a given cue. A resolution must be effected; it is accomplished by means of an unconscious weighting process. Cues which on the basis of past experience are assumed to have the lowest validity are given the least

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3 Ibid., p. 44.

weight and, conversely, the greatest weight is given to cues presumed to have the highest validity.

Due to the "semi-erratic" nature of the environment and the varying trustworthiness of the cues, the organism has no alternative but to venture, formulate, and evaluate these hypotheses, and subsequently select one of them. In the words of Brunswik "[...] while God does not gamble, animals and humans do, and they cannot help but to gamble in an ecology that is in essence only partly accessible to their foresight".[4]

The statistical adequacy or true representativeness of the organism's entire previous sample of experience will determine the veridicality of the selected hypothesis. New experiences are added over time to become part of future hypothesis-formulation, and thus perception.

As just shown, Tolman and Brunswik's interpretation of the perceptual process is largely dynamic in its approach, and primarily concerned with the manner by which the organism stabilizes an environment in spite of an infinite variety and shift in stimulus conditions.

Perceptions change, and learning takes place, by one of two distinct processes. One of these takes place within the already existing framework of assumptions or hypotheses

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[4] Egon Brunswik, "In Defense of Probabilistic Functionalism: A Reply", Psychological Review, Vol. 62, No. 3, May 1955, p. 236.

and results in an assignment of different weights to the existing hypotheses. In another process, new hypotheses are acquired either by "trial and error" learning and the accumulation of adequate experience, or by the application of reasoning based on general experience.

The authors finally assert that "in the case of unmodifiable instinct the new features are never noted and the new hypotheses never acquired; the organism continues to behave in the old fashion and goes under".[5] No suggestion is offered in their paper, however, as to whether maladapted humans conform to this dismal extreme, or otherwise, to what extent their learning process parallels the one advanced in their treatise. This question will be thoroughly explored in the course of the experimental study presented in this dissertation.

It has been shown above that the theory of Tolman and Brunswik primarily evolves about the ability of the organism to make a reasonably accurate probability estimate between certain cues and events or objects.

It might be asked if this theory is sufficient to explain perception. Hilgard,[6] for example, argues that a mere

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5 Tolman and Brunswik, Op. Cit., p. 73.

6 Ernest R. Hilgard, "The Role of Learning in Perception", in Robert R. Blake and Glenn V. Ramsey, (eds.), Perception An Approach to Personality, New York, The Ronald Press, 1951, p. 95-120.

frequency theory of perception is a great oversimplification of perceptual events. He states that "in perception as in learning, interpretations are modified by the patterns of experienced frequencies and not solely by the totals of such frequencies."[7] Notwithstanding this criticism, it nevertheless appears to be a useful theory which can be experimentally demonstrated to account for perceptual learning.

The following section is an examination of some experimentation relevant to this theory in the area of perception and learning, with special emphasis on the discrimination of probabilities.

1. The Discrimination of Probabilities.

Brunswik[8] followed up his aforementioned paper with a study of probability learning in rats. Different groups of animals were rewarded with different frequencies in a simple T-maze. Training consisted of twenty-four runs, four on the 1st day, four on the 2nd, eight on the 3rd, and eight on the 4th day. He found that ratios of reward could be estimated by the rat and that it would go to that side of the maze where it had the highest probability of being rewarded.

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7 Ibid., p. 113.

8 Egon Brunswik, "Probability as a Determiner of Rat Behavior", Journal of Experimental Psychology, Vol. 25, 1939, p. 175-197.

Estes[9] criticized Brunswik's experiment by objecting that his series of trials was so abbreviated that one could not be confident his animals had reached asymptotes. In a study which essentially replicated Brunswik's, save for the fact that their animals were run one trial per day for 56 days, Estes predicted that "under a 75% random reinforcement schedule, the probability of the frequently reinforced response would tend exponentially to .75 as an asymptote."[10] The study yielded mean asymptotic response probabilities in close agreement with the theoretical prediction.

In other studies, human subjects have been asked to predict whether one or the other of a pair of lights would appear,[11] whether one or the other of a list of two words would next occur,[12] or whether or not a vertical or horizontal line would be presented.[13] Close agreement has been found between event probabilities and the frequency of choices.

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9 W.K. Estes, "Of Models and Men", American Psychologist, Vol. 12, 1957, p. 609-617.

10 Ibid., p. 611.

11 Lloyd G. Humphreys, "Acquisition and Extinction of Verbal Expectations in a Situation Analogous to Conditioning", Journal of Experimental Psychology, Vol. 25, 1939, p. 294-301.

12 Murray E. Jarvic, "Probability Learning and a Negative Recency Effect in the Serial Anticipation of Alternative Symbols", Journal of Experimental Psychology, Vol. 41, No. 4, April 1951, p. 291-297.

13 Harold W. Hake and Ray Hyman, "Perception of the Statistical Structure of a Random Series of Binary Symbols", Journal of Experimental Psychology, Vol. 45, No. 1, January 1953, p. 64 74.

There is another class of experiments which demonstrates the acquisition of perceptual biases based on probabilistic cues. Brunswik and Herma[14] argued that if the acquisition of perceptual cues is to be representative of natural conditions in daily life, experiments on perceptual learning will have to duplicate the low dependability of the ecological relationships involved. In their investigation subjects were presented with pairs of weights which were lifted simultaneously. For half the subjects the preponderance of a relatively heavy or light weight was on the right side, and for half on the left. Throughout the series the subjects were asked, on each trial, which of the two simultaneously lifted weights appeared heavier at the moment of lifting.

Three main types of presentations were interspersed in a controlled random fashion during the training sequence of seventy-two uninterrupted trials. Each block of nine presentations consisted of four balanced (O), four positive (+) and one negative (-) pairings. A case in which the presentations on the two sides were either both "heavy" or both "light" represented a balanced pairing. Presenting the heavier weight to the so-called positive side, with a lighter weight on the opposite side, constituted a positive pairing. The

14 Egon Brunswik and Hans Herma, "Probability Learning of Perceptual Cues in the Establishment of a Weight Illusion", Journal of Experimental Psychology, Vol. 41, No. 4, April 1951, p. 281-290.

positions of light and heavy weights were reversed in the case of the negative pairings.

In most of the positive pairings, an objective or "ecological" correlation was established between position and heaviness. The Müller and Schumann weight expectancy illusion was used as a test of perceptual learning of the inconsistent position cue. In this illusion, lifting of a relatively heavy weight elicits an underestimation of weight in subsequent trials and vice versa for light weights. Since the preponderance of heaviness occurred on a particular side, by virtue of the experimental design, the incidence of these illusions was utilized by Brunswik and Herma as a test of the perceptual acquisition of the inconsistent position-cue.

The probability learning curve of these expectancy illusions started at chance and reached a relatively high level on the eleventh training trial which was only the fifth pairing of the balanced condition. The curves of the objective correlations between position and heaviness were followed closely by the incidence of the illusions indicating the subjects' flexibility and sensitivity to the objective state of affairs.

Levin[15] found that the two variables, namely, relative frequency and weight differential, were inextricably tied

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15 Max M. Levin, "Inconsistent Cues in the Establishment of Perceptual Illusions", American Journal of Psychology, Vol. 65, No. 4, October 1952, p. 517-532.

together in Brunswik and Herma's experiment. Correcting this and other methodological shortcomings, he reinvestigated the phenomenon and concluded that:

> The results of the experiment confirmed the findings of Brunswik and Herma. More significantly, however, they indicated that their results are generalizable beyond a particular sequence of presentation. Furthermore, their results can now be said to obtain not only for ecological relationships which fluctuate widely in their probable and partial validity but for relationships which are more uniformly inconsistent as well.[16]

Hake and Hyman[17] have questioned the ability of the subjects in these experiments to perceive the probability rules by which a series of events was generated. In a probability learning experiment, examining responses as a function of the preceding responses, they found that subjects responded to sequences of events. "Subjects do not first perceive the rules by which the series were constructed and then respond accordingly; instead they respond as though the series were composed of small subsequences."[18]

This formulation has been tested by Goodnow and Postman[19] who devised a probability task disguised as a problem solving situation. Since their experimental design

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16 Ibid., p. 530.

17 Hake and Hyman, Op. Cit., p. 64-74.

18 Ibid., p. 72.

19 Jacqueline Jarrett Goodnow and Leo Postman, "Probability Learning in a Problem-Solving Situation", Journal of Experimental Psychology, Vol. 49, No. 1, January 1955, p. 16-22.

is to be modified and incorporated into the present study, it will be presented later in greater detail. The experimental task consisted of matching geometric designs. On each trial the subjects had to choose between two types of variations as matching a key design. There were six experimental groups which differed in the probabilities of the two types of variation being correct. That is to say, the subjects' choices were differentially reinforced according to a predetermined schedule. Their results may be summarized at this point by saying that they were able to conclude that their subjects demonstrated perceptual discrimination of the probability rules contrary to Hake and Hyman's interpretation of probability task solutions. At no time did the subjects' verbal responses give any indication that they perceived the problem as one of probability discrimination.

These findings are in agreement with previous studies on probability learning and "constitute positive evidence for 'learning without awareness'."[20] The basic perceptual processes have generally been shown to consist of the utilization of environmental cues by humans in ways in which they are not consciously aware. Thus, the fact that probability discrimination can take place unconsciously gives further support to its being considered a member of the family of basic perceptual processes. These findings are in agreement

20 *Ibid.*, p. 21.

with Brunswik's view that in order to achieve environmental stability organisms must be sensitive to environmental possibilities.

Hilgard[21] has characterized one of the goals of perception as that of achieving environmental stability:

> If we accept the fact of perceptual learning, and we believe in some sort of goal orientation in learning, can we discover any goals in perception that might control perceptual learning? [One of the perceptual goals is] [...]the achievement of environmental stability.
>
> The organism seeks a perceptually stable environment in a fashion somewhat parallel to that in which it seeks an internally stable environment [...]. The organism tolerates perceptual differences [...] but it does not accept an environment that distorts too rapidly. If a man's perceived environment distorts too rapidly he gets upset [...][22]

This, of course, is entirely consonant with, if not identical to, Brunswik's views on the subject.

2. Perception and Learning in Schizophrenia.

In this section an attempt will be made to elucidate the writer's conception of the perceptual adjustive mechanism. This will be followed by a survey of the relevant literature and an analysis of the contributions that perception and learning have made to the understanding of the schizophrenic process. Then, a rationale for the present study will be presented.

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21 Ernest R. Hilgard, Theories of Learning, Second Edition, New York, Appleton-Century-Crofts, 1956, ix-563 p.

22 Ibid., p. 466.

It is generally conceded that for an organism to respond differentially to two or more stimuli it must be able to discriminate or perceive that the stimuli are unequal. Furthermore, organisms demonstrate the property of generalization, responding to stimuli of the same class in a similar manner, although they are unequal in terms of exact physical properties. In order for the organism to maintain close unity with the environment, i.e., a high correspondence between environmental and response probabilities, it must respond with some degree of appropriateness to the environmental demands or stimuli. Appropriateness would have to be defined in terms of a specific event, but in general may denote those responses which tend to preserve the integrity of the organism.

The environment consists of objects and events which, according to Brunswik and Tolman, are sometimes constant and sometimes changing. Initially, during the earliest phase in its development, the organism is plastic and its response mechanisms are constantly undergoing change and modification. The response potential of the organism is, however, limited, and as maturation proceeds idiosyncratic modes of response become stabilized. Thus, the maturing organism becomes more and more dependent upon its ability to utilize environmental cues in order to minimize the need for response modification.

Brunswik has shown how such cues may be utilized to achieve environmental stability and unity between event and response. It is in this sense that perception and the term adjustive mechanism may be related.

Stated another way, perception is the mechanism by which useful information about environmental events is introduced into the organismic system and organized by it. It is useful in terms of conserving a limited response system and in terms of an adequate response to the environment. This mechanism transforms, combines and otherwise processes incoming sensory data, i.e., those which mediate between the physical world and the organism. If perception or information gathering is an adjustive mechanism, as it has been defined above, how can one assess the relevance and importance of any one of the various processes that comprise perception to the overall adjustment of the organism?

Unfortunately, most of the experimentation to date relating perception to the organism with faulty coping mechanisms, as manifested in personality disorganization, has been in a single direction: that of trying to gain insight into pathological conditions by using perceptual methodologies. That such a unilateral approach exists is possibly the product of several factors. Most, if not all, of the investigators in this area have been clinically oriented and therefore primarily concerned with pathological mechanisms rather than with the validity of the theoretical explanations they have utilized to uncover these mechanisms. Consequently, they have been quick to apply formulations of general psychology to their pathological subjects when the former may not stand up to the scrutiny of careful experimentation or may be faulty on a logical basis. This has been criticized by Witkin *et al.*,[23] for example, in discussing person-centered approaches to perception such as those of Frenkel-Brunswik[24] and others. These studies have utilized well-worked-out conceptions of personality as a starting point relating these to the way in which needs, feelings and coping procedures are expressed in perception. Witkin *et al.* argue with devastating logic that:

> Before a perceptual situation is applied to the study of personal determinants of perception, it must be carefully investigated, in order to establish the roles of other types of variables that influence performance in it. Unless the effects of these variables, and in particular their contributions to individual differences in performance, are known and controlled, it is not possible to presume that differences among subjects reflect differences in the operation of personal factors [...]
> It may be noted here too that often even well-known and long-used perceptual techniques cannot simply be taken over as they are for use in the study of personal factors in perception.[25]

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23 H.A. Witkin, H.B. Lewis, M. Hertzman, K. Machover, P. Bretnall Meissener and S. Wapner, *Personality Through Perception: An Experimental and Clinical Study*, New York, Harper Brothers, 1954, p. 491-493.

24 Else Frenkel-Brunswik, "Personality Theory and Perception", in Robert R. Blake and Glenn V. Ramsey, (eds.), *Perception - An Approach to Personality*, New York, The Ronald Press, 1951, p. 356-419.

25 Witkin *et al.*, *Op. Cit.*, p. 493.

Thus, it would appear that under such scrutiny these formulations may indeed be found lacking.

Another factor contributing to the unilateral approach in this area is the predisposition of the psychopathologist to accept as an immutable truth that maladaptive behavior is continuous with adaptive behavior; that mechanisms of the neuroses and functional psychoses represent mere amplifications of the so-called universal defensive mechanisms of the normal personality. Yet, it is not improbable that some of the neurotic and especially the psychotic conditions may eventually be explained by rules different from those which are posited for the understanding of normal behavior. As Allport[26] says:

> In one sense the hypotheses of strict continuity between the normal and abnormal is acceptable [...] Descriptively, then, we can say that normality-abnormality is a matter of degree.
>
> But this unbroken continuum is one of symptoms, not of processes. The processes making for normality and for abnormality are very different.[27]

In a similar vein, Rosenzweig[28] notes in regard to schizophrenia that "there is always a substratum which seems to reflect a loss of capacity for functioning which differentiates

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26 Gordon W. Allport, Pattern and Growth in Personality, New York, Holt Rinehart and Winston, September 1963, xiv-593 p.

27 Ibid., p. 153.

28 Norman Rosenzweig, "A Mechanism in Schizophrenia", Archives Neurology and Psychiatry, Vol. 74, 1955, p. 544.

the schizophrenic from the neurotic". Strecker[29] likewise commenting on the lack of responsiveness of some patients to cortisone concludes that "some schizophrenic patients do not have the physiological equipment to respond to its stimulus".

It is proposed, therefore, that a reversal of the one-way experimental trend described above is needed. It would seem scientifically more valuable, for instance, to study the maladapted organism with regard to the information it can provide regarding theories of perception rather than to look for validation of psychoanalysis by applying a theory of perceptual defense. Crucial experiments of functionally oriented perceptual theories, such as those of Brunswik, must eventually involve the pathological subject and can serve the double purpose of illuminating the basic nature of the behavioral disturbance as well as testing the theory.

Perhaps the group of humans that best fit a description of behavioral maladjustment is the schizophrenic. The apparent weirdness and mysteriousness of the schizophrenic and the reason for his institutionalization by society is most likely the result of his, by and large, senseless, inappropriate or environmentally non-adaptive behavior. It has been

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29 Edward Allan Strecker, Basic Psychiatry, New York, Random House, 1952, p. 210.

extremely difficult, if not impossible, to explain this non-docility of psychotic behavior in terms of current learning theory. It is contended that the perceptual apparatus of the psychotic must be thoroughly understood before his resistance to acquire adequate responses to many environmental events can be explained.

There is little experimental basis for making any definitive statements about basic perceptual disturbances in schizophrenia. Most psychological studies in schizophrenia of a general nature have been concerned with "thought processes" reviewed elsewhere[30] or deficient responses on standardized and projective test items.[31] Some have related the schizophrenic's poor test performance to motivational factors,[32] others to a primary disturbance in the association of concepts[33] and still others have emphasized the social disarticulation of the disorder.[34] Though most of these

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30 R.W. Payne, "Cognitive Abnormalities", in H.J. Eysenck, (ed.), Handbook of Abnormal Psychology, New York, Basic Books, 1961, p. 210-261.

31 David Rapaport, Merton Gill and Roy Schafer, Diagnostic Psychological Testing, Chicago, Yearbook Publishers, 1945, 2 volumes: Vol. 1, xi-573 p.; Vol. 2, xi-516 p.

32 Bertram D. Cohen, "Motivation and Performance in Schizophrenia", Journal of Abnormal and Social Psychology, Vol. 52, No. 2, March 1956, p. 186-190.

33 Eugen Bleuler, Dementia Praecox or the Group of Schizophrenias, New York, International University Press, 1950, p. 348-363.

34 Norman Cameron, "Perceptual Organization and Behavior Pathology", in Robert R. Blake and Glenn V. Ramsey, (eds.), Perception - An Approach to Personality, New York, The Ronald Press, 1951, p. 283-306.

studies have, to an extent, examined the integrative capacity of the schizophrenic, their main focus has been on the response (or output) side.

A shift in the experimental approach may be found in a recent study by Goldstein *et al.*[35] Comparing one hundred chronic schizophrenics with an equal number of normals, they found that opening the eyes and varying the field of vision produced definite changes in energy content and the variability in the left occipital lobe of normal subjects, whereas the same changes in environmental stimulation did not significantly affect these characteristics in the schizophrenic group. Little is known, however, about how much useful information the schizophrenic is able to extract from his environment. Paradoxically, most of the so-called "diagnostic signs" of schizophrenia relate to the perceptual distortion of reality. For example, the findings that schizophrenics generally exhibit a lowered F+% on the *Rorschach*, or a tendency to concretize verbal similarities on the *Wechsler Adult Intelligence Scale*,[36] however, tell very little about their perceptual

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35 L. Goldstein, H. Stolberg and A.A. Sugarman, "Quantitative Amplitude Analysis of EEG's Obtained on Schizophrenic and Non-Schizophrenic Subjects", *Electroencephelography and Clinical Neurophysiology*, Vol. 18, 1965, p. 327.

36 David Wechsler, *The Measurement and Appraisal of Adult Intelligence*, Fourth Edition, Baltimore, Williams and Wilkins, 1958, p. 183.

abilities, for such findings obviously involve very complex processes.

Studies that deal with learning deficit in schizophrenia likewise lead to equivocality of interpretation. In general, schizophrenics improve at a slower rate than do normals in learning and practice experiments, and their output is more variable.[37,38] Influencing the final result is the method employed, for habits which do not come into direct competition with existing modes of response, will sometimes be established without too much difficulty. Huston and Shakow[39] found deficits in the early phase of pursuit motor learning, but an eventual level which equalled or surpassed that of normals. They conclude:

> The capacity for forming new habits is probably present to the same degree as in the normal person. To develop this capacity, proper motivation and more time must be given to overcome the interfering factors of the earlier stages of learning.[40]

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37 Frederick W. Huff, "Learning and Psychopathology", Psychological Bulletin, Vol. 61, No. 6, June 1964. p. 459-463.

38 H. Gwyne Jones, "Learning and Abnormal Behavior", in H.J. Eysenck, (ed.), Handbook of Abnormal Psychology: An Experimental Approach, New York, Basic Books, 1961, p. 515-[illegible].

39 P.E. Huston and David Shakow, "Learning Capacity in Schizophrenia", American Journal of Psychiatry, Vol. 105. 1949, p. 881-888.

40 Ibid., p. 887.

Affective disturbances, the tendency to shift methods too frequently, and distractions have also been found to contribute to the learning deficit of the schizophrenic. Shakow,[41] for example, in discussing the degree to which the schizophrenic is affected by irrelevant aspects of the stimulus surroundings states:

> It is as if, in the scanning process which takes place before the response to a stimulus is made, the schizophrenic is unable to select out the material relevant for optimal response.[42]

These difficulties must, of course, be taken into consideration in any perceptual study which involves the acquisition of new responses.

At present the only perceptual studies of a basic nature with schizophrenics are those dealing with perceptual constancy. Objects of the same size or shape, seen at different distances and at different angles ordinarily tend to be experienced as very similar (perceptual constancy). This phenomenon occurs despite the fact that retinal images produced by two objects viewed at different distances may be quite different.

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41 David Shakow, "Segmental Set: A Theory of Formal Psychological Deficit in Schizophrenia", Archives of General Psychiatry, Vol. 6, No. 1, January 1962, p. 17-33.

42 Ibid., p. 25.

Raush[43] hypothesized that the markedly self absorbed or socially withdrawn nonparanoid schizophrenic would evidence perceptual underconstancy, whereas the cautious, suspicious paranoid schizophrenic was expected to show extreme over-constancy. Under ordinary visual conditions, nonschizophrenics, paranoid schizophrenics, and nonparanoid schizophrenics showed overconstancy. The paranoid group, however, was significantly more overconstant than the nonschizophrenic group. When size judgments were made in a darkened room, paranoids evidenced even greater overconstancy judgments than those which were made in the lighted room. In this condition overconstancy accentuation was significantly different from both the non-paranoid group and the control group; the latter two groups tended to reduce overconstancy.

Whereas, the study cited above reported overconstancy, others have reported underconstancy in the size judgments of schizophrenics. Lovinger[44] divided his schizophrenic subjects into "good contact" and "poor contact" groups on the basis of staff personnel ratings. Size constancy perception was studied under three conditions: maximized distance cues

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43 Harold L. Raush, "Perceptual Constancy in Schizophrenia", Journal of Personality, Vol. 21, No. 2, December 1952, p. 176-187.

44 Edward Lovinger, "Perceptual Contact with Reality in Schizophrenia", Journal of Abnormal and Social Psychology, Vol. 52, No. 1, January 1956, p. 87-91.

(binocular viewing of the stimuli), minimized distance cues (monocular viewing of the stimuli), and no distance cues (monocular viewing, reduction screen, poor lighting). All groups were very similar under conditions of maximum or absent cues. But when minimal cues were offered, poor contact schizophrenics achieved less constancy (overestimation of the closer object) than the good contact and control groups, which did not signif'cantly differ from each other. No significant differences were found between the constancy performances of paranoid and nonparanoid schizophrenics. In attempting to account for the discrepancy between this latter finding and Raush's data, Pearl[45] stressed the importance of the acute versus the chronic dimension of schizophrenia. He pointed out that Lovinger's "poor contact" underconstant schizophrenics were primarily chronic and that his "good contact" overconstant subjects were mostly early schizophrenics. Similarly, he suggested that Raush's paranoid group were primarily acutes and his nonparanoid group were mainly chronics. Although such an inference may be warranted in the Lovinger study, there is little basis for such a statement about Raush's subjects.

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45 D. Pearl, "Stimulus Input and Overload in Relation to Classifications of Schizophrenia", Newsletter Research Psychology, Vol. 4, 1962, p. 44-56, cited by Julian Silverman, "The Problem of Attention in Research and Theory in Schizophrenia", Psychological Review, Vol. 71, No. 5, September 1964, p. 358.

As stated above, Lovinger, in accordance with his prediction, found significantly less size constancy to minimal distance cues by the poor contact schizophrenics than either the normal or good contact schizophrenics which did not significantly differ from each other. Maes[46] in a follow-up study tested the same type of subjects on the same apparatus. He found no differences in constancy scores between the "good" and "poor" contact schizophrenics, however, both groups were significantly different from the normal group on the minimal cue condition, with the schizophrenics being more constant than the normals. These findings are diametrically opposite to those obtained by Lovinger. As can be seen from the foregoing studies, the conflicting results do not offer any generalizations concerning size constancy in schizophrenia.

What aspect of schizophrenic symptomatology suggests that persons suffering from this disorder may exhibit an impaired ability to perceive probability relationships? As has been shown earlier, one may think of schizophrenia in terms of a relative debility of the adjustive mechanisms. By this is meant that if the perceptual goal of the organism is "(1) the achievement of environmental stability and (2) the achievement of clarity and definiteness in perception",[47]

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46 J.L. Maes, "Size Constancy in Schizophrenia", unpublished Master's dissertation, Michigan State University, 1957, cited by Leopold Bellak, (ed.), Schizophrenia: A Review of the Syndrome, New York, Logos Press, 1958, p. 243.

47 Hilgard, Theories of Learning, p. 466.

there is reason to believe that the schizophrenic fails to accomplish this end. The division between the objective and subjective world of this type of patient is perhaps the most consistent symptom of the various types of schizophrenics. Furthermore, it has been suggested that if the organism is to adjust to the subtle changes in its environmental demands, it must remain docile, and flexible. Stereotyped, perseverative behavior is one of the characteristics of the schizophrenic. The strength of his resistance to change is highlighted by the extent to which some of the psychiatric therapies have gone to, in order to assault the nervous system to dislodge the maladaptive patterns.

In studying schizophrenics as a group, it is not meant to imply that this diagnostic term denotes a disease entity. This investigation is concerned with this class of humans only as representing an extreme form of maladaptiveness. Nor is it believed that the etiology of this disorder would be delineated by proven defects in such basic perceptual processes as object constancies and probability discriminations (if the latter prove to be basic). For instance, the evidence for the role of affect, or lack thereof, is regarded as compelling as a contributive factor to many schizophrenic manifestations. It is only contended that the more elaborate conceptualizations of perceptual organization in schizophrenia will become more meaningful when the elementary mechanisms are understood.

3. Summary and Statement of the Problem.

The purpose of this review has been twofold, the presentation of Brunswik's theory of Probabilistic Functionalism which provides the framework for the present study and the delineation of the research related to the discrimination of probabilities and to perceptual learning in schizophrenia.

Brunswik proposes that the environment has many causal strands, i.e., cause and effect sequences, some of which are firm, consistent, and dependable, others which are unsure, inconsistent, and contingent upon circumstances. The theory deals with the organism's interpretation of cause and effect sequences as a matter of venturing "an hypothesis" which will have a certain probability of being correct.

A review of the relevant literature lends support to this position. Organisms have shown an ability to reach close agreement between event probabilities intended by an experimenter and the frequency of choices. This indicated their sensitivity and flexibility to the objective state of affairs. Furthermore, there is evidence that learning of intended response patterns occurs without the organism's awareness.

Concerning perceptual learning in schizophrenia, however, there is little experimental basis for making any definitive statements. Investigators have, for the most part, concerned themselves with the response, or output, side of the schizophrenic's maladaptive behavior. It was suggested that before any conclusions can be reached, basic research is needed regarding the perceptual learning of schizophrenics.

The general purpose of the investigation which follows is threefold:

1. To explore the validity of Brunswik's theory of Probabilistic Functionalism when applied to the maladapted organism.
2. To investigate the importance of the organism's adjustment, of the perception of simple probabilities and the organization of probability information.
3. To investigate the maladapted organism's perceptual functioning in the discrimination of simple probability events.

The problem resolves to (a) ascertaining the ability of schizophrenics to subliminally detect simple probability principles, when these are disguised as a problem solving task and (b) to ascertain the effect of experience upon learning in such a task.

The following chapter discusses the statistical formulation of the problem and presents the experimental design employed.

CHAPTER II

THE EXPERIMENTAL DESIGN

This chapter will start out with a statement of the statistical hypotheses tested during the course of the experiment. It will establish criteria for and describe the selection of maladjusted subjects and an experimental control group of normals. One section will be devoted to a description of stimulus cards, the manner and order of their presentation to subjects, the recording, and scoring of responses. A final section discusses the analysis of variance techniques and t-tests which apply to the data, for the purpose of a statistical evaluation of the results found in the experimental study.

1. Statement of the Statistical Hypotheses.

As will be recalled from the previous chapter, the specific research problem of the present study is to determine the ability of schizophrenics to subliminally detect simple probability principles when these are disguised in a problem solving task, and to ascertain the effect of experience upon learning in such a task.

The following experimental hypothesis and sub-hypotheses were derived from the statement of the problem:

Schizophrenics, in contrast to normals, show an impaired ability to perceive simple probability demands, when these are disguised in a problem solving task.

a) Schizophrenics tend to respond to the disguised demands more randomly than do normals.

b) Schizophrenics are less able than normals, to match their response pattern to the disguised demands.

From this experimental hypothesis four major statistical hypotheses may be formulated. In view of theoretical considerations concerning formulation of the hypotheses presented in Appendix 2 they are stated in null form as follows:

1. There is no significant difference between schizophrenics and normals with respect to the mean number of correct responses in the discrimination of a simple probability demand when this is disguised as a problem solving task.
2. There is no significant difference between the mean responses given by normals and schizophrenics during the initial stages of the experiment and those obtained in other stages.
3. There is no significant difference between the mean responses given by normals and schizophrenics in various reinforcement schedules and those to be expected as a result of chance.

4. There is no significant difference between schizophrenics and normals with respect to the mean number of correct responses for the different blocks of trials in the discrimination of a simple probability demand.

2. The Subjects of the Study.

Since the investigation of perceptual learning in the maladapted organism is the focal point of this study, it was essential to devise a proper method for the selection of respondents. The criteria for inclusion of subjects in the experimental group were as follows:

1. A diagnosis of schizophrenia agreed upon by the staff psychiatrist, psychologist, and psychiatric social worker.
2. Absence of neurological involvement, or previous lobotomy.
3. Absence of shock treatments within thirty days prior to testing.
4. Ability to comprehend and follow the instructions of the experiment.

The sixty schizophrenic subjects in the experimental group were selected from among the first admissions and re-admissions at Lakeshore Psychiatric and Toronto Psychiatric Hospitals, Toronto. There is no evidence in the literature that variables such as sex, age, education or intelligence would influence the results of this study; therefore, it was not considered necessary to control for these dimensions.

The primary diagnosis of all the subjects was schizophrenia; they were selected and assigned to the various groups without regard to the specified type. Length of hospitalization at the time of the experiment varied from several days to seventeen years. All patients were actively psychotic, as evidenced by their symptamatology at the time of administering the experiment. Those patients who exhibited gross confusion or severe loss of reality resulting in an inability to persevere or understand the experimental instructions were of necessity excluded from the study. An account of the selection procedure is presented below.

Ward psychologists were contacted for the names of all patients on their ward, which they had diagnosed as schizophrenic. This list was checked against hospital files. Only patients whose diagnosis on these files agreed with that of the psychologists were retained in the sample. The list thus obtained was then checked against current nursing records with regard to E.C.T. and drugs. Those engaged in a course of shock therapy within the preceding thirty days were arbitrarily dropped. Heuristically this restriction was deemed sufficient, since staff psychiatrists administering shock treatments indicated that, in their opinion, three to five days would be sufficient for most of the effects to dissipate. Furthermore, it must be remembered that any subject that showed gross confusion or failed to grasp the basic requirements of the experiment was automatically excluded from this study, regardless of any other considerations. This procedure produced an acceptable sample of fifty-nine respondents. An additional schizophrenic was randomly chosen from a group of two patients under intensive study at Toronto Psychiatric Hospital. This completed the planned sample size of sixty maladjusted respondents. The diagnostic categories at both institutions were based on the Canadian classification of mental illness.[1]

The final group of sixty maladapted respondents was composed of thirty-three females and twenty-seven males. The subtypes of schizophrenia were: twenty-seven unspecified, twenty-two paranoid, six catatonic, two schizoaffective, two simple, and one hebephrenic. The mean age for the group was 38.7 years with a standard deviation of 12.36. The mean educational level was 10.5 years with a standard deviation of 2.29.

Because the precise effect of ataractic (stelazine, largactil, etc.) or mood-elevating drugs (e.g. elavil) on

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1 Dominion Bureau of Statistics, Health and Welfare Division, *Mental Statistics Handbook*, Second Edition, Ottawa, Queen's Printer, 1954, 79 p.

basic psychological processes remains to be determined, every attempt was made to study non-medicated patients throughout the experiment. From a practical standpoint, it was impossible to obtain a sufficiently large sample of non-medicated cases, as nearly all patients received some quantity of these drugs. It was, however, possible to collect data on one maladjusted group of five male and five female schizophrenic subjects. These were tested either prior to drug administration or after they had been taken off drugs for at least thirty days. A pilot study[2] compared this group with ten "medicated" schizophrenics matched for age and educational level. The experimental task for both groups was identical to the one in the present investigation. No significant differences were found between schizophrenics receiving medication and the "non-medicated" schizophrenics ($F = .507$). These findings led to the conclusion that the administration of medication does not significantly alter the over-all performance of the medicated schizophrenics in this experiment.

It will be remembered that the primary concern of this investigation was to assess differences in perceptual learning between "maladapted" and "adapted", or "normal", subjects.

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2 Erich Schneider, Interim Report presented to the Faculty of Psychology and Education of the University of Ottawa, Ontario, January 1966, viii-163 p.

The criteria for the latter subjects' inclusion in the experimental control group were as follows:

1. Active engagement in the environment.
2. Absence of a history of mental illness.
3. Current residence in a location other than a hospital, penal or mental institution.
4. Ability to comprehend and follow the instructions of the experiment.

The above criteria are deemed necessary and sufficient to distinguish between the two groups along the continuum of adaptation. No special attempt was made to assess mental health other than inquiring whether subjects had any previous history of mental illness. The experimental control group consisted of thirty subjects who were members of Chevra Tiferes Israel Anshei New York Synagogue, Toronto, and thirty subjects composed of volunteer workers, and staff personnel at the Ambassador Home, Norwood, Ohio.

The group of schizophrenics previously described was contrasted to the above group of sixty which contained thirty males and females respectively, and satisfied the criteria laid down for "adapted" subjects. The mean age for the group was 39.3 years with a standard deviation of 12.74, a mean educational level of 10.5 years with a standard deviation of 2.29. This experimental control group will be referred to as the normals.

The sex, age and educational characteristics of the various groups are shown in Table I. It will be noted that, while the mean age for the normals is somewhat higher than for the schizophrenics, the groups appear reasonably similar for age ($t = -.266$) and educational level ($t = .638$). The manner of alloting subjects to the different experimental treatments is described below.

The findings in this experimental study were subjected to analysis of variance techniques which are based on an assumption of homogeneity of variance.[3] It was imperative to select subjects randomly for each group, so that the above assumptions would not be violated. Originally the use of a table of random numbers was planned for that purpose. However, several complicating factors interfered with this procedure. Some of the subjects were placed on probation, while others became involved in a variety of therapeutic activities. It became therefore necessary, for practical reasons, to substitute a randomization procedure which would be sufficiently flexible to allow the experimenter to test the available subjects, as well as assigning them randomly to the different groups.

Randomization was achieved by placing numbers on disks corresponding to the group's reinforcement schedule.

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3 Allen L. Edwards, Experimental Design in Psychological Research, New York, Holt, Rinehart and Winston, 1962, p. 108-109.

Table 1.-

Range, Means and Standard Deviations for Sex, Age and Educational Characteristics of the Normal and Schizophrenic Groups.

	N	Sex		Age in Years			Education		
		M	F	Range	Mean	S.D.	Range	Mean	S.D.
Normal	60	27	33	[illegible]	[illegible]	12.74	6-16	10.3	2.24
Schizophrenics	60	[illegible]	[illegible]	[illegible]	30.7	12.36	8-16	1?.?	2.2?

Since each group was to consist of ten subjects, there were thus ten disks for each of these groups numbered respectively, 50:50, 60:40, 70:30, 80:20, 90:10 and 100:0, a total of sixty disks. These were placed in a box, and thoroughly mixed. Just prior to a subject's entry into the experimental room, the experimenter would draw and remove one disk out of the box. The subject was then assigned to the group shown on the selected disk, for example 80:20. The same procedure was followed until all the disks had been withdrawn. All subjects were thus randomly assigned to the different groups.

The formulation of the six groups here described was inspired by the earlier experiment with normals by Goodnow and Postman,[4] previously referred to. Unlike this earlier work, each group of normal respondents in this experiment was compared to similar groups of schizophrenics, their responses compared, and analyzed. Following the description of the research tool in the pages to follow, a later section entitled "Reinforcement Schedule" will explain the intended frequencies of 50, 60, 70, 80, 90 and 100 per cent assigned to the various groups.

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4 Jacqueline Jarrett Goodnow and Leo Postman, "Probability Learning in a Problem-Solving Situation", Journal of Experimental Psychology, Vol. 68, No. 3, Whole No. 374, 1954, p. 1-24.

3. The Research Tool of the Study.

The stimulus used throughout the experiment was designed by the experimenter in accordance with principles first developed by Postman.[5] There were ten basic sets of 3" x 5" cards, each showing a pair of abstract geometric designs. One of the five cards in each set was a "key card" showing a basic pair of designs and the other four cards showing variations of the "key card". The variations were obtained by removing a line from the basic pair and adding it to the other. Thus all members of the basic pair are preserved in the variations. The four variations were divided into two basic types, each consisting of two different combinations.

When a line is removed from the left design and placed on the right design, the card is termed a "subtractive" card. Conversely, when the line is added to the left design from the right design, the card is termed an "additive" card. The first or left design is thus the reference for determining the nature of the card. The variation pairs were constructed in such a way that the added line is not obscured by any other line in the figure to which it was added. All ten sets are displayed in Appendix 3.

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5 Leo Postman, "Learned Principles of Organization in Memory", Psychological Monograph, Vol. 68, No. 3, Whole No. 374, p. 1-24.

It was felt necessary in testing the designs, to make certain that none would evoke undesirable and unsteadying emotional associations; this would have been especially disturbing in the case of schizophrenics, in which case their responses may be assumed acutely influenced by the emotionally charged perception.

Initially, therefore, fifteen sets of five cards were drawn, and tested by asking twenty of the normal and as many maladjusted subjects about the meaning of the drawings shown them, and their impression gained thereby. Only the remaining ten "neutral" designs were retained in the study.

To facilitate handling of the cards, as well as to reduce the number of incidental cues (viz., spotting, tears, bent corners, etc.) which might interfere, or distract the subjects, Xerox copies of the original design were made. These were mounted on four-ply Bristol board and cut to the required size. The total number of cards in the experiment was 350, allowing the experimenter to present each card only once to a given subject, throughout the entire experiment.

4. Order of Presentation of the Stimulus Cards.

In the section describing the experimental procedure it will be shown that the experimental task required the subject to decide which of two variations constituted a correct match to the "key" card. For each "key" card, two "additive" and two corresponding "subtractive" variations were constructed. As a result a total of eight different presentations ("key" card and two variations) were possible. This was done so that the effect of memorization from one presentation to a subsequent one would be minimized to allow examination of the subject's actual learning process.

In order to further reduce the use of memory as a clue to specific designs, as well as to obviate position effects, the stimulus cards were ordered according to a predetermined random design. The method employed in the arrangement of the cards is presented below.

Each of the basic "key" designs was assigned a different number ranging from one to ten. Their respective variations were also coded, A1, A2, representing the "additive" variations, S1, S2, the "subtractive" variations. The order in which the cards were presented is shown in Table II. The underlying principle of classification is as follows: Each column represents one block of ten trials or presentations. The cell entries indicate the specific cards used in any given trial. For example, the first cell entry in the table denotes the set of three stimulus cards presented to every subject on the first trial. Thus the "key" card of the second set was placed to the subject's left, "additive" card number one was placed to the right of the "key" card, followed by "subtractive" card number two of the same set. In a similar manner, the

TABLE II.-

Order of Presentation of the Stimulus Cards.

Trials	Blocks 1	2	3	4	5	6	7	8	9	10
1	2 A1 S2	1 S1 A1	3 S1 A2	5 A1 S1	8 A2 S1	9 A1 S2	10 A2 S2	4 A2 S1	7 A2 S2	6 S2 A2
2	5 S1 A1	2 S2 A2	10 A1 S2	6 S2 A1	4 A2 S2	1 A2 S1	3 S2 A2	7 S1 A1	[illegible] S1 A2	[illegible] S1 A1
3	8 A1 S1	9 S1 A2	7 S3 A2	3 A2 S2	1 S2 [illegible]	4 S1 A1	2 A2 S1	5 S2 A2	6 S1 A1	10 S1 A2
4	7 S2 A1	6 A2 S1	[illegible] A1 S2	2 S1 A1	9 A2 S1	5 A2 S2	4 A1 S2	10 A2 S1	1 A1 S1	3 A1 S1
5	[illegible] S2 A1	7 A2 S1	1 S1 A1	8 S2 A2	3 S1 A1	10 S2 A1	5 S1 A1	6 A1 S2	2 S2 A1	4 S2 A1
6	6 A1 S2	4 S1 A1	9 S1 A1	7 A2 S1	2 A1 S2	8 S2 A1	1 S2 A1	3 S2 A1	10 A1 S1	5 A2 S1
7	3 S1 A2	10 A1 S1	5 A2 S1	4 S1 A2	7 S2 A1	2 S2 A2	9 S2 A2	8 A2 S2	5 A1 S2	1 A2 S2
8	1 A2 S2	5 S2 A2	2 A2 S2	10 S1 A1	6 A1 S1	3 A1 S2	8 A1 S1	9 S2 A1	4 S2 A2	7 A1 S2
9	4 A1 S2	3 A2 S1	5 S2 A1	9 A1 S2	10 S2 A2	7 A1 S1	6 A2 S2	1 S1 A2	8 S1 A2	2 S1 A2
10	10 S2 A2	8 A2 S2	[illegible] [illegible]	1 A1 S2	5 S1 A2	6 S1 A2	7 S1 A2	2 A1 S1	3 A2 S1	9 A2 S2

next cell indicates that the second trial consisted of "key" card number five, "subtractive" number one and "additive" number one in that order.

The following observations may be made regarding the presentation schedule: In each series of ten trials the basic design is never repeated. No "key" or variation ever repeats in the same position (i.e. "key" card number eight is shown only once first or second, etc.). The same "key" card does not appear on trial ten of one block, and on the same trial in the following block. After the first two series of ten trials, no combination ("key" and variation) is ever identically repeated. In each series of ten trials the "additive" (or "subtractive") card is shown one half of the time in the middle position and one half of the time in the right position, in random order. "Additives" or "subtractives" are never consecutively shown any more than three times at the most. Thus, the schedule of presentation was also designed to reduce extraneous position effect. Variations were presented with "additive" and "subtractive" cards presented at times on the right, at other times in the center, next to the "key" card, in unpredictable order, so that the relative positioning offered no clue to the respondent.

It is not contended that this matrix alone completely eliminated memory or position effects, but any cues that may have been derived as a result of these factors were reduced to a minimum. In the following section it will be shown that the use of a randomized reinforcement schedule resulted in another control for the above-mentioned effects.

5. Reinforcement Schedule.

It was previously stated that there were six experimental ("maladapted") groups and six experimental control ("adapted") groups which differed in regard to the frequencies with which "additive" and "subtractive" variations were called correct, viz., 50:50, 60:40, 70:30, 80:20, 90:10 and 100:0 per cent.

Based on the subject's guessing preferences shown during ten practice trials, any variation seemingly preferred by the respondent and chosen sixty per cent of the time or more, was given the lower frequency of reward, as will be illustrated in a hypothetical example to be presented in a later section. The intended frequency was expressed in terms of the less desirable variations in order to test unconscious learning under the most stringent conditions. This assignment does not apply to the 50:50 condition, in which case reinforcement was equally distributed between the two variations.

The intended ratios relate to all of the ten blocks of 10 trials for a given subject, and refer to the frequencies with which the alternatives were called correct by the experimenter. In a 70:30 group the alternative (say, "additive") less favored by the subject was identified as "correct" exactly seven times, in each ten presentations, in predetermined random order. Whenever the subject chose this alternative, he was advised that *his* choice was "correct", whereas he was told that the *other* card was "correct", whenever his selection failed to coincide with the reinforcement schedule. The schedule of correct alternatives was designed by means of a table of random numbers.

It will be remembered that the presentation of variation cards alternated, as previously explained, to avoid building up a position habit, to negate the effects of an existing position preference, and the possibility of responses due to memorization rather than learning. The preceding safe-guards in the design of the presentation and reinforcement schedules materially reduced, if not completely eliminated, contamination by the above-mentioned factors.

Subjects selected for the 70:30 group, for example, did not realize that they faced the problem of choosing an unidentified variation card, exactly seven times in each block of 10 trials. The only reliable clue was the experimenter's cryptic remark that the subject's choice was or was not "correct". During the course of the ten trials in the first of such blocks the experimenter thus identified a particular variation (say, an "additive" card) as correct seventy per cent of the time. After additional exposure to similar blocks of experiments, an ideal learning process should result in the subject's selection of the designated, but variation exactly seven times, in each block of ten presentations. Since the experiment is designed as a disguised problem solving task, it can of course be expected only that successful learning will approximate the above ideal in all groups except the 100:0 probability ratio. In this latter case the respondent may be expected to realize the experimenter's objective, if the learning process was successful.

6. Experimental Procedure.

The subject was seated at a desk facing the experimenter. The experiment was introduced as a study of learning. The initial instructions were as follows: "I want to see if you can solve a problem without me telling you what the problem is about. I will help you though, by showing you something about the problem and telling you when you are right and when you are wrong. Your job is to figure out why I am saying 'right' or 'wrong'."

The subjects in all groups received explicit instructions and training in the derivation of variation pairs from the "key" design. They were given the following instructions: "Your first task is to learn to identify cards made up of geometric figures. In these cards we have 'key' figures which can be broken down in several different ways." At this point the experimenter exposed the first set of cards showing an example of one "key" and two variations. "What we do to form different cards is to take a line from one of the 'key' figures and add it to the other. If we add a line to the first figure we call it an 'additive' card. Here is an example of an 'additive' card (pointing to the 'additive' variation of the set). If we take away a line from the first figure, we call it a 'subtractive' card. This one is a 'subtractive' card (pointing to the 'subtractive' variation). Remember, we either add or subtract a line from the first figure. Therefore, if you look at the 'key' card, you will be able to identify the other cards. I will show you other 'key' cards and their variations. Study them carefully and try to identify them since you will be asked to call them by name later." At this point a practice series of ten trials was presented, in which the subject was asked to name each of the alternatives and to select the card he preferred in that set, without being told that his choice was correct or not.

The responses recorded during the practice series were considered as an estimate of the subject's guessing preferences towards the two variations, in the absence of reinforcement clues. They also assured the experimenter that the subject understood the instructions given him with regard to the principles of correctly identifying the variations.

Following the practice series, the subject was given one hundred trials divided into ten block of ten trials each, in which his choices were differentially reinforced by the experimenter's acknowledgment as to the "correctness" of the selection, according to the predetermined schedule for that group.

The experimenter presented the stimulus cards by drawing them from a box in prearranged order. The "key" card was drawn first and placed in front and to the left of the subject. The two variation cards, one "subtractive" and the other "additive", were then successively placed to the right of the "key" card.

After placing the cards in front of the subject, he was asked, "Which one of these two cards might be correct?" while the experimenter pointed to the variation cards. When the subject had made his choice, the experimenter recorded the response, and commented on the subject's choice; a response was labeled correct if it coincided with the experimenter's predetermined choice. An incorrect response constituted the selection of the opposite variation card, in which case the subject was advised, "No, this additive (subtractive) card is correct."[6] The two variation cards were withdrawn simultaneously, then the "key" card.

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6 A sample data sheet used in the study appears in Appendix 4.

The subject was limited to about ten seconds after presentation of the cards, for each choice; this was the minimum time required for recording the responses on the standard data sheet, and replacing one set of cards for another. The interval between successive blocks lasted approximately thirty seconds. After every other block the subject was asked, "How did you decide which card to choose?" His responses were then recorded verbatim, if they were brief, or otherwise summarized; this procedure required up to sixty seconds.

7. Scoring Procedures.

The method of recording and scoring of responses may now be presented in greater detail. It will be remembered that the one hundred experimental presentations were divided into ten blocks of 10 trials each. On every trial the subject selected either the "additive" (A) or "subtractive" (S) variation as matching the "key" design. The subject's selection was recorded, as given by him: A for "additive", S for "subtractive" and his choice evaluated as correct (V) or incorrect (X). A hypothetical illustration of one block of 10 trials in an assumed 70:30 group is:

Table III.-

Hypothetical Illustration of a Block of Ten Trials, 70:30 Reinforcement Group.

Trial Number	Required Choice	Subject's Selection	Experimenter's Response
1	A	Subtractive	"The other card is correct"
2	A	Additive	"correct"
3	S	A	"The other card is correct"
4	A	A	"correct"
5	A	A	"correct"
6	S	S	"correct"
7	S	S	"correct"
8	A	S	'The other card is correct'
9	A	A	"correct"
10	A	A	"correct"
Total		6[a]	

a Total number of times the required answer (additive) was given.

The predetermined random reinforcement schedule indicated that the "additive" variation would be the required one and would be identified as 'correct' on trials 1, 2, 4, 5, 8, 9, and 10, whereas the "subtractive" variation would be called correct if offered on trials 3, 6, and 7.

The sample shows that the subject gave six "A" responses on the first block of trials. Some of these were called correct; others were called incorrect. Regardless of the experimenter's comment, his score for the six "A" responses in that block is 6. This score indicates the frequency with which ("additive") the more frequently reinforced variation was selected by him in that block.

In summary, the score for each block of trials equals the number of times the subject selected the required variation ("additive" in this case) regardless of the reinforcement given (i.e., correct or incorrect). For a given block, scores may thus vary between 0 and 10, depending on the frequency with which the required alternative was selected by the subject. Since there were ten blocks of trials, each subject received ten scores. A total of all scores indicates what per cent of the time the required answer was offered, during the entire experiments of one hundred trials.

6. Statistical Procedures.

The hypotheses set out at the beginning of this chapter indicated that group and trial effects would be analysed. A three-factor[7] and a two-factor[8] analysis of variance model with repeated measures on one factor were selected as the most suitable method of analyzing the data of this study. In addition, t-tests were offered where indicated.

The three-factor analysis of variance is concerned with (a) an examination of the statistical significance of mean responses given by the maladjusted group, as compared to those given by normals, (b) with mean responses given by subjects when the desired frequency to be learned is varied, and (c) the means on successive blocks of trials, as the experiment takes its course.

The two-factor analysis of variance is essentially concerned with an examination of the statistical significance of mean responses given by the maladjusted group as compared to those given by normals for each frequency, and with the respective means on successive blocks of trials. The same model was also used to examine the statistical significance

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7 B.J. Winer, Statistical Principles in Experimental Design, New York, McGraw-Hill Book Co. Inc., 1962, p. 337-344.

8 Ibid., p. 302-312.

of mean responses given by groups receiving a lower frequency of reinforcement, as compared to those given a higher frequency of reinforcement, and to examine means on successive blocks of trials.

t-tests were computed to examine the significance of a difference between the maladapted and the adapted groups. The first analysis[9] examined the significance of a difference between the obtained means for each block in each frequency. A second analysis[10] compared each block in each frequency for each group to a hypothetical chance pattern in which the mean was equal to .5. A third analysis,[11] finally, compared each block in each frequency for each group to a hypothetical ideal in which the mean was equal to the desired frequency.

In this chapter the experimental design of the investigation was presented. It described the instruments used, the method of administration, the experimental and experimental control populations, and the statistical analysis of the data. The following chapter will summarize the results of this investigation and discuss these in detail.

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9 Allen L. Edwards, Experimental Design in Psychological Research, New York, Holt, Rinehart and Winston, 1962, p. 93.

10 Lawrence T. Dayhaw, Manuel de statistique, Editions de l'Universite d'Ottawa, 1958, p. 358-359.

11 Ibid.

CHAPTER III

PRESENTATION OF RESULTS AND DISCUSSION

This chapter will present and interpret the results of the experiment described in the preceding chapter.

The first section will summarize the results of the statistical analyses applied to the data, followed by a discussion of the results and their implication relative to the underlying theory. An additional section devotes itself to critical comments concerning the techniques employed in the experiment and the relevancy of the results found.

The limitations of the present paper will be examined, and a final section offered with suggestions for further research.

1. The Results.

Quantitative Results.- The mean number of successful choices obtained by all subjects over successive trials will be considered first. Reference to Figure 1 indicates that the mean number of such choices in all first trials approximates .5 which would be expected in a pure guessing situation. In successive trials the mean number of choices rises towards the intended probability as expressed by the reinforcement schedule. The final portion of each curve is found at increasingly higher levels reflecting the increasing reinforcement intended by the experimenter. Inspection of Figure 1 thus presents a series of curves at successively and significantly higher levels, ($F = 41.191$, $p < .005$)[1] starting with the 50:50 group and topped by the curve which represents the 100:0 reinforcement schedule. As learning takes place, the means obtained in trial after trial increase significantly ($F = 35.242$; $p < .005$). The relative steepness of the initial part of the curve indicates the speed with which the observed learning process has taken place; it is found to be steepest for the 100:0 group in which substantial achievements are observed as early as the third block of ten trials. It will be noted, however, that even the final segments of each curve fail to reach the ideal goal; thus even the highest curve, representing the 100:0 reinforced group merely reaches a mean response of 9 on the final block of trials, ten per cent short of its ideal goal. This is due to the fact that the observations shown here are obtained from all the subjects that took part in the experiment, including the maladapted group.

Analysis of variance, however, presented in Table IV, indicates a highly significant difference ($F = 66.070$; $p < .005$) in the performance of the respective groups which took part in this study, namely, normals and maladjusted subjects. This

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1 The results of the Analysis of Variance here referred to are presented in Table IV.

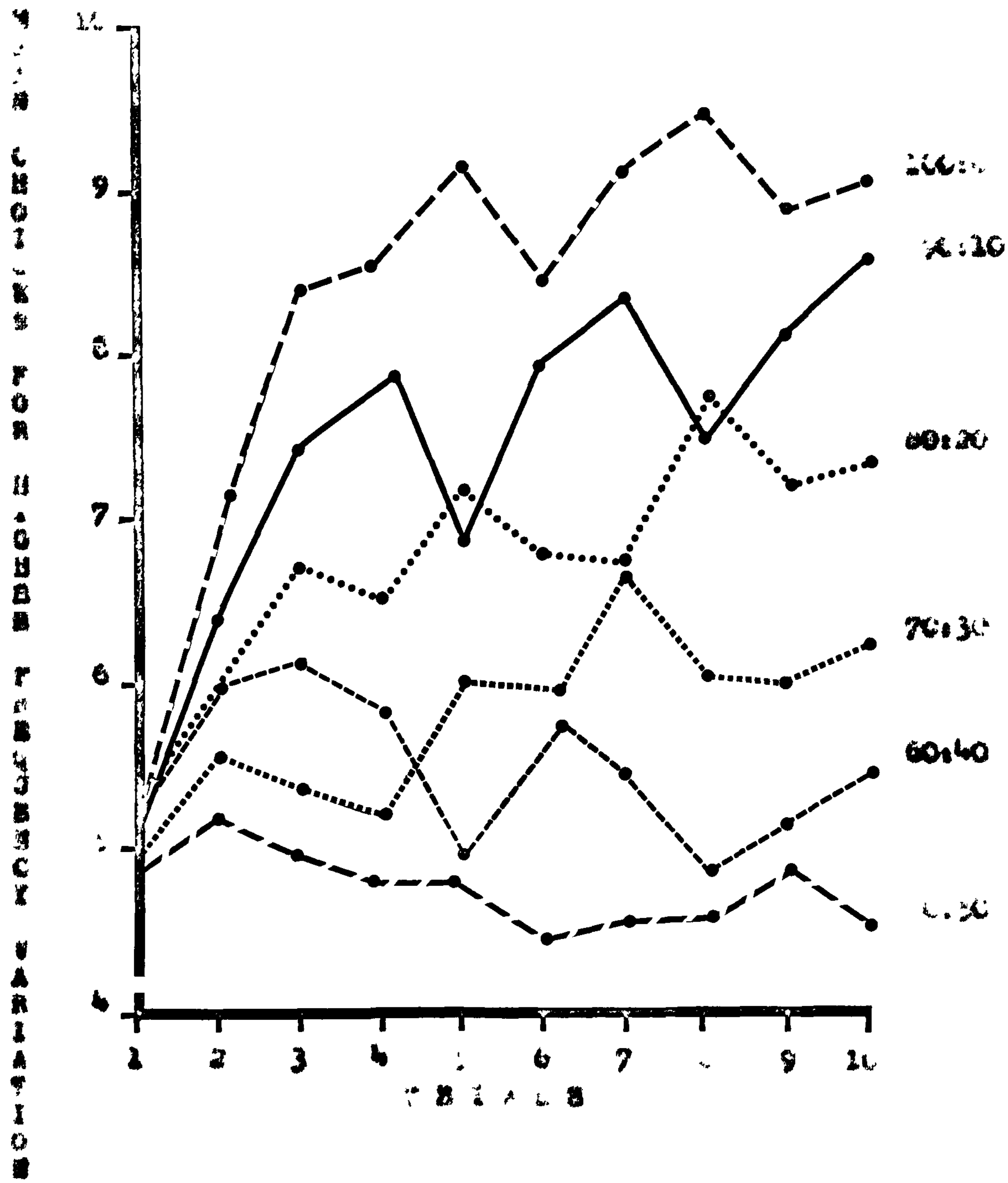

Figure 1.- Mean Number of Choices of [illegible] Schizophrenics and Normals Combined of the More Frequently Reinforced Variation on Ten Blocks of Trials for each of Six Reinforcement Schedules.

Table IV.-

Summary of Analysis of Variance Comparing the Mean Number of Choices for the Higher Frequency Variation of All Groups, Schizophrenic and Normal, All Reinforcement Schedules and All Trials.

Source of Variation	Sum of Squares	df	Est. of Variance	F	Sig.
Groups	552.163	1	552.163	66.070	p<.005
Reinforcement Schedule	1721.226	5	344.245	41.191	p<.005
Group x Reinforcement Schedule	121.976	5	24.395	2.919	p<.025
Error	902.530	108	8.357		
Trials	309.946	9	34.438	35.242	p<.005
Group x Trials	55.636	9	6.181	6.326	p<.005
Reinforcement x Trials	386.573	45	8.590	8.791	p<.005
Groups x Reinforcements x Trials	150.423	45	3.342	3.420	p<.005
Residual	949.620	972	.977		
Total	5150.346	1199			

B.J. Winer, Statistical Principles in Experimental Design, New York, McGraw-Hill Book Co. Inc., 1962, p. 337-344.

is further evidenced by the results shown in Table V. A more detailed break-down is presented in Table VI which finds highly significant differences in the mean responses of normals and schizophrenics in nearly all the blocks of trials in the higher reinforcement schedules (viz., 80:20, 90:10, 100:0). Clearly a separate analysis of each group seems justified and promising.

Normal Groups.- When considered separately the results obtained for the normals alone are even more striking. Figure 2 shows the mean number of choices of the more frequently reinforced variation for the normal groups for each of the reinforcement schedules. While here, as in the previous analysis for all groups combined, each curve representing a higher reinforcement schedule is found at a significantly higher level ($F = 311.769$; $p < .005$)[2] and successive blocks of trials record mean responses which are significantly different from other blocks in the experiment ($F = 25.920$; $p < .005$), the evidently smoother-appearing curves clearly point to the progressive success achieved in the learning process examined in this study. Table VIII proves that the successively higher levels of the curves shown in Figure 2, previously referred to, are in each case of statistical significance in the order of $p < .005$.

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2 The statistics cited for normals are taken from the results of an Analysis of Variance presented in Table VII.

Table V.-

Summaries of Analyses of Variance Comparing the Mean Number of Choices for the Higher Frequency Variation for Groups, i.e., Normal vs. Schizophrenic, and Trials in Each Reinforcement Schedule.

Analysis	Source of Variation	Sum of Squares	df	Est. of Variance	F	Sig.
50:50	Groups	4.500	1	4.500	3.201	N.S.
	Error	25.300	18	1.405		
	Trials	10.000	9	1.111	.553	N.S.
	Group x Trial	28.900	9	3.211	1.599	N.S.
	Error	325.300	162	2.008		
	Total	394.000	199			
60:40	Groups	35.200	1	35.200	28.074	p<.005
	Error	22.620	18	1.256		
	Trials	27.400	9	3.044	1.508	N.S.
	Group x Trial	37.220	9	4.135	2.048	p<.05
	Error	326.980	162	2.018		
	Total	449.500				
70:30	Groups	134.400	1	134.400	251.627	p<.005
	Error	9.620	18	.534		
	Trials	48.300	9	5.366	2.498	p<.025
	Group x Trial	45.120	9	5.013	2.333	p<.025
	Error	347.900	162	2.146		
	Total	585.500	199			
80:20	Groups	79.380	1	79.380	71.442	p<.005
	Error	20.000	18	1.111		
	Trials	92.380	9	10.264	6.541	p<.005
	Group x Trial	21.220	9	2.357	1.502	N.S.
	Error	254.200	162	1.569		
	Total	467.180	199			

Table V.- (Cont'd.)

Summaries of Analyses of Variance Comparing the Mean Number of Choices for the Higher Frequency Variation for Groups, i.e., Normal vs. Schizophrenic, and Trials in Each Reinforcement Schedule.

Analysis	Source of Variation	Sum of Squares	df	Est. of Variance	F	Sig.
90:10	Groups	200.000	1	200.000	127.569	p<.005
	Error	28.220	18	1.567		
	Trials	205.820	9	22.868	13.641	p<.005
	Group x Trial	53.000	9	5.888	3.512	p<.005
	Error	271.560	162	271.560	1.676	
	Total	756.620	199			
100:0	Groups	220.500	1	220.500	156.137	p<.005
	Error	25.420	18	1.412		
	Trials	312.620	9	34.73[illegible]	28.830	p<.005
	Group x Trial	20.600	9	2.288	1.89[illegible]	p<.05
	Error	195.160	162	1.204		
	Total	774.320	199			

B.J. Winer, Statistical Principles in Experimental Design, New York, McGraw-Hill Book Co., Inc., 1962, p. 302-312.

Table VI.-

"t" Values Comparing Normals and Schizophrenics on the Mean Number of Choices for the Higher Frequency Variation for Each Block of Trials Within Each Reinforcement Schedule.

Block	Reinforcement Schedule					
	50:50	60:40	70:30	80:20	90:10	100:0
1	1.434274	.539905	-.623850	1.049761	-.274433[b]	1.537043
2	-2.628928[b]	1.941893	1.508239	1.523019	2.046542[c]	4.455664[d]
3	0.000000	.317799	1.755617	.325395	4.725369[d]	4.437444[d]
4	1.797624	.320713	3.213650[c]	2.981651[c]	3.263810[d]	5.343523[e]
5	-.647034	5.219433[e]	1.735477	2.761004[b]	6.562855[e]	4.630461[d]
6	1.271997	0.000000	4.074108[d]	3.066660[c]	5.878775[e]	7.236272[e]
7	1.682169	1.271997	1.979898	3.348937[d]	3.452612[d]	4.070403[d]
8	.668733	-.473684	4.018856[e]	1.107823	4.085510[d]	3.086974[e]
9	0.000000	3.681432[d]	3.705882[d]	2.983516[c]	2.831639[c]	6.000000[e]
10	.017102	1.024363	5.061569[e]	4.024922[d]	2.923064[c]	5.477225[e]

a Allen L. Edwards, <u>Experimental Design in Psychological Research</u>, New York, Holt, Rinehart and Winston, 1962, p. 93.
b Significant at the .05 level.
c Significant at the .02 level.
d Significant at the .01 level.
e Significant at the .001 level.

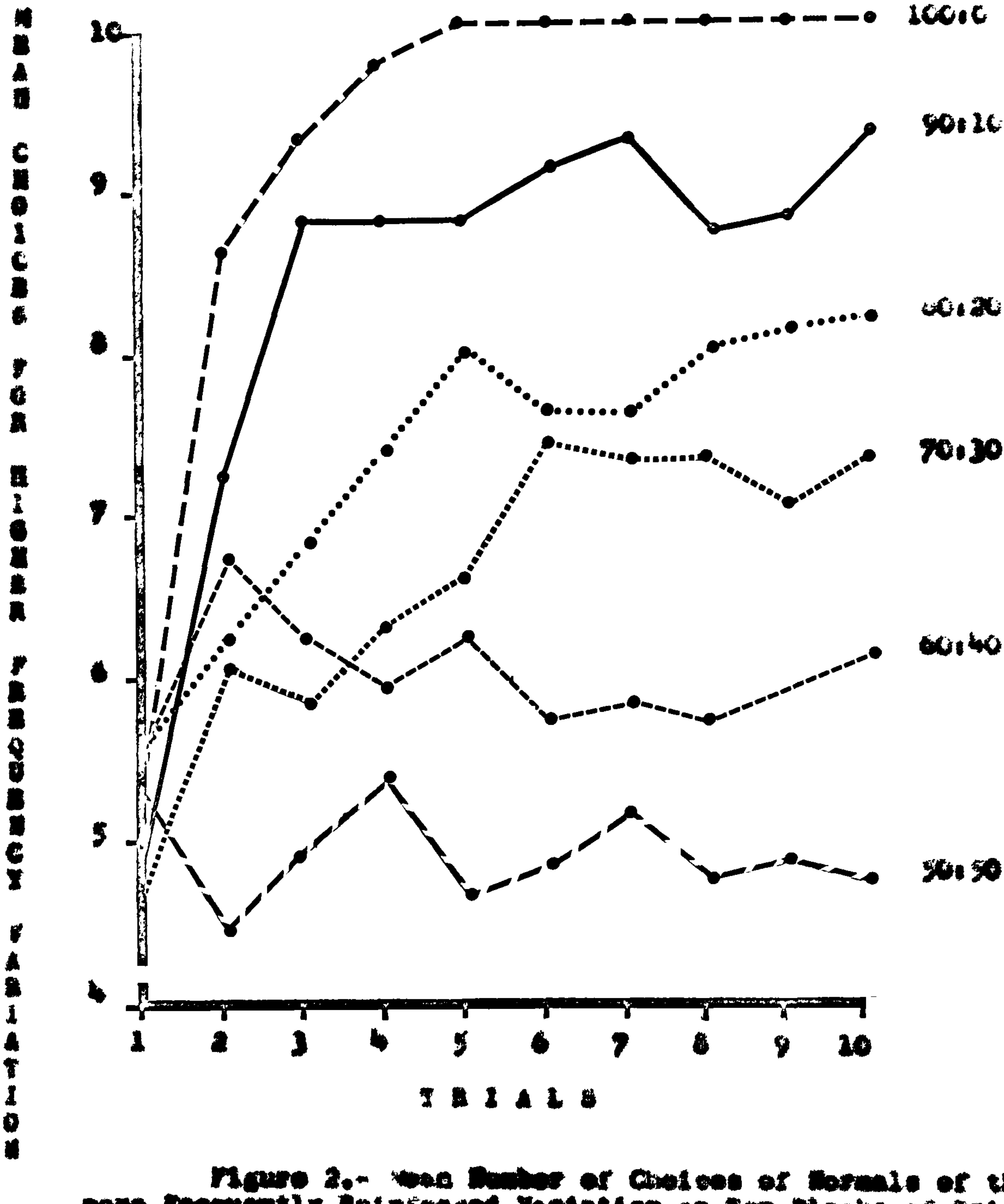

Figure 2.- Mean Number of Choices of Normals of the more Frequently Reinforced Variation on Ten Blocks of Trials for each of Six Reinforcement Schedules.

Table VII.-

Summary of Analysis of Variance Comparing the Mean Number of Choices for the Higher Frequency Variation of Normals for All Reinforcement Schedules and Trials.

Source of Variation	Sum of Squares	df	Est. of Variance	F	Sig.
Reinforcement	1325.888	5	265.177	311.769	p<.005
Error	45.930	54			
Trials	279.835	9	31.092	25.920	p<.005
Reinforcement x Trials	219.295	45	4.873	4.062	p<.005
Error	582.970	486	1.199		
Total	2453.918	599			

B.J. Winer, Statistical Principles in Experimental Design, New York, McGraw-Hill Book Co. Inc., 1962, p. 302-312.

Table VIII.-

Summaries of Analyses of Variance Comparing the Mean Number of Choices for the Higher Frequency Variation of Normals for Trials on any Two Successive Reinforcement Schedules.

Analysis	Source of Variation	Sum of Squares	df	Est. of Variance	F	Sig.
50:50	Reinforcements	62.720	1	62.720	54.120	p<.005
vs.	Error	20.860	18	1.158		
60:40	Trials	3.080	9	.342	.217	N.S.
	Reinf.x Trials	14.580	9	1.620	1.028	N.S.
	Error	255.140	162	1.574		
	Total	356.380	199			
60:40	Reinforcements	18.000	1	18.000	26.086	p<.005
vs.	Error	12.420	18	.690		
70:30	Trials	38.420	9	4.268	3.[illegible]	p<.005
	Reinf.x Trials	41.[illegible]	9	4.644	3.317	p<.005
	Error	226.780	162	1.399		
	Total	337.420	199			
70:30	Reinforcements	29.645	1	29.645	82.730	p<.005
vs.	Error	6.450	18	.358		
80:20	Trials	134.845	9	14.982	11.040	p<.005
	Reinf.x Trials	7.805	9	.867	.639	N.S.
	Error	219.850	162	1.357		
	Total	398.595	199			
80:20	Reinforcements	53.045	1	53.045	86.408	p<.005
vs.	Error	11.050	18	.613		
90:10	Trials	214.845	9	23.871	24.71[illegible]	p<.005
	Reinf.x Trials	23.405	9	2.600	2.692	p<.01
	Error	156.450	162	.965		
	Total	458.795	199			
90:10	Reinforcements	46.080	1	46.080	44.545	p<.005
vs.	Error	18.620	18	1.034		
100:0	Trials	334.600	9	37.177	55.777	p<.005
	Reinf.x Trials	4.220	9	.468	.703	N.S.
	Error	107.980	162	.666		
	Total	511.500	199			

B.J. Winer, Statistical Principles in Experimental Design, New York, McGraw-Hill Book Co. Inc., 1962, p. 302-312.

The rate at which the learning takes place is reflected in the initial segment of each curve. This rate of learning accelerates in direct relation to the reinforcement schedule employed. It is most rapid in the case of the 100:0 schedule; inspection of Figure 2 distinctly portrays the sudden and sharp rise of the 100:0 curve subsequent to the very first trial. Only the 50:50 curve shows no significant changes over its entire length as contrasted to a pure guessing situation as indicated in Table IX. Regardless of the reinforcement schedule employed, the normal subject has assimilated the intended probability goal of the experimenter with the fourth block of trials at the very latest, as is further apparent from the "t" values shown in Table X under the columns marked Normals.

Schizophrenic Groups.- In contract to normals, schizophrenics quite evidently do not learn as fast nor as well nor possibly in the same way. Examination of Table X just referred to, indicates that schizophrenics rarely attain the expected response pattern. Only for the 50:50 and 60:40 reinforcement schedules do the responses approximate those intended by the analyst, but at the very same time they do not materially differ from responses to be expected by chance alone.

Table I[illegible].-

"t" Values Comparing the Mean Number of Choices Obtained for the Higher Frequency Variation with a Hypothetical Value Equal to .5 in Each Block of Trials within Each Reinforcement Schedule for Normals and Schizophrenics.

	Block	Reinforcement Schedule					
		50:50	60:40	70:30	80:20	90:10	100:0
Normals	1	.452	1.463	-.616	1.463	-.198	1.107
	2	-1.202	4.636[d]	2.535[b]	6.000[e]	4.490[d]	10.590[e]
	3	-.317	3.342[d]	1.921	4.630[d]	13.076[e]	14.333[e]
	4	.557	2.211	2.750[b]	9.000[e]	1[illegible].000[e]	36.000[e]
	5	-1.176	4.129[d]	3.207[c]	11.618[e]	15.233[e]	999.999[e]
	6	-.428	2.688[b]	5.622[e]	7.648[e]	22.840[e]	[illegible]
	7	.190	2.057	[illegible].610[e]	[illegible].510[e]	20.146[e]	[illegible]
	8	-.818	2.686[b]	7.666[e]	9.000[e]	17.335[e]	[illegible]
	9	-.390	3.897[d]	6.706[e]	11.195[e]	1[illegible].233[e]	[illegible]
	10	-.895	2.905[c]	7.666[e]	8.913[e]	28.150[e]	[illegible]
Schizophrenics	1	-1.765	.152	.190	-.218	.190	-1.065
	2	3.250[d]	.294	.245	2.688[b]	1.463	1.032
	3	-.207	1.936	-.514	3.360[d]	1.936	7.855[e]
	4	-2.752[b]	1.481	-1.860	1.107	3.475[d]	[illegible].126[e]
	5	-.317	-3.771[d]	.536	2.326[b]	-.361	8.231[e]
	6	-2.371[b]	2.333	-1.000	2.076	4.636[d]	4.070[d]
	7	-2.282[b]	0.000	1.535	1.809	4.270[d]	7.236[e]
	8	-1.481	1.732	-.668	5.622[e]	2.092	9.775[e]
	9	-.301	-1.909	-.207	2.092	5.622[e]	6.500[e]
	10	-1.562	-.449	.317	5.250[e]	5.715[e]	8.215[e]

a L.T. Dayhaw, Manuel de Statistique, Editions de l'Universite d'Ottawa, 1956, p. 358-359.
b Significant at the .05 level.
c Significant at the .02 level.
d Significant at the .01 level.
e Significant at the .001 level.

Table X.-

"t" Values Comparing the Mean Number of Choices Obtained for the Higher Frequency Variation with an Ideal Value Equal to the Desired Frequency in Each Block of Trials Within Each Reinforcement Schedule for Normals and for Schizophrenics.

	Block	Reinforcement Schedule					
		50:50	60:40	70:30	80:20	90:10	100:0
Normals	1	.452	-1.463	-6.272[e]	-7.319[e]	-5.128[e]	-6.124[e]
	2	-1.202	1.909	-2.535[b]	-9.000[e]	-3.674[d]	-4.118[d]
	3	-.317	.557	-2.882[c]	-3.086[c]	-.688	-2.333[b]
	4	.557	-.245	-1.481	-2.250	-1.000	-1.500
	5	-1.176	.688	-.801	0.000	-.801	.000
	6	-.425	-1.152	.937	-1.176	.557	.000
	7	.190	-.514	.757	-1.309	1.405	.000
	8	-.816	-1.152	1.000	0.000	-1.405	.000
	9	-.390	-.426	0.000	.361	-.801	.000
	10	-.595	.264	1.000	.557	1.963	.000
Schizophrenics	1	-1.765	-1.368	-3.612[d]	-8.764[e]	-7.414[e]	-9.968[e]
	2	3.250[d]	-1.176	-4.669[d]	-8.834[e]	10.246[e]	-7.570[e]
	3	-.207	0.000	-5.859[e]	-2.940[c]	-5.809[e]	-6.510[e]
	4	-2.752[b]	-.634	-5.581[e]	-4.431[d]	-3.841[d]	-6.020[e]
	5	-.317	-6.465[e]	-3.042[c]	-3.042[c]	-7.584[e]	-4.630[d]
	6	-2.371[b]	-1.000	-4.333[d]	-4.846[e]	-6.272[e]	-7.236[e]
	7	-2.282[b]	-2.022	-1.877	-4.974[e]	-3.156[c]	-4.070[d]
	8	-1.481	0.000	-5.128[e]	-1.405	-4.882[e]	-3.086[c]
	9	-.301	-4.636[d]	-4.357[d]	-3.138[c]	-3.748[d]	-6.000[e]
	10	-1.562	-1.947	-6.041[e]	-6.000[e]	-2.449[b]	-5.477[e]

a L.T. Dayhaw, Manuel de Statistique, Editions de l'Universite d'Ottawa, 1958, p.358-359

b Significant at the .05 level.

c Significant at the .02 level.

d Significant at the .01 level.

e Significant at the .001 level.

On practically none of the trials in all other groups does the schizophrenic give evidence of perfect learning. Mean responses, in nearly all blocks significantly differ from the intended ideal probability goal.

In spite of the foregoing it must be noted that highly significant differences do exist between trials ($F = 4.066$; $p < .005$), as shown in Table XI as well as between different reinforcement schedules ($F = 65.536$; $p < .005$). The reader will find these results reflected in Figure 3 which shows the mean number of choices for the more frequently reinforced variation for the schizophrenic groups for each of the reinforcement schedules. While the clear pattern and smooth curves of Figure 2 shown for the normal group are conspicuously absent, one may nonetheless recognize the presence of some learning especially in the higher reinforcement groups as the series of trials progresses. Thus the curves representing the 80:20, 90:10, and 100:0 groups respectively become quite distinct after the sixth block of trials and appear at successively higher levels in direct relation to the higher reinforcement employed. Table IX which compares the responses obtained for each reinforcement schedule to those to be expected purely at random finds highly significant "t" values for a majority of the mean responses recorded in these groups. It may be instructive to note the curve for the 50:50 schedule in comparison to the others shown in

Table XI.-

Summary of Analysis of Variance Comparing the Mean Number of Choices for the Higher Frequency Variation of Schizophrenics for All Reinforcement Schedules and Trials.

Source of Variation	Sum of Squares	df	Est. of Variance	F	Sig.
Reinforcement	[illegible]17.315	5	103.463	65.[illegible]	p<.[illegible]
Error	55.290	[illegible]	1.570		
Trials	8[illegible].74[illegible]	9	9.527	4.[illegible]	p<.005
Reinforcement x Trials	317.7[illegible]1	45	7.060	3.014	p<.005
Error	1138.[illegible]	406	2.342		
Total	2144.26[illegible]	599			

B.J. Winer, Statistical Principles in Experimental Design, New York, McGraw-Hill Book Co. Inc., 1962, p. 30[illegible]-31[illegible].

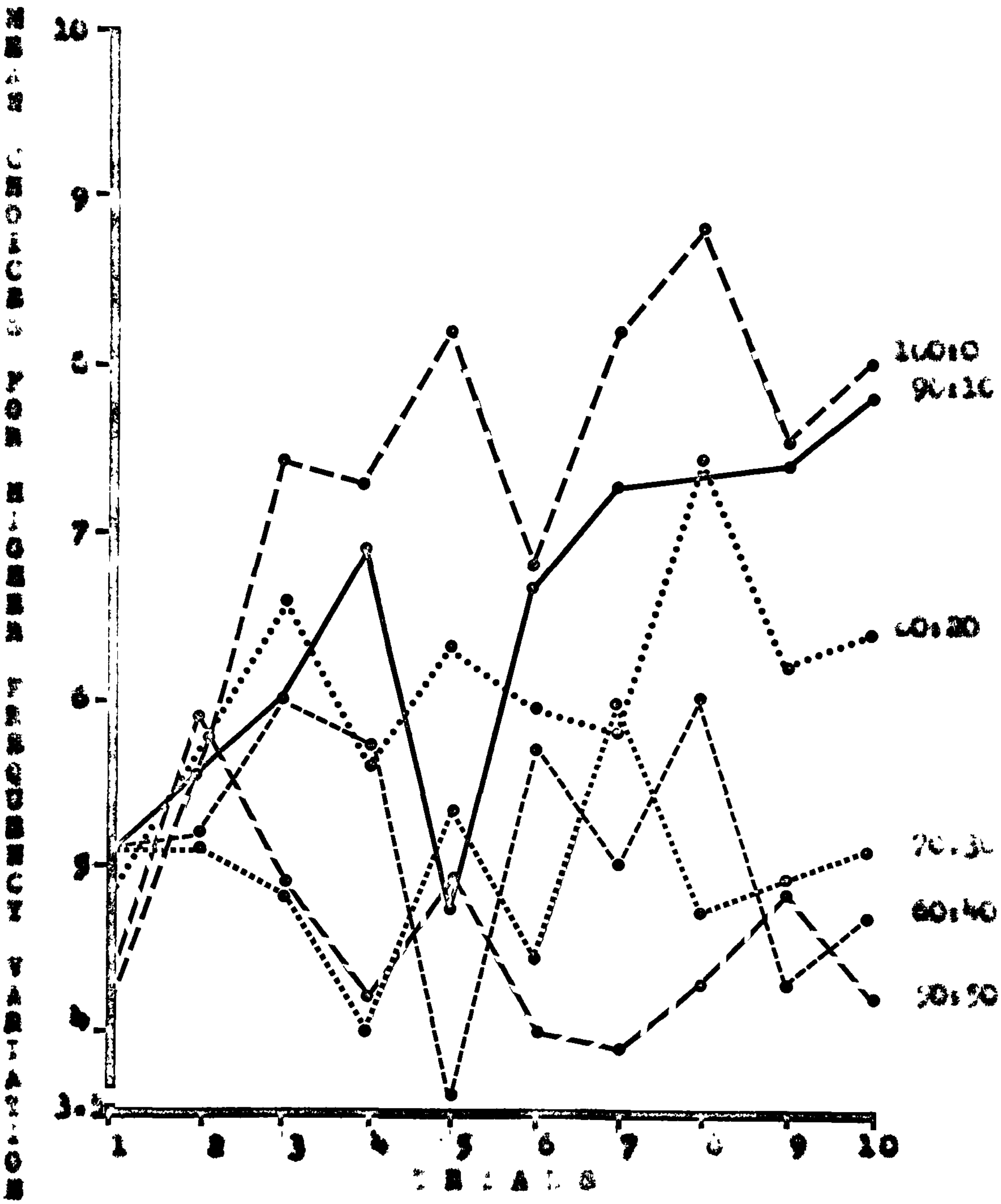

Figure 3.- Mean Number of Choices of Schizophrenics of the More Frequently Reinforced Variation on Ten Blocks of Trials for Each of Six Reinforcement Schedules.

Figure 3; in the complete absence of learning on the part of the schizophrenics the curves for each of the reinforcement groups would be expected to approximate the one actually found for the 50:50 group, with a slope of approximately zero. Even a cursory inspection of the graph shows that this is not so.

From the preceding analysis the following conclusions may be drawn:

1. For the normal group the mean number of choices approaches the intended probabilities as the trials progress. This is true for each of the reinforcement schedules studied.
2. Subsequent to the third trial, performance of the normal group remains stable. The mean number of responses does not significantly differ from the intended probability. This is true for each of the reinforcement schedules studied.
3. The mean responses given by schizophrenics on each of the reinforcement schedules other than the 50:50 are found to be lower than those given by normals.
4. The difference between the mean responses on each of the reinforcement schedules above the 50:50 group given by schizophrenics as compared to the mean responses given by normals, is highly significant.

5. The mean responses given by schizophrenics for each of the reinforcement schedules above the 60:40 group differs significantly from the intended probability in thirty-eight out of forty blocks of trials.

6. The mean responses given by schizophrenics in reinforcement schedules above the 70:30 group indicates a response pattern which is different at a highly significant level from the one to be expected by chance alone.

Qualitative results.- It has been stated previously that learning took place in an unconscious process. Evidence to this effect is found in an examination of the verbalized explanations offered by the subjects in justification of their selections. None of these statements gives the slightest indication that the subjects sensed the actual purpose of the experimenter except for the obvious 100:0 frequency in which normals invariably recognized the intent of the experiment as it proceeded.

Generally the responses given by normal subjects, such as the following: "Memory doesn't help. I remember distinctly that this additive card was correct the last time." "The first three subtractives were wrong, so I switched." "It may have something to do with the positions of the variations which keep switching", showed a preoccupation with the geometric designs presented, in an attempt to seek a logical solution in the nature of these designs.

Schizophrenics offered similar explanations but, in addition, persisted in reading meaning into extraneous clues as exemplified by answers such as the following: "I thought it must be the one on the right", "It couldn't be the one in the middle again", "This one looks right." Some of the recorded answers were bizarre and of an erratic nature, as exemplified by the following: "The angles look sharper on this one", "I've been listening to you carefully and I know", "If a line is moved straight across the angle remains the same."

It is evident that the content and wording of these explanations is entirely unrelated to the unconscious learning process which the subject undergoes. The primary interest concerns the frequency with which these rationalized explanations induced the subject to select a specific alternative, and how this frequency is related to the one intended for his group.

2. Discussion.

The experimental results found in the response pattern of normal subjects substantiates Brunswik's theory outlined in the first chapter of this report. In each of the reinforcement schedules the normal respondent bases his initial answer on various hypotheses which by the nature of the experimental design can not in any way be related to the objectives of the experimenter. As the trials proceed the normal subject seemingly extracts sufficient information from the experimental setting which results in a response pattern nearly identical to that intended by the experimenter. This ability can be observed under all circumstances regardless of the reinforcement schedule employed, and thus regardless of the amount of information supplied the respondent.

This learning takes place as an unconscious process, during which the respondent builds up an inventory of experiences which forms the basis for the formulation of successive hypotheses. Even though each individual answer given by normal subjects is justified by them with a rational explanation, the overall distribution of responses given by all normal subjects in the latter trials indicates a stochastic process operating with the mean response nearly identical to the one intended by the experimenter, be it 60, 70, 80 or 90 per cent.

Only in the case of the 100:0 group do normal respondents uniformly learn that the experimenter's answers constitute reliable cues and adjust their hypotheses accordingly. This is evidenced by the responses given by normal subjects in the 100:0 group in all trials following the fourth. Inspection of the results shows the means equal to 10 and a standard deviation equal to 0.

In all other reinforcement patterns examined, the subject bases his first hypotheses on a series of clues which presumably include the misleading ones provided by the location of the cards and the geometric designs which appear on them in addition to the ambiguous clues provided by the responses of the experimenter. As the experiment progresses, the subject continues to evaluate those clues that he considers relevant before formulating his hypotheses, a process which simultaneously takes place at the conscious and unconscious level. It can be safely assumed that the weights assigned to the various cues are progressively refined as experience is building up during the learning process of the normal subjects. This ability to critically evaluate the relevant importance of the various perceptual cues, and to extract pertinent information from them, seemingly allows the normal subject to adjust to his environment.

Quite evidently, subjects who lack this ability would be severely handicapped. The responses of the maladjusted subjects included in this study give evidence that such an impairment can be assumed in the group examined.

The results of this study have shown that regardless of the amount of information supplied, the maladjusted group (by increasingly higher reinforcement schedules) fail to sense and reach the ideal goal set by the experimenter. Even the clues supplied in the 100:0 group, which provide normal respondents with reliable guides in their processes of formulating hypotheses, act only in an ambiguous manner in the case of maladjusted subjects. This inability to recognize and efficiently select reliable cues to the exclusion of others coincides with the theory of Cameron and Margaret.[3] These authors have pointed out that exclusion is necessary for success on a given task. At first, the normal subject attends to too many aspects of the stimulus situation, and much of his response is superfluous. Gradually he focuses on the crucial aspects of the stimulus situation and ignores irrelevant aspects; similarly, he drops out hypotheses that he does not need. Presumably the schizophrenic cannot exclude nonessential stimulus elements, hence the weightings attached to the clues differ markedly from those attached by normals.

Even in the 100% group, the mean response fails to reach the ideal, regardless of the number of trials provided for in this experiment; the observed standard deviation remains substantial throughout the experiment. While normal respondents, however, benefit from clues provided them with any degree of reinforcement, the maladjusted group shows poor results when confronted with a paucity of clues, in the lower reinforcement schedules and can extract information only

3 Norman Cameron and Ann Margaret, Behavior Pathology, Boston, Houghton Mifflin, 1951, xvi-645 p.

from more evident clues in the higher reinforcement schedules (viz., 80:20, 90:10 and 100:0).

An explanation as to the poor performance of the maladjusted subjects, which is reflected in the erratic pattern of the learning curves presented in Figure 3, and previously referred to, is suggested by the theory of Cameron.[4] The latter asserts that schizophrenics' behavior is acutely influenced by random interference. This theory assumes that when a schizophrenic is faced with a task, he cannot attend properly or in a sustained fashion, maintain a set, or change the set quickly when necessary. His ongoing response tendencies suffer interference from irrelevant, external cues and from internal stimuli which consist of deviant thoughts and associations. These irrelevant, distracting mediated stimuli prevent him from maintaining a clear focus on the intended perceptions. The effect of this extraneous interference manifests itself in the sharp fluctuations observed in the latter segments of the learning curve (Figure 3).

The process that has been examined in this study is presumed to take place in the following manner:

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[4] Norman Cameron, "Reasoning, Regression, and Communication in Schizophrenics", Psychological Monographs, Vol. 50, No. 1, Whole No. 221, 1938, p. 34.

1. Clues.- The principle clues presented to the subject consist of the stimulus cards and the experimenter's responses. Initially the subject also considers additional, extraneous clues.

2. Hypotheses.-

   a) Wording: Each clue is evaluated as signifying "it is additive", or "it is subtractive".

   b) Reasoning: Each hypothesis is justified by a rationalized comment.

   c) Weight: Each hypothesis is assigned a weight which is some fraction between zero and one. The sum of all weights assigned to each of the hypotheses invariably equals one.

3. Response.- The response, "it is additive (subtractive)" is determined by the appropriate hypotheses with a total weight exceeding .5.

4. Frequencies.- As the learning process takes effect, the frequency with which a certain hypothesis is chosen (e.g., "it is additive") tends in some degree to approximate that intended by the experimenter. At the same time the subject unconsciously assigns weights (step 2.c above) in such a manner that the resultant response pattern conforms to the learning curves observed in this investigation (see Figures 2 and 3).

The process just outlined illustrates the manner in which an organism adapts to his environment by learning from past experience, even though these include a multitude of unreliable clues. To the extent that he is unable to extract the full measure of perceptual experience from admittedly ambiguous clues, the so-called maladjusted organism finds himself handicapped in his ability to adjust to the environmental demands. In the words of Tolman and Brunswik, "Indeed, we would like to throw out here, as a final word, the suggestion that all problems of psychology [...] center around this one general feature of the given organism's abilities and tendencies for adjusting to these actual causal textures, - these actual probabilities as to causal couplings."[5]

3. Comments.

These results might be criticized as merely substantiating previous findings that schizophrenics are relatively unable to hold a learning set, are less well motivated and do not understand instructions as well as normals. Careful observations of respondents in this study indicated that practically all of the subjects thoroughly understood the experiment as evidenced by the practice series and is further

5 Edward C. Tolman and Egon Brunswik, 'The Organism and the Causal Texture of the Environment", Psychological Review, Vol. 42, 1935, p. 73.

documented by their verbalizations throughout the experiment. Most were indeed highly motivated since they perceived the task as a test on which they assumed good performance might hasten their release from the hospital.

The discussion in the preceding section has asserted that maladjusted subjects do undergo a learning process but do not seem to extract the same amount of information from clues as normals succeed in doing. It might be asked, if this truly follows from the experimental findings. Is it not possible, that the maladjusted subjects' perception is identical to that of the normal, but that only his answers are unrelated to his perceptions and the analysis is therefore not justified in drawing any conclusions from the observed response patterns.

It must be remembered, though, that the experiment was disguised as a problem solving task in which subjects, normals as well as maladjusted, had no inkling of the true purpose in the mind of the experimenter. Since, moreover whatever learning process took place occurred without awareness by the subject, the responses given by the latter can be but a reflection of the extent of this learning. In addition, it must be remembered that the maladjusted subjects were highly motivated to cooperate in the experiment; he felt thus compelled to answer (which in itself indicates that perception has taken place) and thus unknowingly provides the very data which the experiment calls for.

Furthermore, it may be pointed out that the high level of significance found for the mean answers given in the higher reinforcement schedules gives further evidence of the unconscious learning process that has taken place. Quite evidently these responses would be either not significantly different from a purely random pattern, or, if given purposely and maliciously, would be found to be significantly <u>lower</u> from such a chance pattern.

Finally, the following point bears elaboration: The problem solving task outlined above, which was presented to the subjects in this study, appears to be one of extracting geometric principles similar to what is found in a concept formation task. Goldstein and Sheerer[6] have shown that schizophrenics generally show a tendency toward concrete solutions of abstract problems. A superficial analysis might suggest that since schizophrenics are deficient in abstract problem solving, this could be a major source of the differences observed in this study between normals and schizophrenics. Exactly the opposite is true: The concept formation set is actually a distracting feature of the task and thus acts as an interfering feature in the conscious detection of the pattern of reinforcement. A subject who experienced difficulty with finding geometric relationships might be expected to

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6 Kurt Goldstein and M. Sheerer, "Abstract and Concrete Behaviour: An Experimental Study with Special Tests", *Psychological Monographs*, Vol. 53, No. 2, 1941, vi-151 p.

abandon the search for lawful relationships. In this study it was found, in fact, that some of the schizophrenics did just that. Without the distracting influence of the concept formation set, the subject should perhaps be in a better position to detect the presence of the reinforcing schedule. Judging from the results, however, if abandonment of the set was present to a significant degree, it did not in the least seem to facilitate the learning of the pattern among the schizophrenics.

4. Limitations of the Data.

This study is the first step in what should become an extensive area of research. No attempt has been made here to delinate the precise functional relationship between levels of adaptiveness and probability discrimination. The group in this study is a small and heterogeneous one in terms of precise diagnosis. Nonetheless, the design that has been employed has yielded valuable information. Only those inferences which are directly related to the empirical events of the experimental situation have been attempted.

5. Implications for Further Research.

A variety of researches is suggested by the rather promising results of this application of perceptual theory of behavior disorder. The following are some lines of investigation which might represent first steps in building a comprehensive body of knowledge in this area:

1. A more precise definition is needed of the point on the continuum between a 50:50 and 100:0 disguised pattern at which the schizophrenics show a differential responsiveness greater than chance to two alternatives.

2. Extended probability trials in a design similar to that of this study might show some improvement in probability learning as a function of the increased number of trials.

3. The present study has used probability patterns which are invariant in terms of the response patterns. The relationship between organism and environment is one of interaction, however. There is a feedback relationship and the event probabilities are often altered by the organism's responsiveness. Therefore, the study of contingent probability tasks wherein the stimulus probability is modified by the subject's response would seem profitable.

4. Besides varying the stimulus dimention, the subject variable need also be investigated. It would be interesting to determine whether differences exist between the various schizophrenic subcategories. Thus,

for example, one might investigate for differences among process and reactive; paranoid and nonparanoid; simple, catatonic, hebephrenic and paranoid schizophrenics on this perceptual task.

SUMMARY AND CONCLUSIONS

Brunswik's perceptual theory of probabilistic functionalism holds that the environment of the organism contains both constant and varying elements. According to this view, the organism must interpret the cause-and-effect sequences of the environment by means of probabilistic cues because of the ambiguity of many environmental signposts. In order to stabilize an environment that is in part undergoing constant change, the organism must be able to make a reasonably accurate estimate of events or objects from certain cues. Hilgard has elaborated this theory by adding that it is not only the simple perception of event frequencies which characterizes perceptual events, but also the patterns of experienced frequencies.

Brunswik's view that organisms are sensitive to a large range of ecological probabilities has been substantiated by a number of so-called probability matching studies. These studies, involving both humans and infra-humans, have shown close correspondence between event and response probabilities. The theory has thus proven useful as a theoretical framework for the analysis of patterns of response in some probability situations.

If the perception of probability events in their elemental form is an essential part of the adaptive process, then organisms manifesting extreme non-adaptive behavior might exhibit an impairment of this perceptual process. The schizophrenic human seems an ideal subject for the study of maladaptiveness, for his behavior tends to be poorly articulated with the demands that his environment places upon him. There is presently no adequate explanation for the etiology of the loss of reality contact exhibited by the schizophrenic. And, in fact, little is known about how severe the "loss of reality contact" really is. For it is not known whether the bizarreness with which he responds to his environment is because of an inability to extract certain information from his environment necessary for adaptation, or whether he lacks the capacity to integrate the information.

This study is an attempt to apply the formulation of Brunswik to the maladapted organism. The general purpose is threefold: (a) to explore the validity of Brunswik's theory of probabilistic functionalism when applied to the maladapted organism; (b) to investigate the importance of perception of simple probabilities and the utilization of probability information necessary for the adjustment of organism; and (c) to examine the possibility that symptom manifestation of schizophrenia might be related to impaired perceptual functioning in the discrimination of simple probabilities.

A group of sixty schizophrenics and a corresponding group of normals were given a two-choice probability task disguised as a problem solving task. This task consisted of matching geometric designs. On each trial the subject had to choose between two types of variations as matching a key design. The probability pattern was the schedule of reinforcing the variations.

On the basis of the results obtained in the present investigation the following conclusions appear warranted:

1. Schizophrenics, in contrast to normals, evince impairment in the ability to discriminate simple probability patterns when such patterns are disguised as a problem solving task. The response patterns and event probability patterns of these subjects do not show the close degree of correspondence characteristic of normal subjects but rather tend toward an erratic pattern.
2. Schizophrenics' response probabilities show no tendency to reach asymptotically the ideal predicted by probability learning theory.

Thus the sensitivity of the organism to the ecological events of a probabilistic nature has been shown to be impaired in schizophrenia under conditions of discrimination without awareness.

This results confirm the importance of Brunswik's theory of probabilistic functionalism for arriving at an understanding as to how the organism adapts to his environment. Normal subjects have been shown to possess the ability to extract the necessary information from a series of clues which allows them to perfectly adjust to the demands of an identical experimental setting.

Since this study has been primarily of an exploratory nature, there was no need to relate the magnitude of the reinforcement provided and the amount of information extracted to the relative degree of maladjustment in each subject. Future studies may well investigate the precise functional relationships between levels of adaptation and sensitivity to various probability schedules.

The implication of these results would be more far reaching if one could demonstrate, for instance, that this perceptual inability exists in those patients who are in remission from their schizophrenic psychosis, or in those normals who become schizophrenic for brief periods once it has been established that schizophrenics respond in a similar manner to various reinforcement schedules. It is hoped that this study has suggested a fruitful line of investigation for both testing functionalistic theories of perception and for gaining insight into important information-gathering abilities of the functional psychotic.

BIBLIOGRAPHY

Brunswik, Egon, "Probability as a Determiner of Rat Behavior", *Journal of Experimental Psychology*, Vol. 25, 1939, p. 175-197.

A report of research with animals designed to test Brunswik's theoretical position with regard to probability learning. In a two-choice situation, he found that ratios of reward could be estimated by the rat in close agreement with the theoretical prediction.

Brunswik, Egon and Hans Herma, "Probability Learning of Perceptual Cues in the Establishment of a Weight Illusion", *Journal of Experimental Psychology*, Vol. 41, No. 4, April 1951, p. 281-290.

Aside from demonstrating acquisition of perceptual biases based on probabilistic cues in human subjects, the study shows that at times, perceptual probability learning seems not only to be based on, but to run counter to, what is being learned at the conscious level.

Burke, C.J., "A Brief Note on One-Tailed Tests", *Psychological Bulletin*, Vol. 50, No. 5, September 1953, p. 384-386.

The main thesis is that the widespread use of one-tailed tests can lead to serious abuses. The theoretical position stated in this article led to the non-directional statement of the statistical hypothesis of the present investigation.

Goodnow, Jacqueline Jarrett and Leo Postman, "Probability Learning in a Problem-Solving Situation", *Journal of Experimental Psychology*, Vol. 49, No. 1, January 1955, p. 16-22.

Confronted with a two-choice task, human subjects learned to respond in accordance with the probabilities of alternative outcomes even though they did not recognize the task as a probability situation. Besides the significance of the findings which substantiate Brunswik's theoretical contention, the experimental design employed by the authors served as a general model for the present investigation.

Lovinger, Edward, "Perceptual Contact with Reality in Schizophrenia", *Journal of Abnormal and Social Psychology*, Vol. 52, No. 1, January 1956, p. 87-91.

The author's hypothesis that schizophrenics considered clinically in poor contact with reality are also perceptually in poor contact with reality, was substantiated. This was interpreted as suggesting that the schizophrenic's break with reality involves not only more complex psychological functions, but basic perceptual processes as well.

Tolman, Edward C. and Egon Brunswik, "The Organism and the Causal Texture of the Environment", Psychological Review, Vol. 42, 1935, p. 43-77.

The authors, in a formalized theory, present their views on the behavior of organisms. Functionally oriented, they contend that the organism ventures an hypothesis as to what a given object will probably lead to in the way of goals. The wholly successful organism, according to them, is one which brings reliable perceptual hypotheses and good relational hypotheses to a situation, and can immediately modify or abandon these as the occasion arises. These hypotheses involve not only the problems of perception but also those of instinct, memory, insight, emotion, in short perhaps all the problems of psychology. The value of this theoretical formulation is that it allows for the delineation of numerous hypotheses for research, some of which are investigated in the present study.

APPENDIX 1

GLOSSARY OF TERMS USED

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The definitions given below are intended to clarify the meaning given in this study to terms which elsewhere might be used otherwise.

ADDITIVE CARD:
A card on which a line is removed from the right side of the design of the key card and placed on the left design.

BLOCK:
A series of ten successive trials (quod. vide).

ENVIRONMENT:
A collection of objects, which are subject to change.

FREQUENCY:
The number of times a specific event is observed.

GUESSING PREFERENCE:
The higher of the two ratios with which the additive and subtractive variations were chosen in a series of practice trials before the actual experiment.

KEY CARD:
A card containing one of ten basic designs used in the experiment.

PERCEPTION:
Mechanism by which useful information about environmental events is introduced into the organismic system and organized by it.

PRESENTATION SCHEDULE:
A predetermined random order in which cards are shown to a subject in a manner designed to minimize extraneous clues not part of the experiment.

PROBABILITY EVENTS:
INTENDED PRINCIPLES:
The ratio of a specific selection (additive or subtractive) to the total number of trials in the experiment.

PROBABILITY RATIO:
1/10 times the number of times a chosen variation (i.e., either additive or subtractive) was acknowledged as "correct" during a trial run of ten observations; sometimes expressed as per cent (by multiplying the above ratio by 100).

PROBABILITY, SUBJECTIVE:
The degree of certainty which an individual attaches to an hypothesis or an event. A value of one indicates complete certainty that the hypothesis is valid; a value of zero expresses complete certainty that it is invalid; while a value of .5 signifies complete uncertainty as to the validity of the hypothesis. Other values can be similarly interpreted.

RELATIVE FREQUENCY:
The number of times a certain event occurred, related to the total number of trials.

SCORE:
The number of times the subject selected the required variation in a block of ten trials.

SUBTRACTIVE CARD:
A card on which a line is removed from the left design of the key card and placed on the right design.

TRIAL:
The presentation of one key and two variation cards to a subject, his selection of a specific variation, and recording of the answer by the experimenter.

VERIDICAL PERCEPTION:
Perception (quod vide) corresponding to objective fact.

WEIGHT:
"Weights" are used in a probability sense. Each weight is a non-negative number equal to or less than one. The sum of all weights assigned to all possible alternative hypotheses is one.

APPENDIX 2

THEORETICAL CONSIDERATIONS CONCERNING THE FORMULATION OF THE HYPOTHESES

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It will be noted that the general experimental hypotheses are stated in the direction that they are expected to take and therefore would require a one-tailed statistical analysis. The statistical hypotheses on the other hand are stated in null form which indicates the application of a two-tailed test. In the discussion to follow a rationale will be developed indicating that the two forms of the hypotheses are not contradictory but rather complementary and necessary to the theoretical position adapted by the investigator.

Researchers have often been faced with the problem of deciding between a one-tailed and two-tailed test of significance whenever theory is being tested. The literature on this question is quite extensive. In brief, the following major positions exist: Jones[1] and Mark[2] among other proponents of the one-tailed test argue that theory (or previous research) dictates the direction of the hypothesis. The appropriate and more powerful statistical test is, therefore, one-tailed.

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1 Lyle V. Jones, "Tests of Hypotheses: One-Sided vs. Two-Sided Alternatives", Psychological Bulletin, Vol. 49, No. 1, January 1952, p. 43-46.

2 Melvin R. Marks, "Two Kinds of Experiment Distinguished in Terms of Statistical Operations", Psychological Review, Vol. 58, No. 1, May 1951, p. 179-184.

Jones, for example, in presenting his arguments against the use of a two-tailed test, states:

> Yet in many cases [...] it is not the test most appropriate for their experimental problems. More often than not, in psychological research, our hypotheses have a directional character. [...] theoretical considerations allow postulation of the direction of the experimental effects. The appropriate experimental test is one which takes this into account, a test of the null hypothesis, against a one-sided alternative.[3]

The opponents of this viewpoint, on the other hand, concede that in psychological research experimentally conceived hypotheses are directional. But, they argue, it does not follow from this that the one-tailed test should be used. The major arguments against using a one-tailed test may be summarised as follows:

1. Burke[4] presents a very cogent argument against the use of a one-tailed test:

> From any careful examination of the contemporary literature we must conclude that nowhere in the field can we have sufficient a priori confidence in the outcome of any genuinely new experiment to justify the neglect of the differences in the unexpected direction.[5]

Furthermore, this would only lead to conclusions at low levels of confidence which tend to be unreliable, "[...] and the

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3 Jones, Op. Cit., p. 44.

4 C.J. Burke, "A Brief Note on One-Tailed Tests", Psychological Bulletin, Vol. 50, No. 5, September 1953, p. 384-386.

5 Ibid., p. 385.

adoption of one-tailed tests is equivalent to a general lowering of levels of confidence."[6]

2. The research worker's primary concern will inevitably be to prove his own (pet) theory. Few attempts, if any, will be made to test the limitations of a theory. And if, by chance, the results happen to fall on the opposite tail, the investigator will not question his theory and "nothing will shake his faith in 'pure chance' as the cause of it."[7]

3. One of the major goals in theory building lies in its applicability. To remain strictly on the theoretical level is to exclude the living organism and since organisms do, at times, behave in a manner contrary to theory the adequacy of a one-tailed test becomes questionable. As Cattell says, "It seems that one must subscribe to the extreme sense of Allport's argument and admit that all traits are in some way unique."[8] No two individuals are exactly alike; therefore, no mathematical characterization can do complete justice to their individuality unless we allow and account for all behavior, even when it takes a direction opposite to that dictated by theory. (A two-tailed test is more sensitive to these fluctuations.)

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6 *Ibid.*

7 W.E. Hick, "A note on One-Tailed and Two-Tailed Tests", *Psychological Review*, Vol. 59, No. 4, July 1952, p. 317.

8 Raymond B. Cattell, *Description and Measurement of Personality*, Yonkers, N.Y., World Book Co., 1946, p. 61.

An additional point may be made along this line of reasoning: The process of building a theory leads to experimentation which in turn leads to sampling. The purposes for sampling are many; besides putting theory to an empirical test, a properly designed sample allows the experimenter to generalize from his sample to the entire population in this class. The sample must, of course, be representative of the population. For it is only then that one is able to make inferential statements and to generalize from the sample to the population. Representativeness is achieved only when idiosyncratic modes of behavior are also permitted inclusion and are thus free to influence the results regardless of the direction they take.

Furthermore, Brunswik[9] has advocated that in psychological research it is not only necessary that individuals be representatively sampled from well defined populations but also stimulus situations from well defined natural-cultural "ecologies". These representative sampling situations will allow one to take cognizance of the occasional major failures while at the same time, allowing full recognition of the favorable cases.

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9 Egon Brunswik, "Systematic and Representative Design of Psychological Experiments", in Jerzy Neyman, (ed.), Berkeley Symposium on Mathematical Statistics and Probability, Berkeley, University of California Press, 1949, p. 143-202.

What are the relative statistical merits between a one-tailed and two-tailed test? If a one-tailed test is used and the true alternative is in the direction of the rejection region, then this would be the more powerful test. "In a way, we get a little statistical credit for asking a more searching question."[10] The "credit" is the critical value necessary for acceptance or rejection of the null hypothesis. This value is always less than would be required if a two-tailed test were used. If, however, the true alternative is on the tail opposite the rejection region in a one-tailed test, the power would be extremely low "[...] in fact the power will always be less than alpha in the test of a mean."[11]

In view of the preceding discussion, the following conclusions may be reached: It is conceded that the more searching question in testing a theory undoubtedly is one which predicts the direction of the results. This does not, however, imply that it need be univocal. Even though the prediction is expected to be confirmed in the majority of cases, there may be instances where the findings are not consistent with the predicted direction. As will be seen the experimental design in this study attempts to sample six discrete points along a continuum of probabilities (viz., 50:50, 60:40, 70:30, 80:20,

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10 William L. Hays, Statistics for Psychologists, New York, Holt, Rinehart and Winston, 1963, p. 2[illegible]5.

11 Ibid.

90:10, 100:0). Due to the very nature of the schizophrenics' illness it is quite possible that no differances exist at the lower end of the continuum. It is for these reasons that the general and statistical hypotheses are stated differently.

The general experimental hypothesis predicts the general direction that the results are expected to take consistent with the theoretical formulations. The statistical hypotheses, on the other hand, are stated in a more stringent fashion (two-tailed). This, it would appear, would be the more appropriate question to pose. The advantage in this formulation is that: (a) it requires a larger critical value before its significance is accepted; (b) it is more sensitive regardless of the direction of the results; and (c) it tests the limitations of the theory along with the favorable cases.

APPENDIX 3

THE TEN SETS OF KEY CARDS AND THEIR "ADDITIVE" AND "SUBTRACTIVE" VARIATIONS

APPENDIX 3

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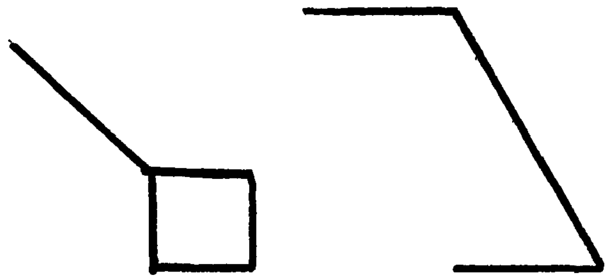

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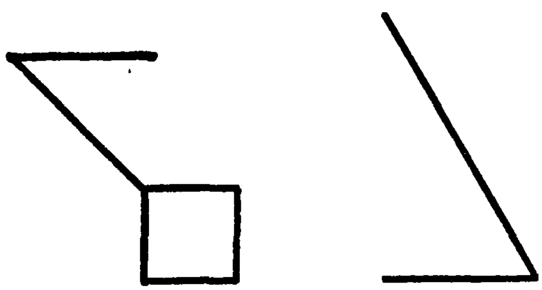

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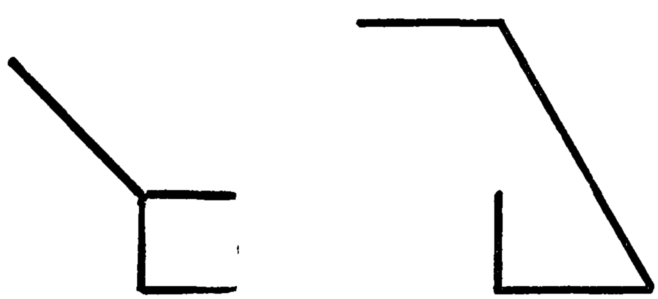

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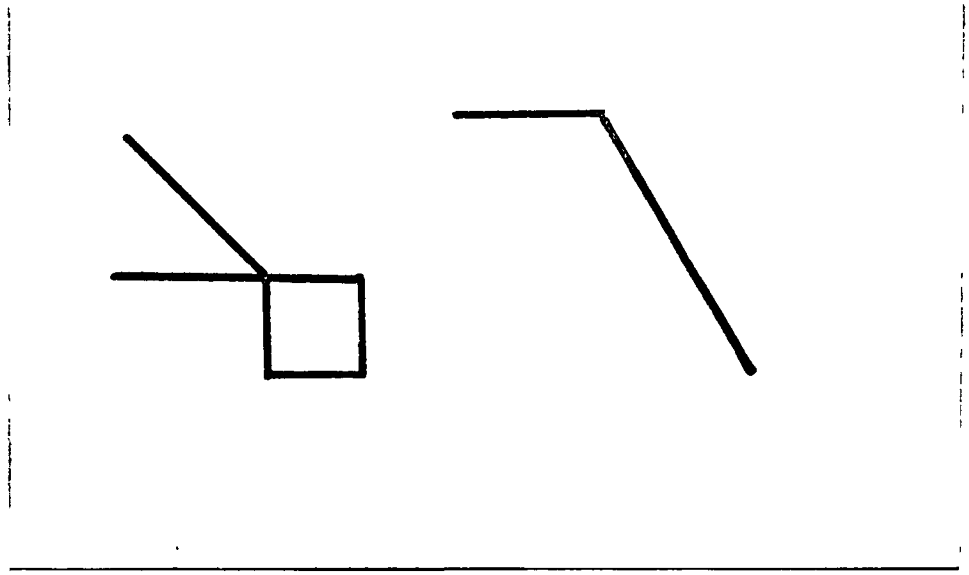

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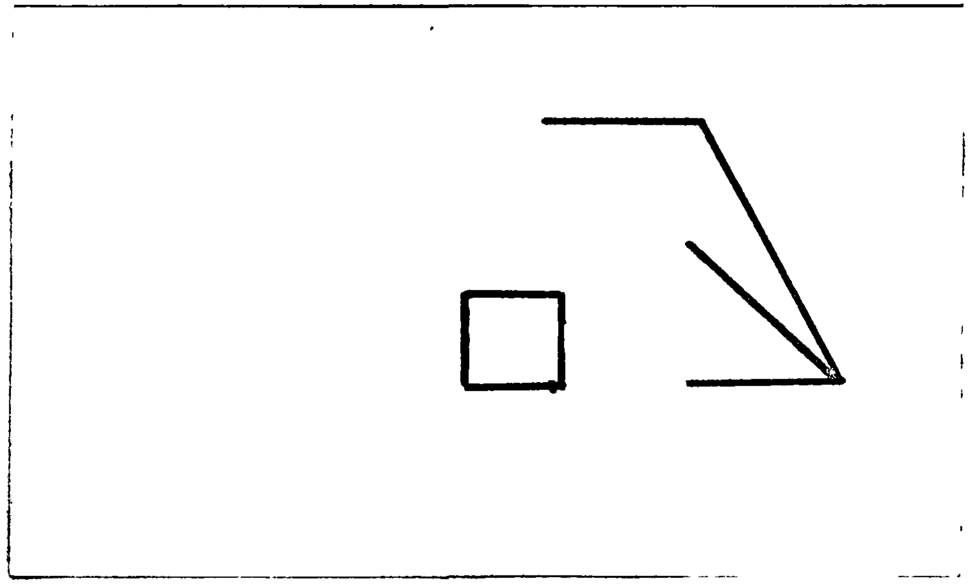

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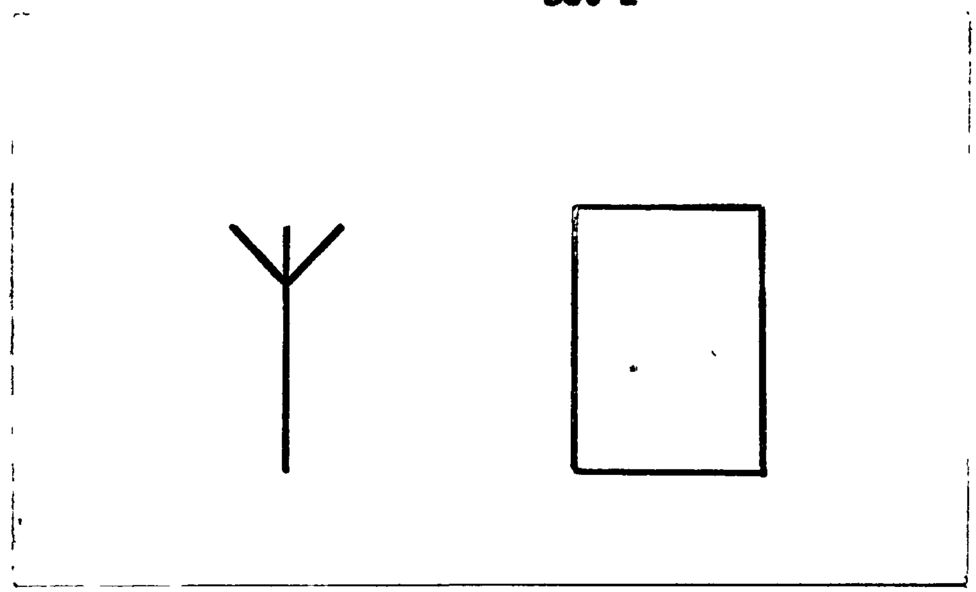

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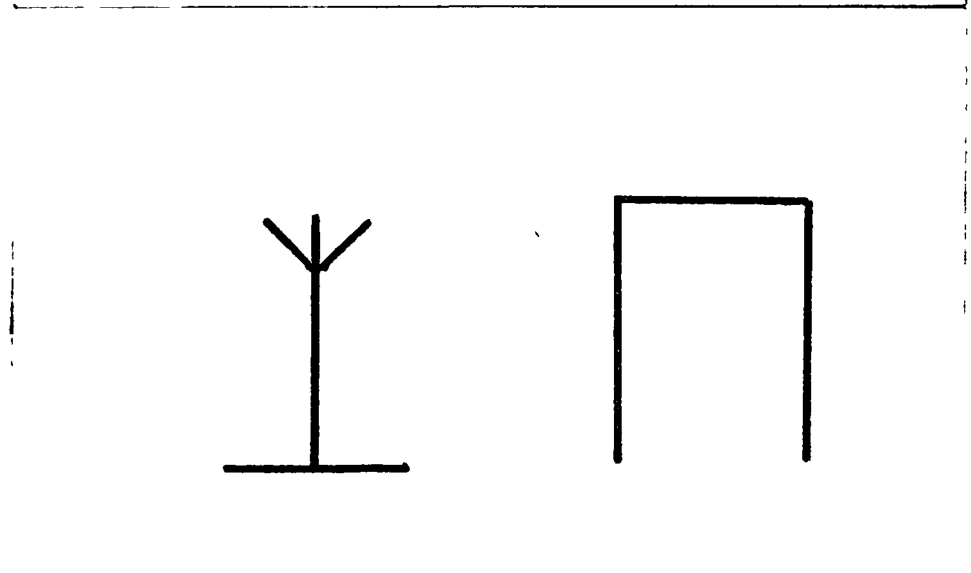

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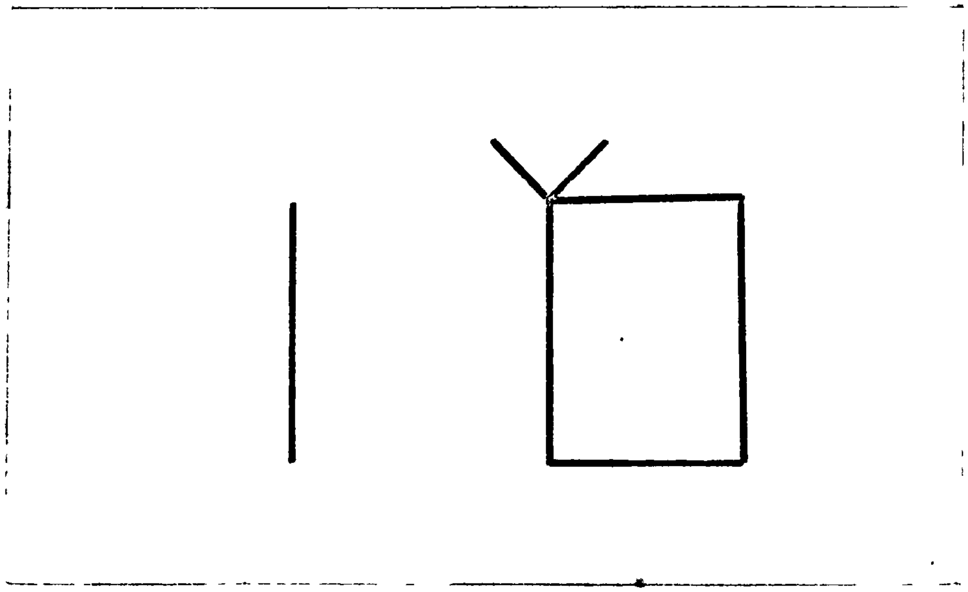

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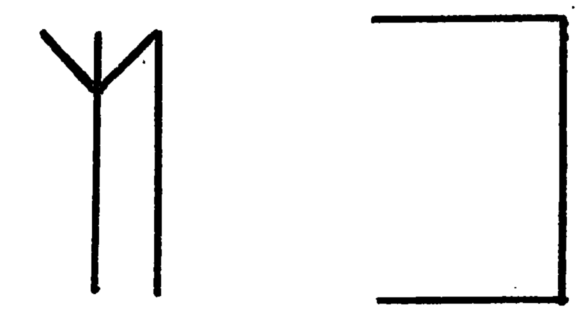

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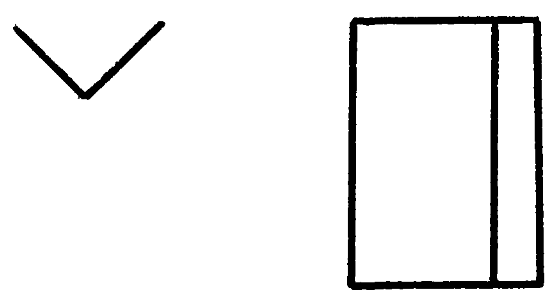

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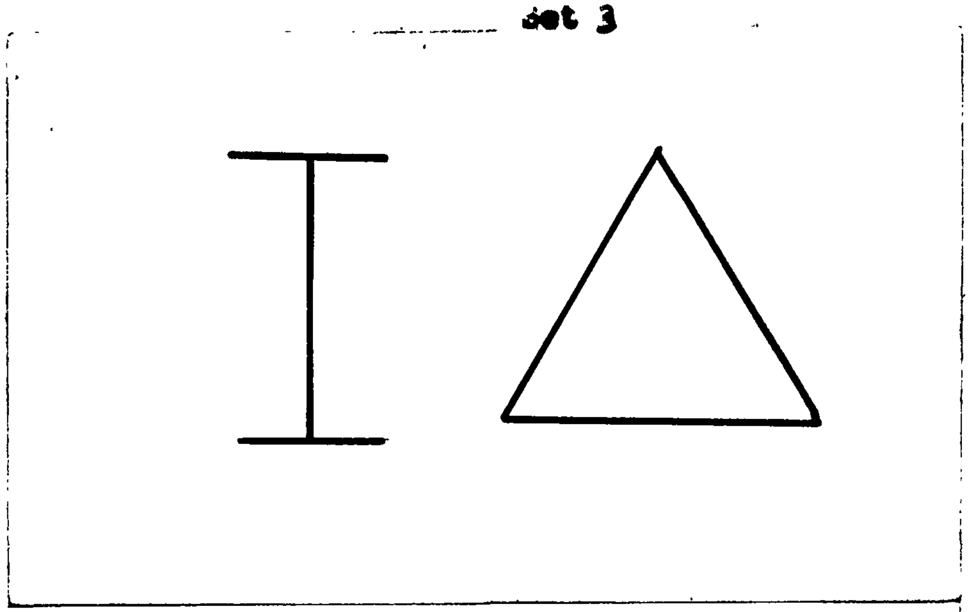

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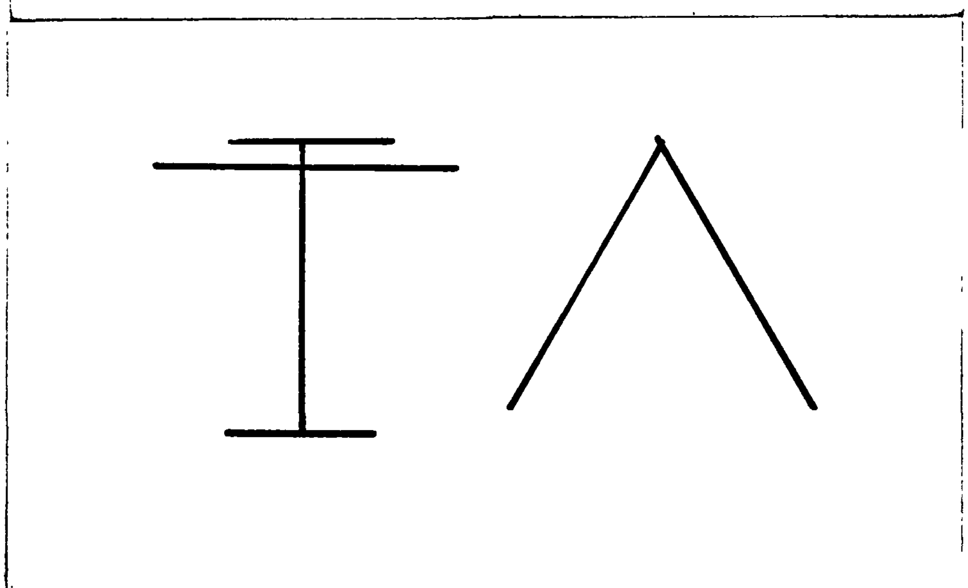

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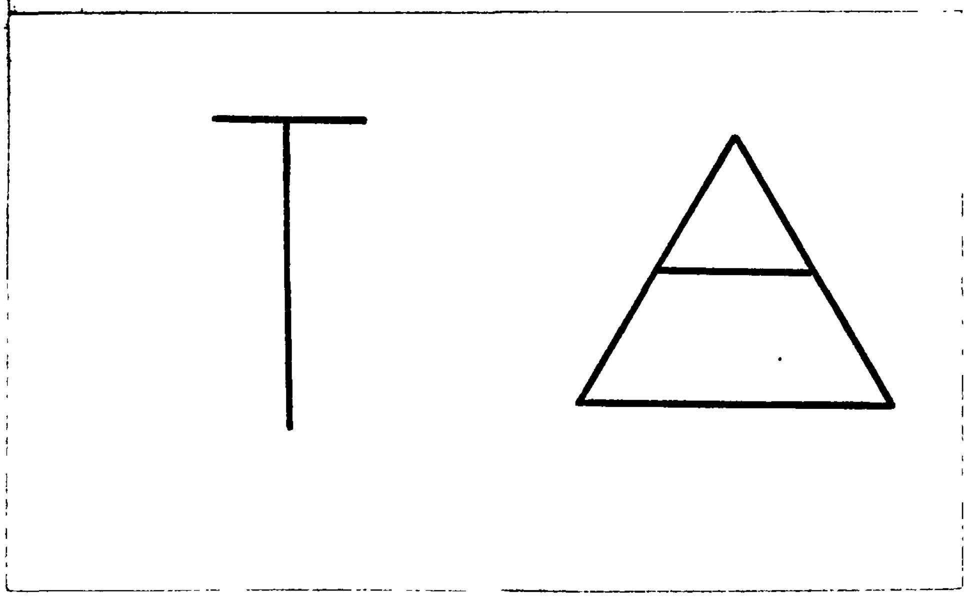

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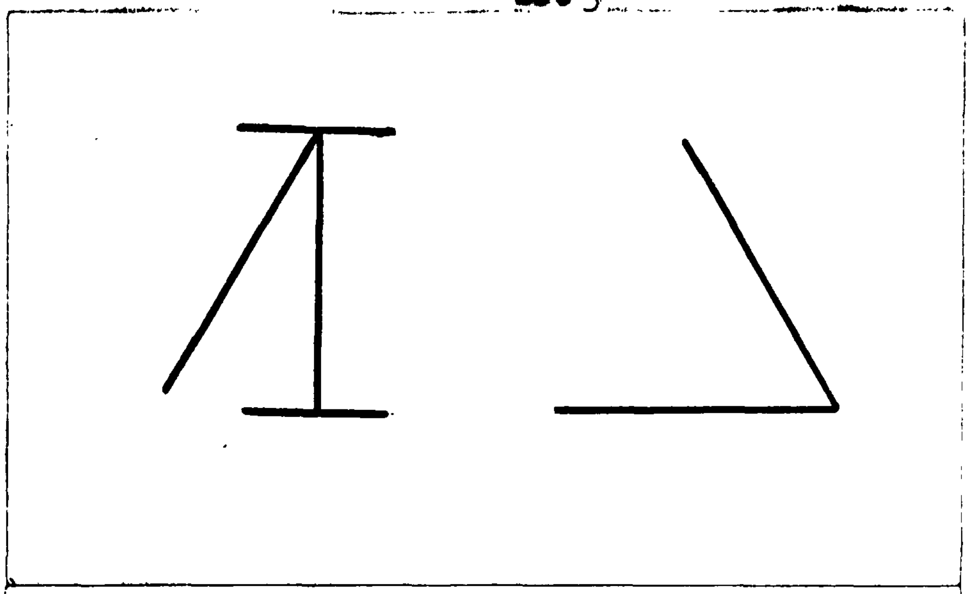

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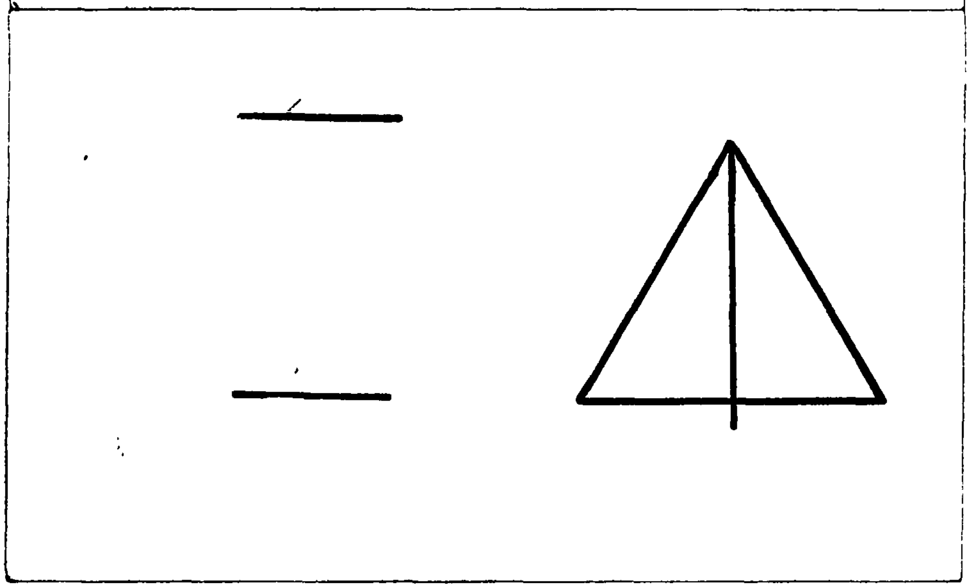

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APPENDIX 3

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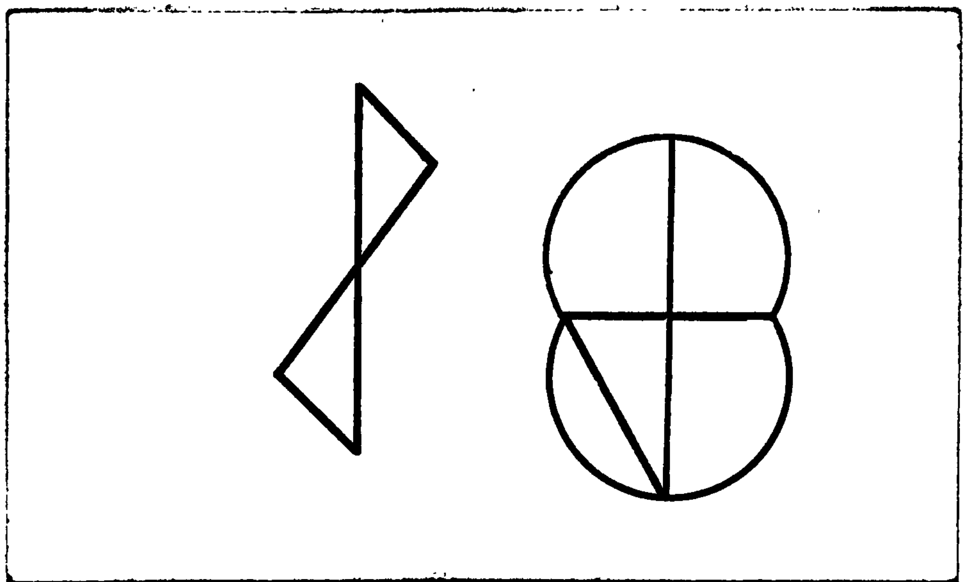

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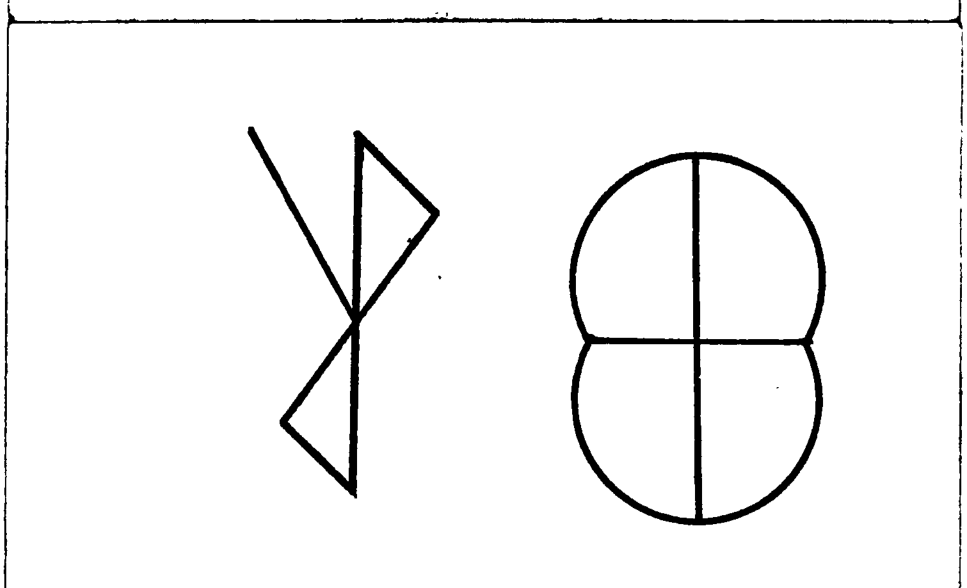

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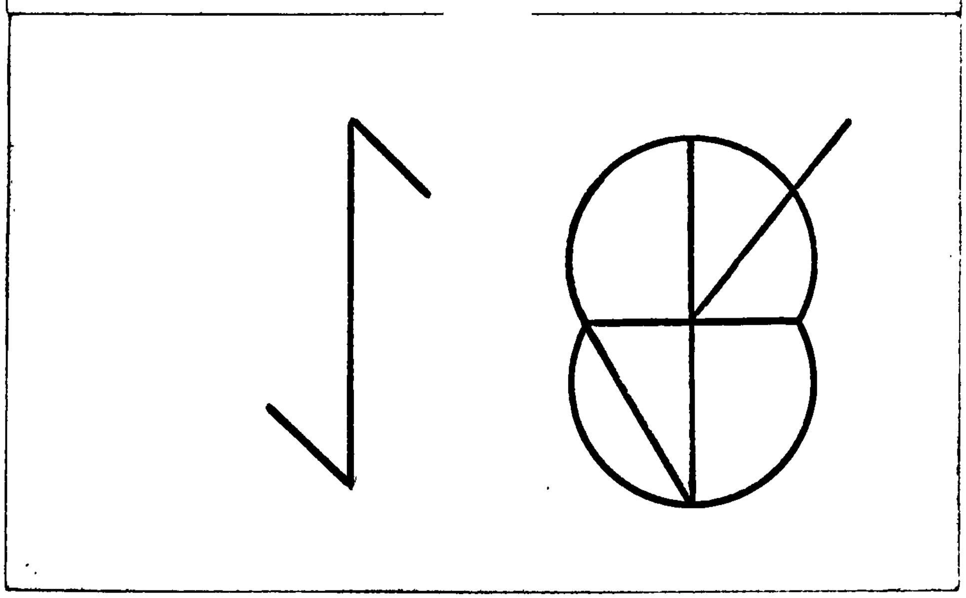

Subtractive 1

APPENDIX 3

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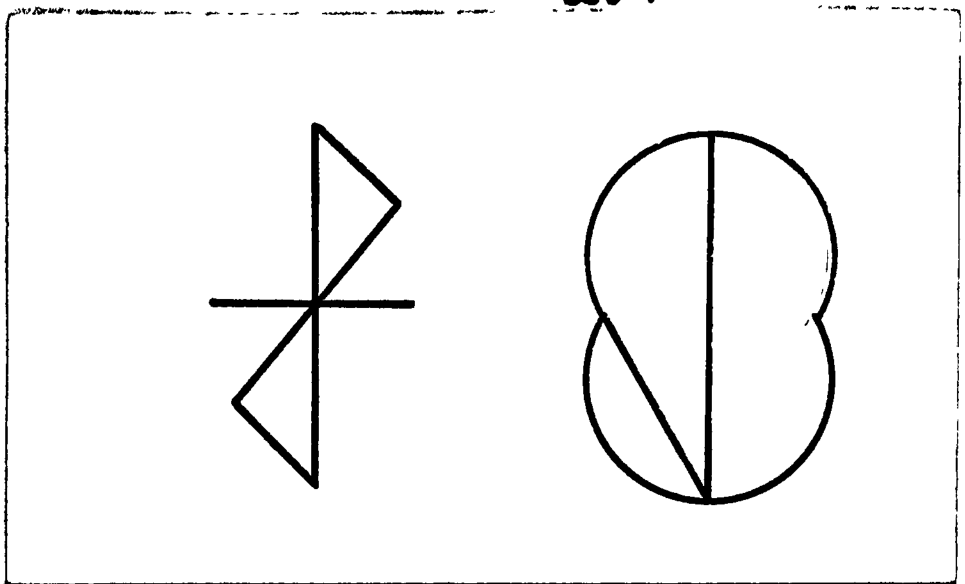

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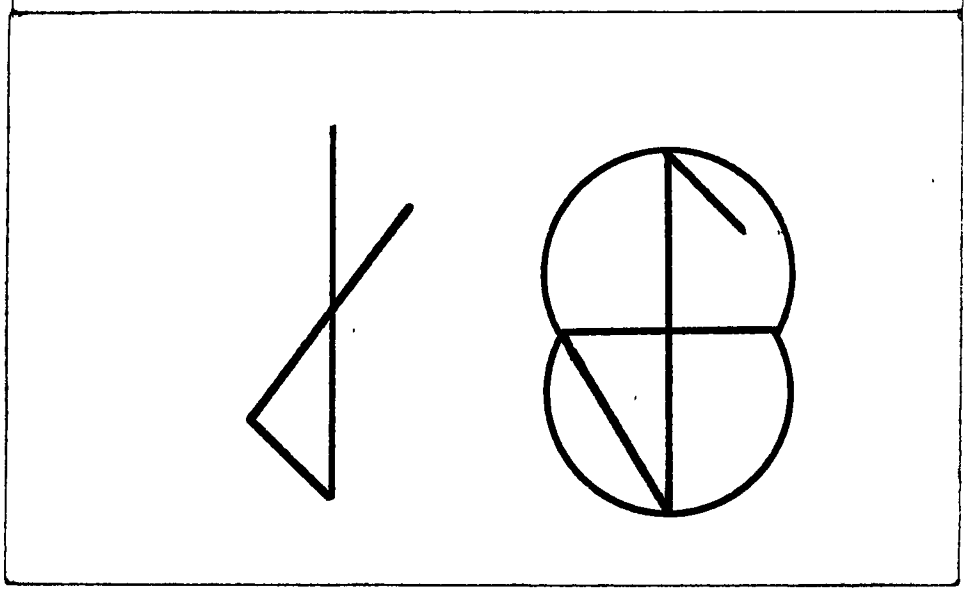

Subtractive 2

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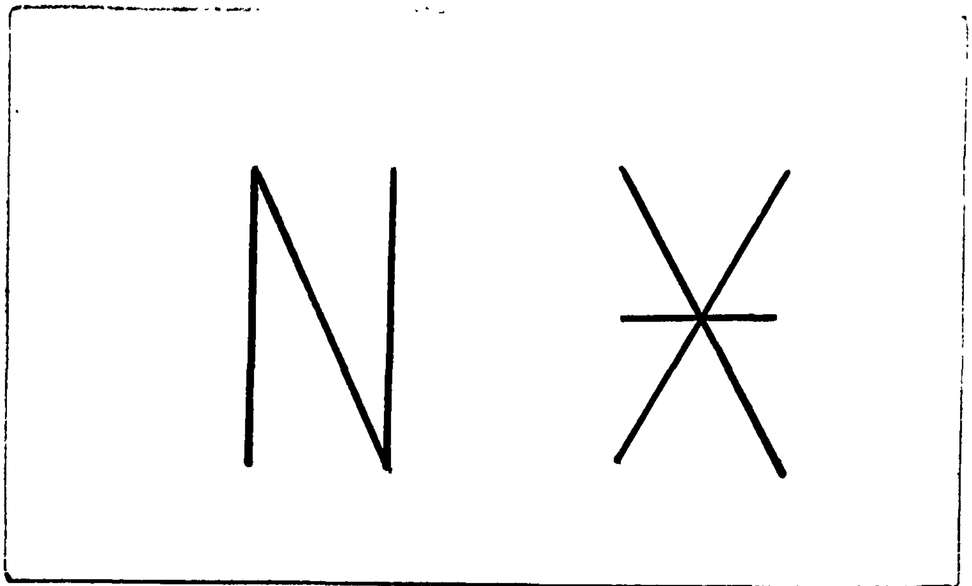

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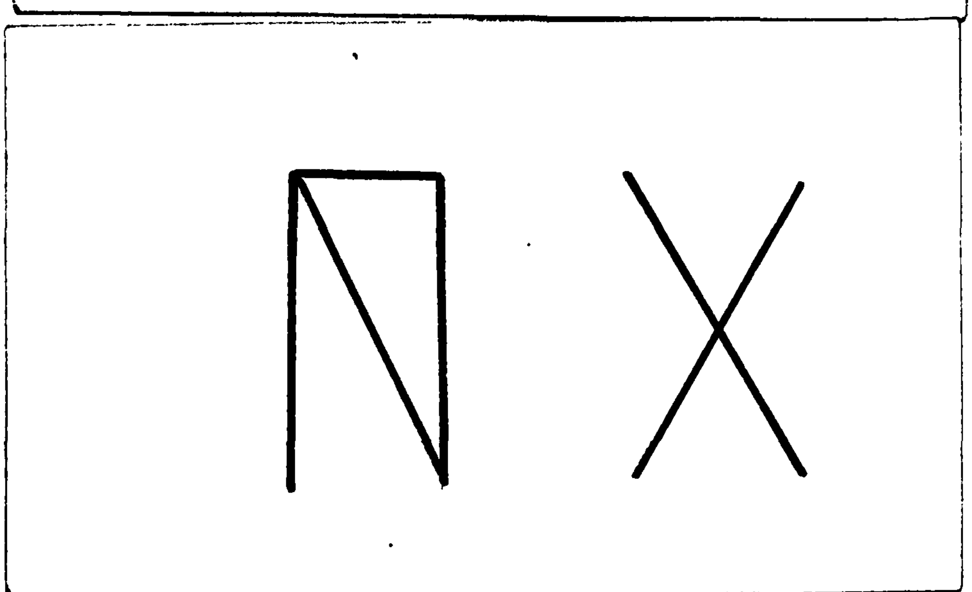

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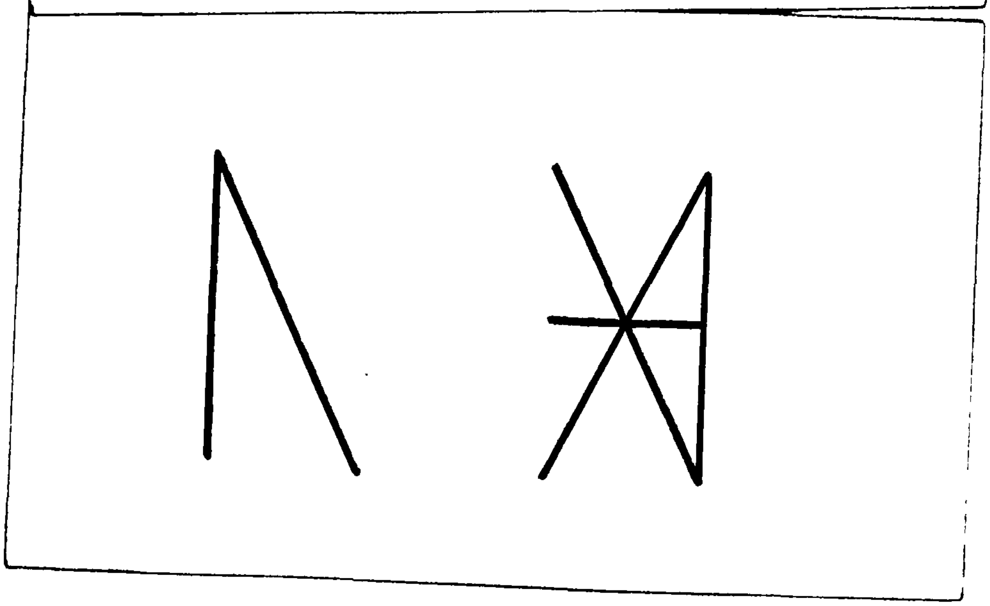

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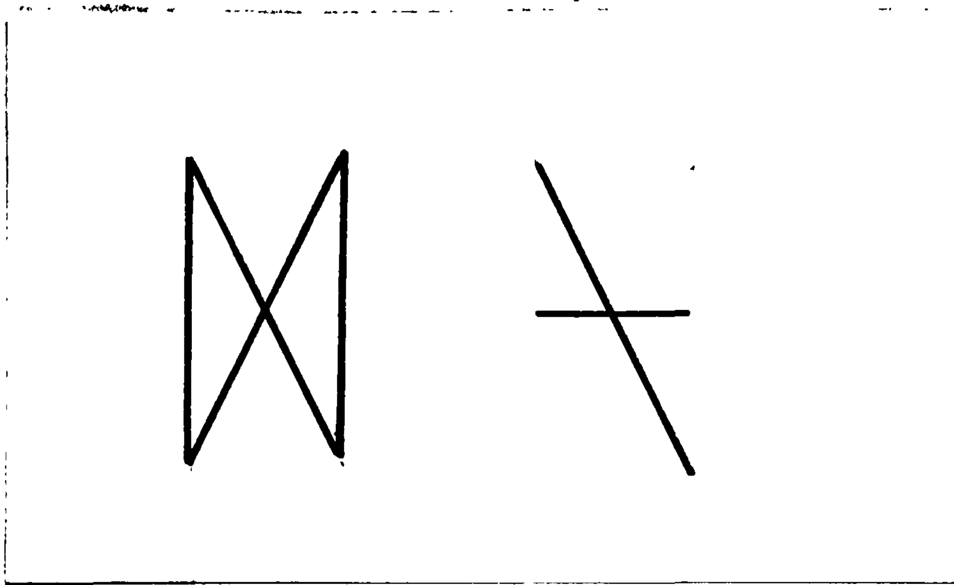

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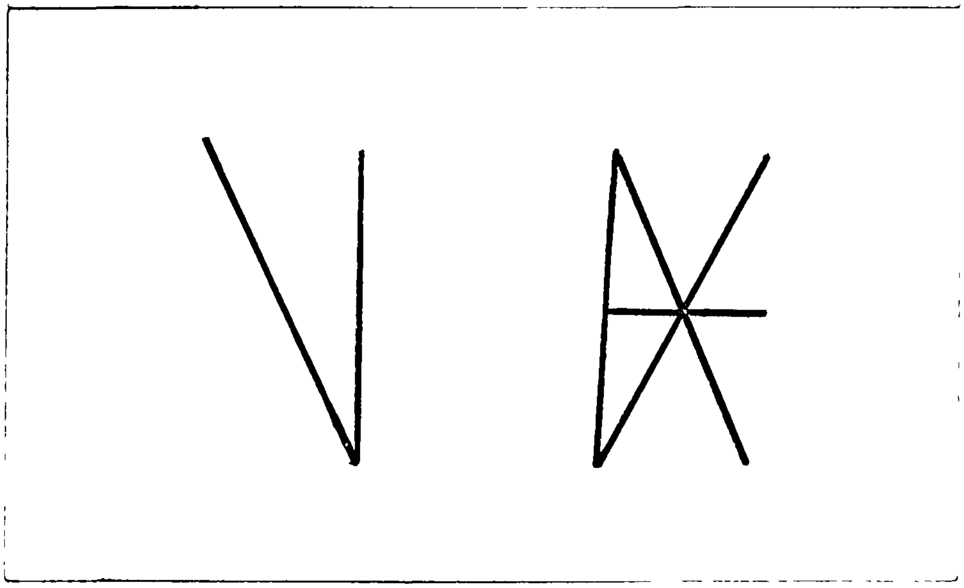

Subtractive 2

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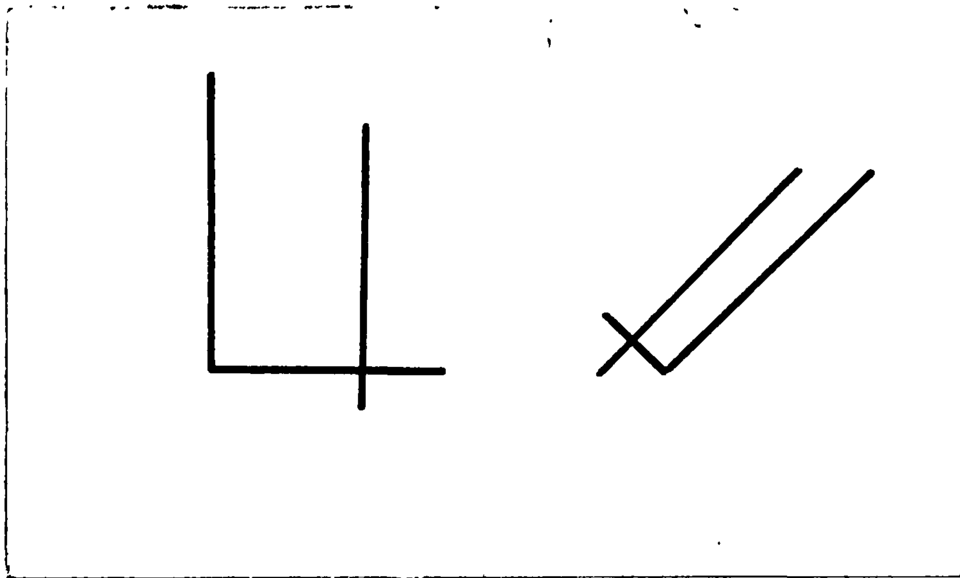

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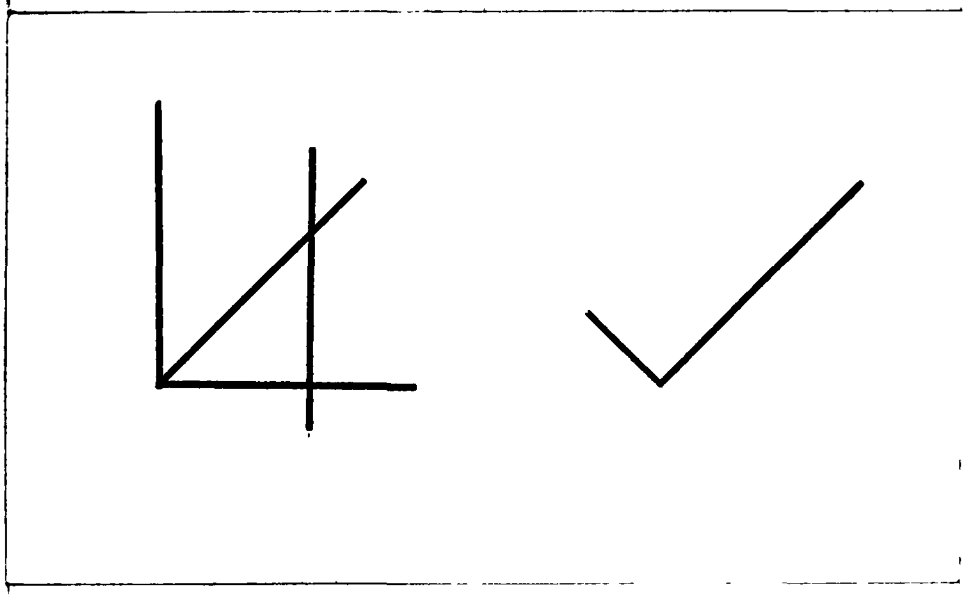

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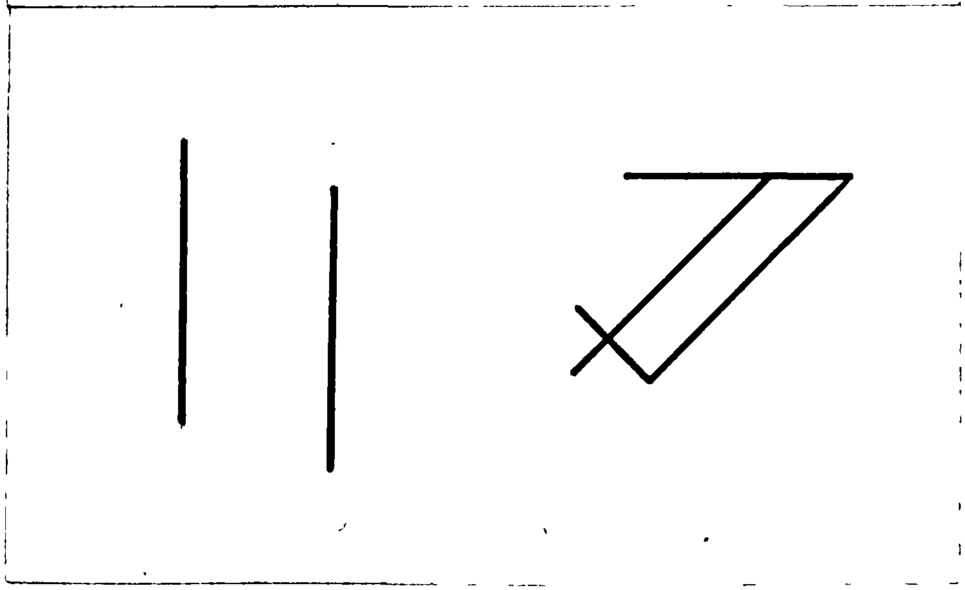

Subtractive 1

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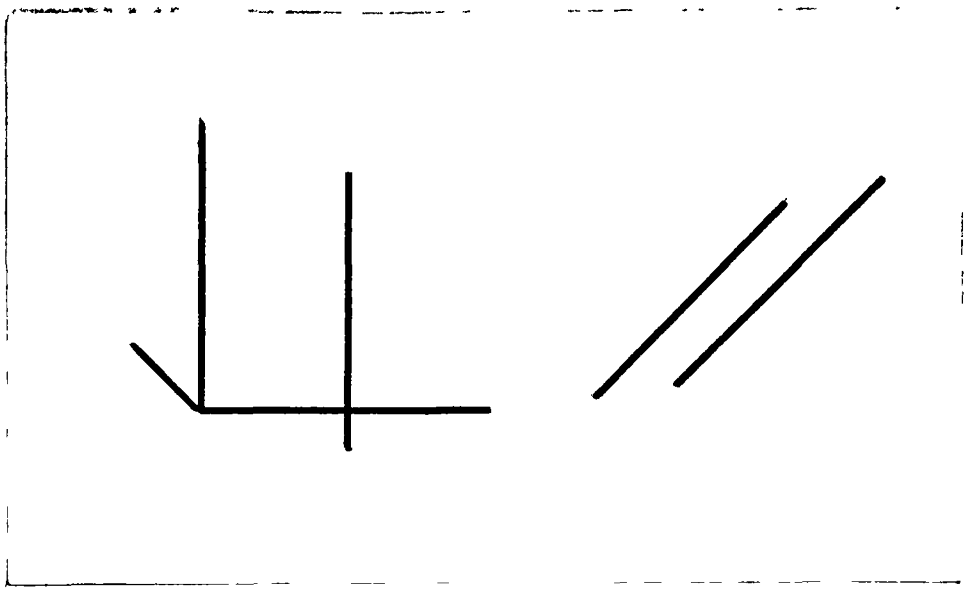

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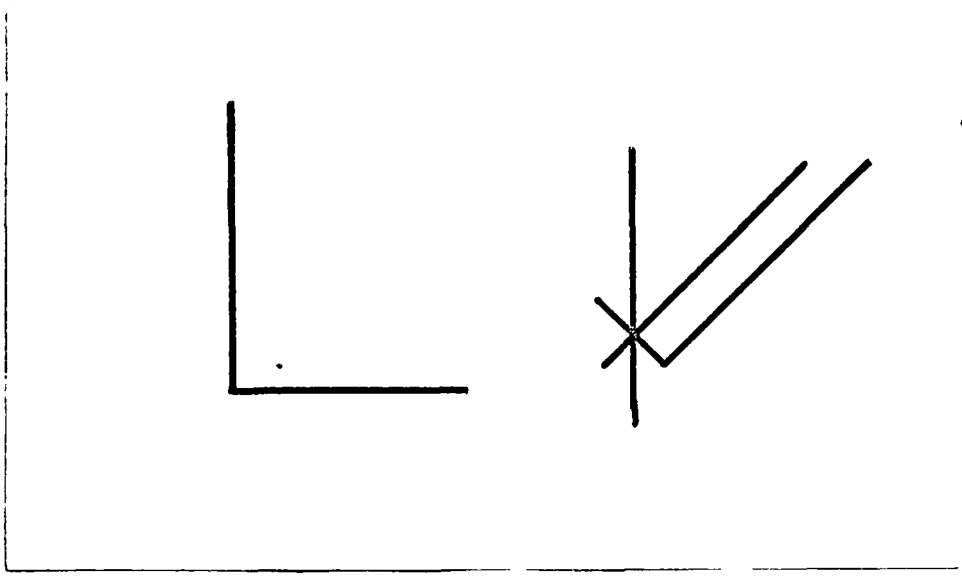

Subtractive 2

APPENDIX 3

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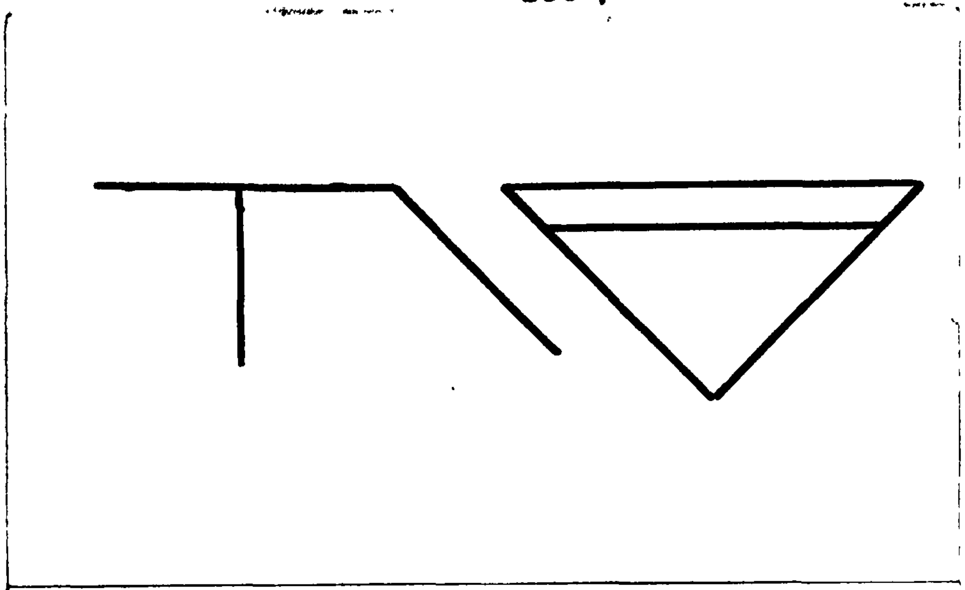

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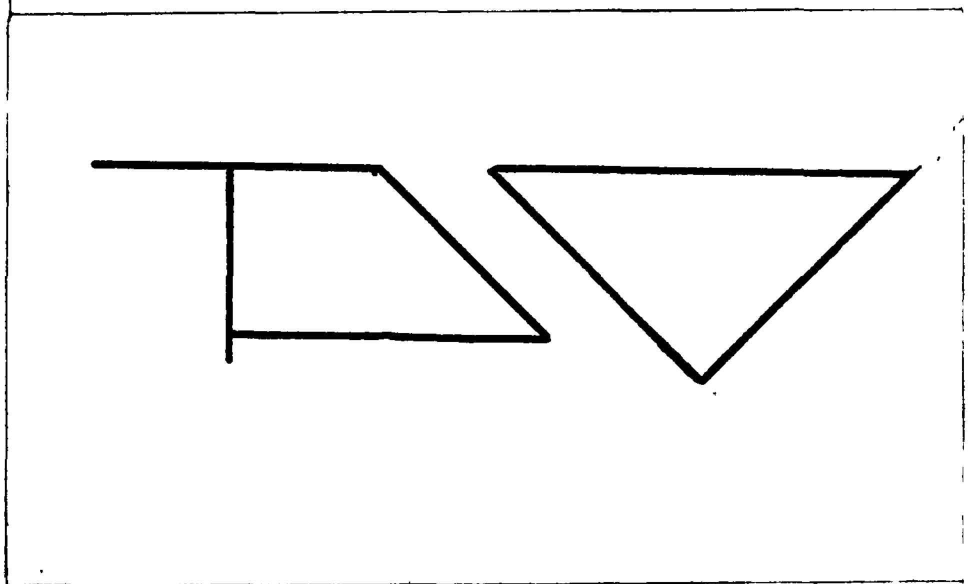

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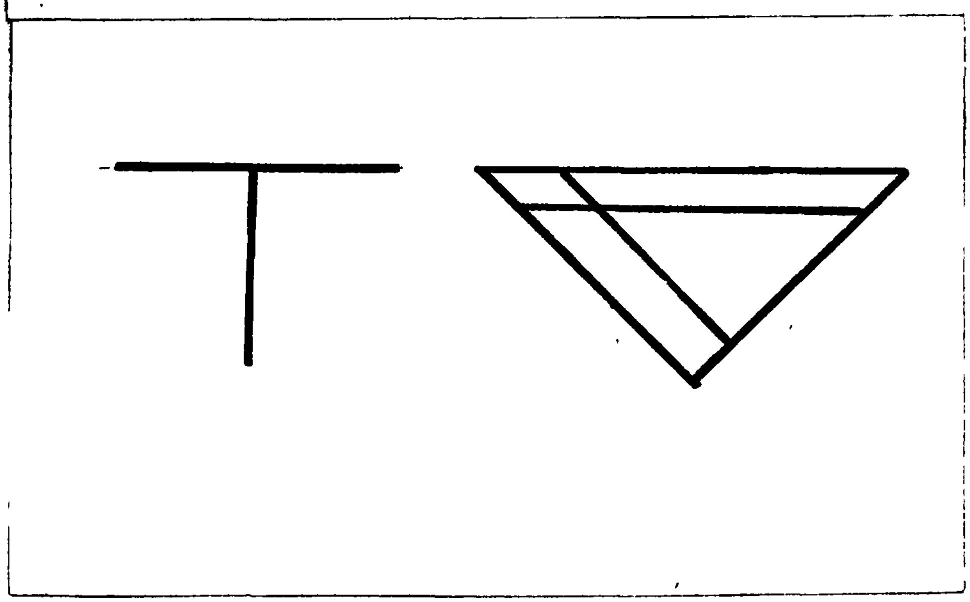

Subtractive 1

APPENDIX 3

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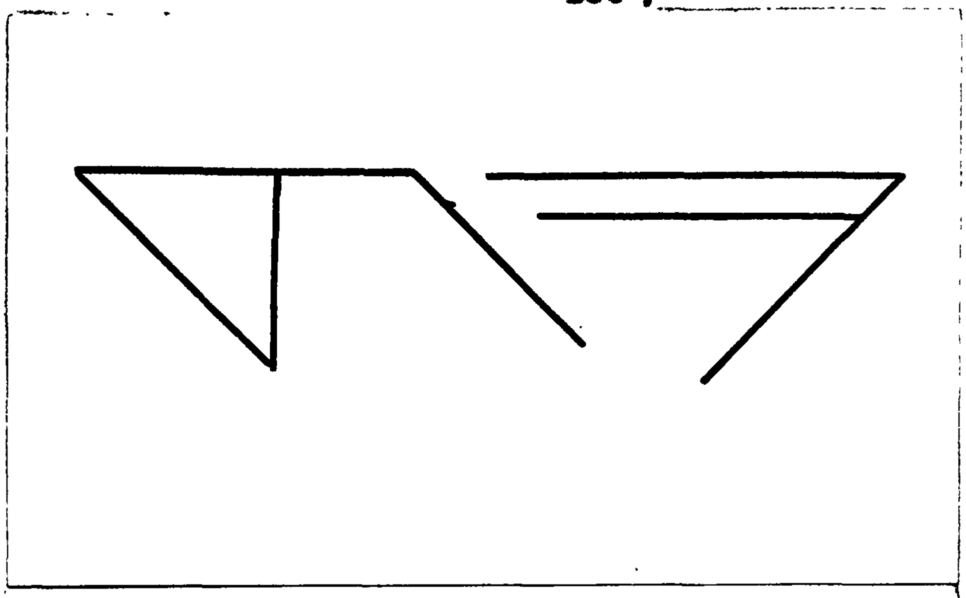

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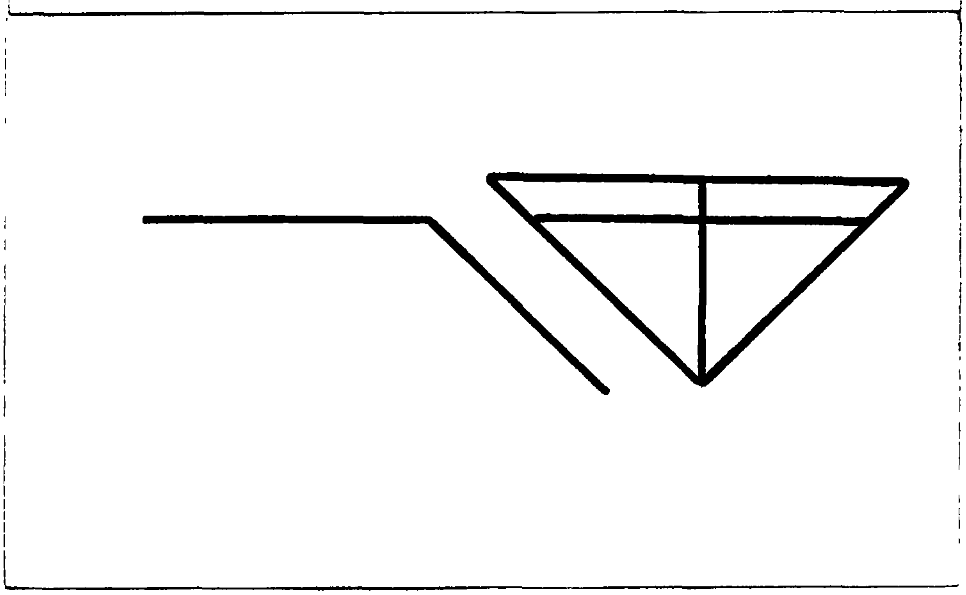

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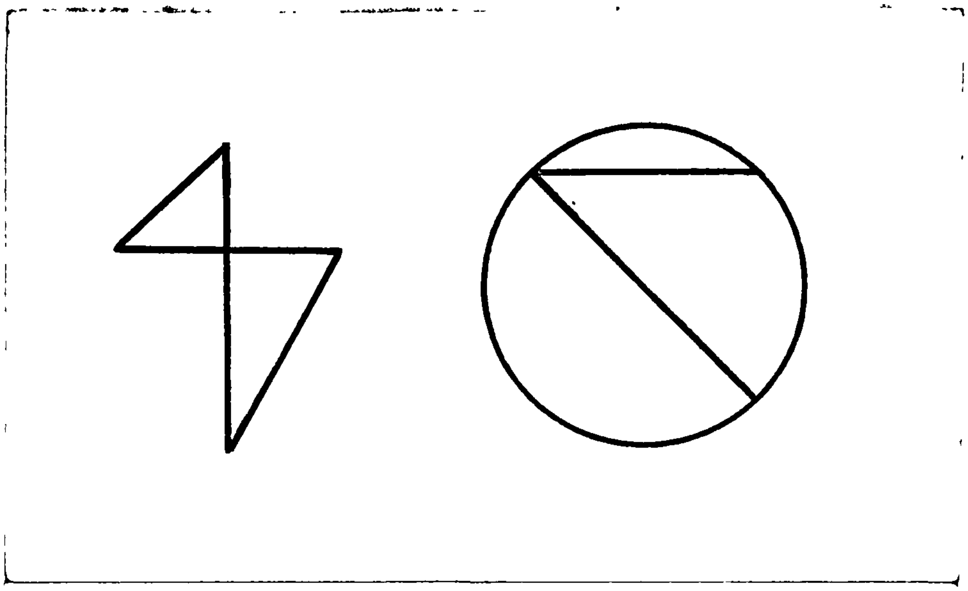

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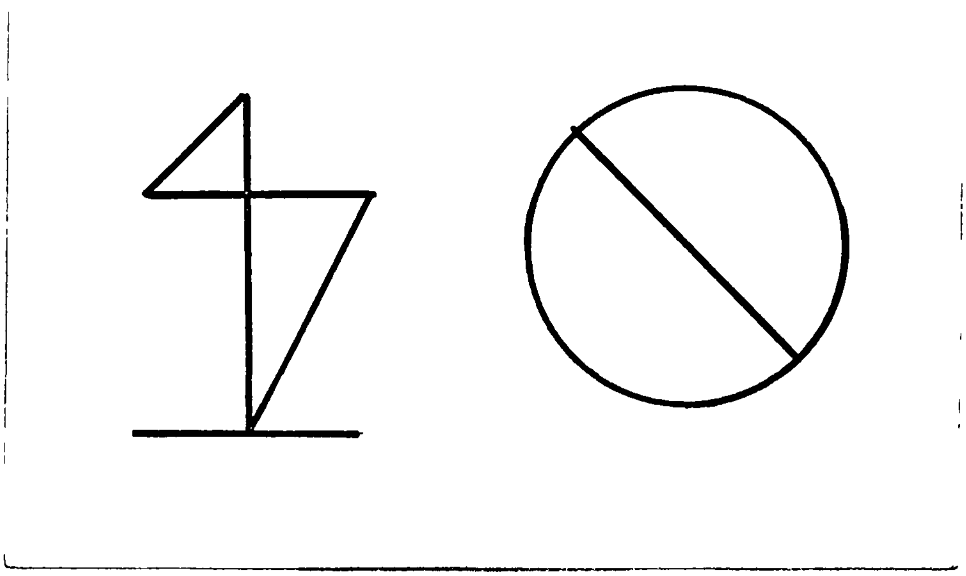

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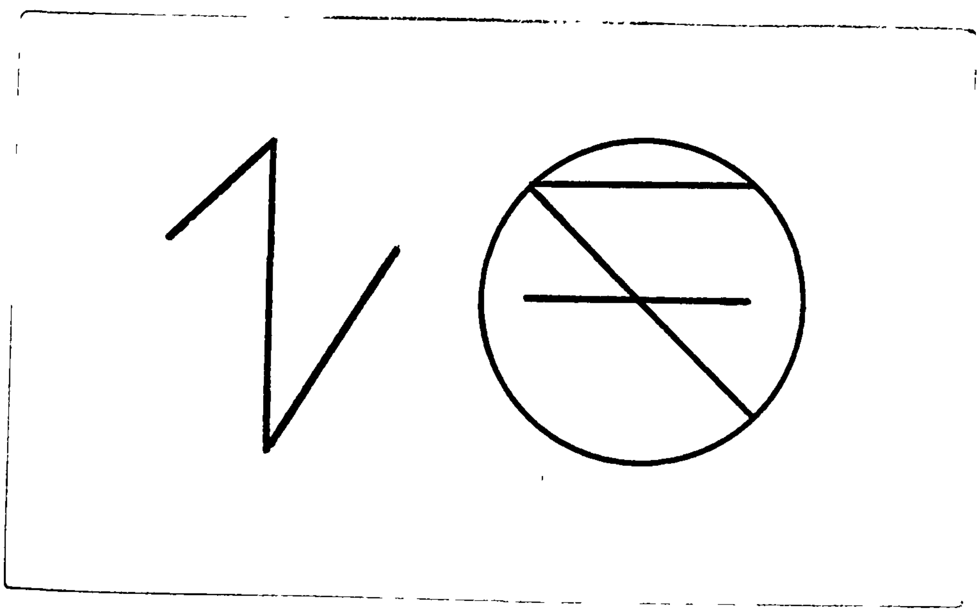

Subtractive 1

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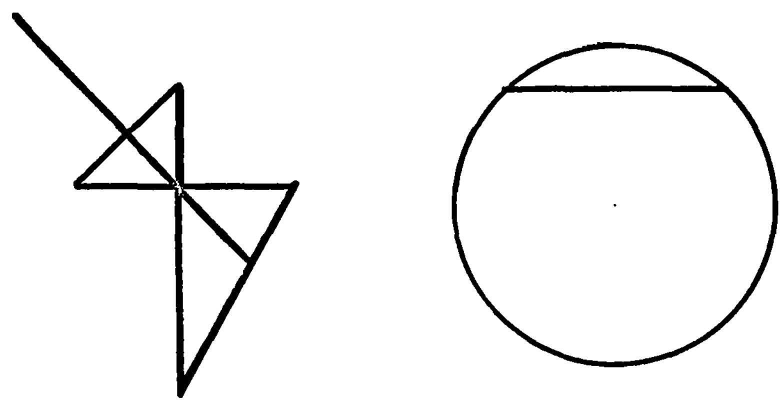

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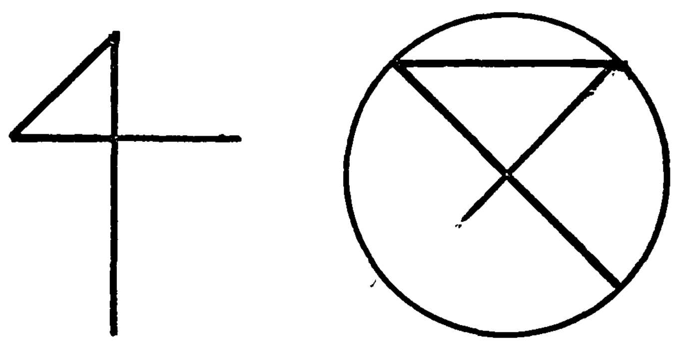

Subtractive 2

APPENDIX 5

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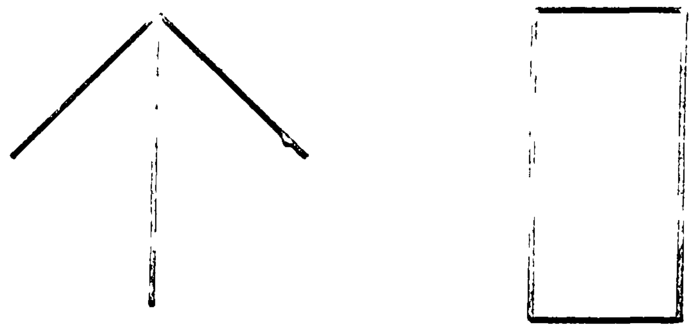

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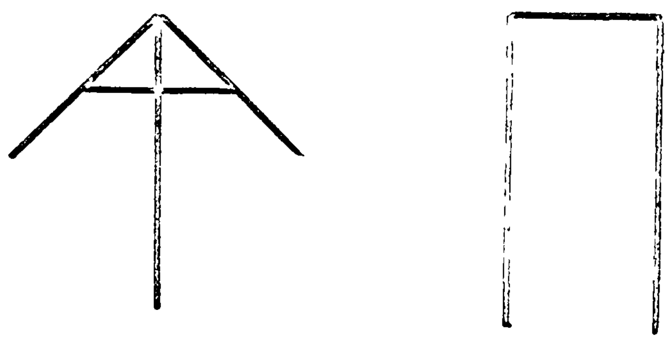

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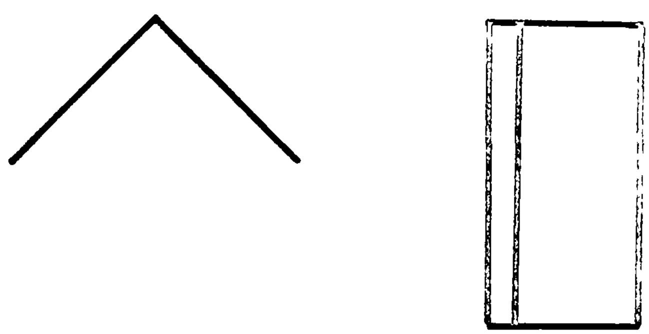

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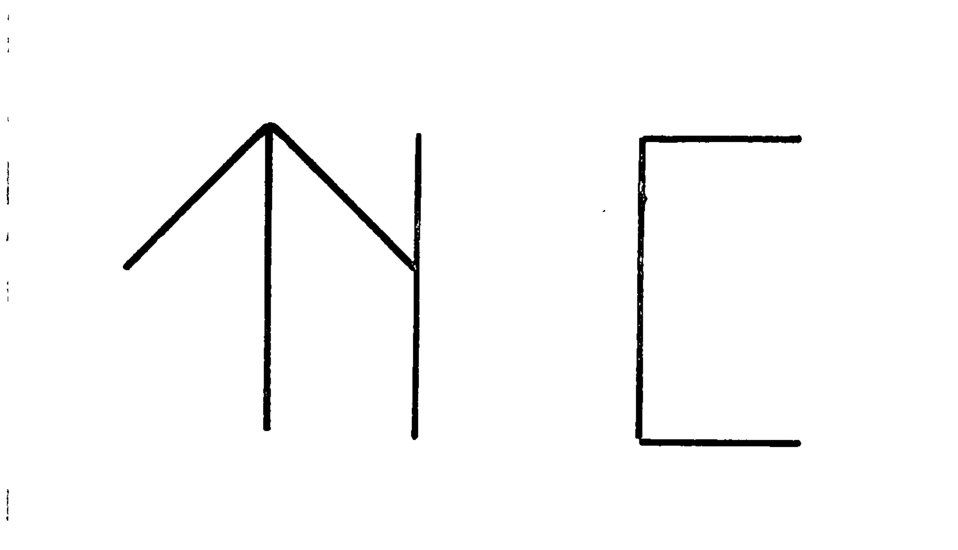

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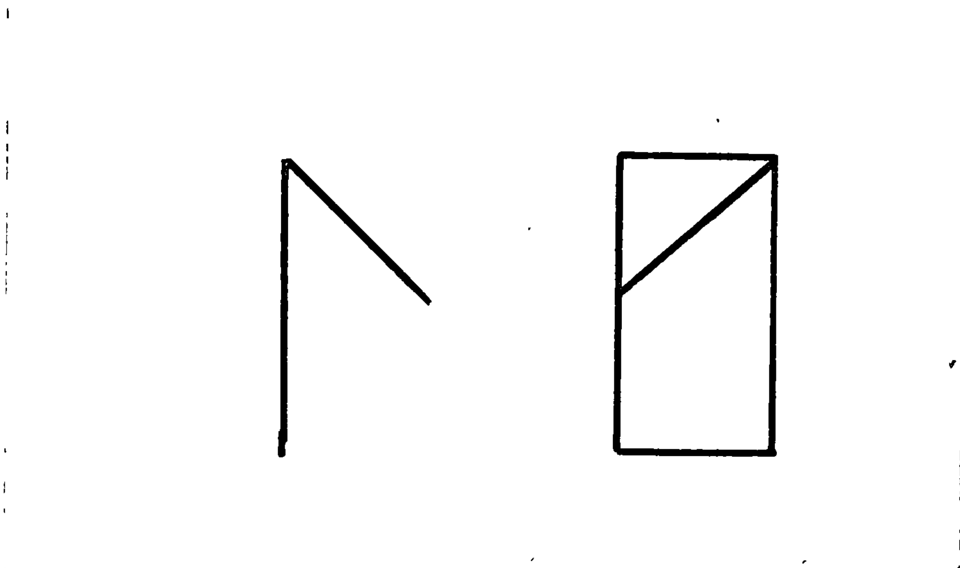

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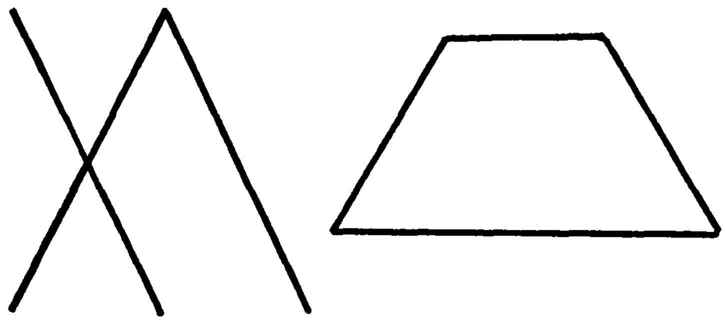

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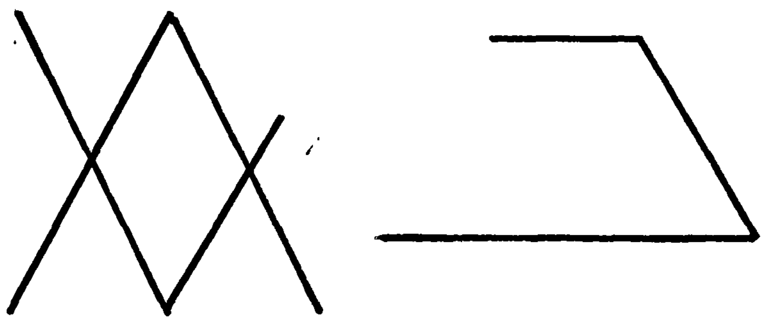

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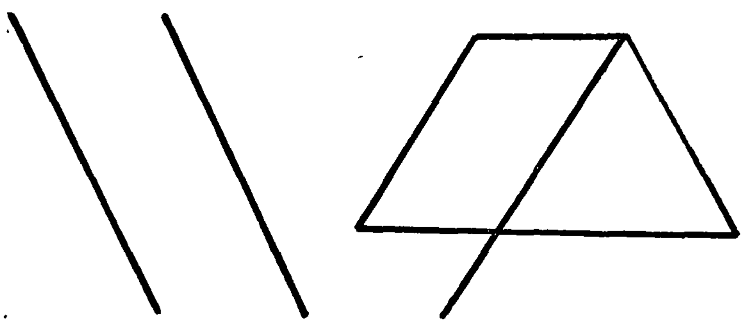

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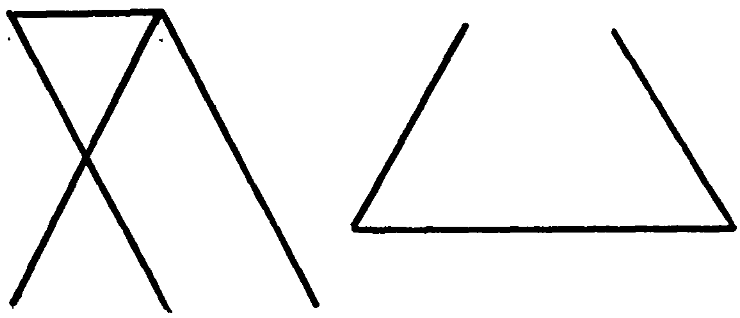

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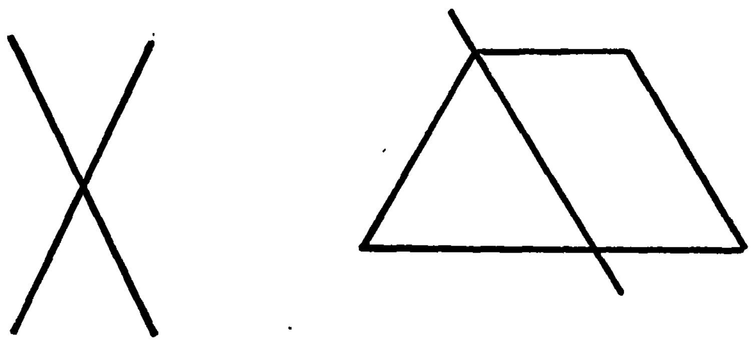

Subtractive 2

APPENDIX 4

REINFORCEMENT SCHEDULE

APPENDIX 4

Name: Place:

Sex: M F Age .... I.Q. .... Education (last grade completed) .....

First Admission Yes No Readmission Yes No

Treatment: Drugs:

Shock: Yes No Type: Last Administration:

Diagnosis: Age of Onset:

Favored: A S B A REQUIRED: A B Correct: ✓
Incorrect: X

(1)		(2)		(3)		(4)		(5)	
1	R	11	O	21	R	31	R	41	O
2	R	12	R	22	R	32	R	42	R
3	O	13	R	23	O	33	R	43	R
4	R	14	R	24	O	34	R	44	R
5	R	15	O	25	R	35	O	45	O
6	O	16	R	26	O	36	R	46	R
7	O	17	R	27	R	37	R	47	R
8	R	18	R	28	R	38	O	48	R
9	R	19	O	29	R	39	O	49	R
10	R	20	R	30	R	40	R	50	O
______		______		______		______		______	

(6)		(7)		(8)		(9)		(10)	
51	R	61	O	71	R	81	O	91	R
52	R	62	O	72	R	82	O	92	R
53	R	63	R	73	O	83	R	93	O
54	O	64	R	74	R	84	R	94	R
55	R	65	R	75	O	85	R	95	R
56	O	66	R	76	R	86	R	96	O
57	R	67	O	77	R	87	R	97	R
58	O	68	R	78	O	88	R	98	R
59	R	69	R	79	R	89	R	99	O
60	R	70	R	80	R	90	O	100	R
______		______		______		______		______	

COMMENTS:

70:30

APPENDIX 5

ABSTRACT OF

Probabilistic Functionalism and Maladaptive Behavior

APPENDIX 5

ABSTRACT OF

Probabilistic Functionalism and Maladaptive Behavior[1]

Brunswik's perceptual theory of probabilistic functionalism holds that the environment contains both constant and varying elements. According to this view, the organism must interpret the cause-and-effect sequences of the environment by means of probabilistic cues because of the ambiguity of many environmental signposts. In order to stabilize the environment that is in part undergoing constant change, the organism must be able to make a reasonably accurate estimate of events or subjects from certain cues.

This study is an attempt to apply the formulations of Brunswik to the maladapted organism. The general purpose is threefold: (a) to explore the validity of Brunswik's theory of probabilistic functionalism when applied to the maladapted organism; (b) to investigate the importance of perception of simple probabilities and the utilization of probability information necessary for the adjustment of the organism; and (c) to examine the possibility that symptom manifestation of schizophrenia might be related to impaired perceptual functioning in the discrimination of simple probabilities.

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1 Erich Schneider, doctoral dissertation presented to the Faculty of Psychology and Education of the University of Ottawa, Ontario, 1966, viii-117 p.

Sixty schizophrenics and as many normals were given a two-choice probability task disguised as a problem solving task. This task consisted of matching geometric designs. On each trial the subject had to choose between two types of variations as matching a key design. The probability pattern was the schedule of reinforcing the variations.

On the basis of the results obtained the experimental hypotheses were accepted. This led to the following conclusions, which appear warranted.

1. Schizophrenics, in contrast to normals, show impairment in their ability to discriminate simple probability patterns when these are disguised as a problem solving task.
2. The response patterns and event probability patterns do not show the close degree of correspondence characteristic of normal subjects but tend towards an erratic pattern.
3. Schizophrenic response probabilities show a tendency to reach a level, significantly below the ideal predicted by probability learning theory.

These results suggest that Brunswik's theory of probabilistic functionalism may have important implications for understanding how any organism adapts to his environment. The limitations of the study were discussed along with recommendations for further research.