AN ANALYSIS AND TEST OF THE RECONSTRUCTIVE-SCHEMATIC MODEL OF MEMORY

by

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ABSTRACT

The present study involved a test of the reconstructive-schematic model of memory. This model is presented within the historical context in which it developed, with the emphasis being placed on Piaget's research.

The reconstructive-schematic model is analyzed and its two key assumptions concerning the nature of memory and recall are isolated. Thus according to this model: (1) representation is closely linked and dependent upon the nature of perception. The active role of the individual during perception is of critical importance as representation and recall are determined by the individual's analysis of the stimuli during perception. (2) Memory involves a conservation of "rules" in schematic form and recall is characterized by a reconstructuve process in which these rules are used to reconstruct the original stimulus as adequately as possible.

To test these two assumptions an incidental learning paradigm involving two different orienting tasks was used. Twelve series of pictures per series comprised the visual stimuli which were employed in this study. Six groups of seventeen volunteer university students per group were tested. Three groups solved an analogy orienting task while three groups completed a ranking orienting task. In Piagetian terminology, the analogy orienting task was assumed to emphasize the "operative" aspect of cognition while the ranking task emphasized the "figurative" aspect.

All six groups were tested for free recall one week after performing

the orienting tasks. Two groups (AImm and RImm) were tested for free recall immediately after completing the orienting tasks. Four of the groups (AImm and RImm as well as AWk and RWK, two groups not tested for immediate free recall) were tested for probed recall immediately after completing the delayed free recall test. Finally, two groups (ARec and RRec) received a recognition test instead of the probed recall test.

To test all predictions that followed from the two major assumptions of the reconstructive-schematic model, it was necessary to conduct two different phases of analysis. The first phase focused on the subjects'performance on the dependent variables: immediate, final free, and probed recall, "clustering", "component clustering", time spend solving orienting task, and recognition. In the second phase, the scores on each dependent variable were collapsed across subjects, resulting in a mean score for each of the seven positions in each of the series. This type of analysis was required to examine the "pattern" or organization of free recall, probed recall, and clustering scores. In both phases, one way analyses of variance were conducted for each dependent variable and each comparison under consideration.

The first assumption was supported by the finding that the "pattern" of immediate, final free, and probed recall scores and recognition scores varied with the type of orienting task involved. The second assumption received support from the finding that the "analogy" groups were characterized by greater clustering and probed recall scores and fewer errors during final free recall. However, contrary to predictions, the analogy groups were not characterized by greater free recall.

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INTRODUCTION

The purpose of this thesis is to test the schematic-reconstructive model of memory by studying long term recall and recognition of visual stimuli. However, before such a study can be described, it will be necessary to give an adequate presentation of this position. The schematic-reconstructive position is not represented by a unitary, well-formulated theory. Instead, it represents a common conception or approach to memory that can be found in the works of several theorists widely removed in time and background. This approach is best understood when viewed within the historical context in which it evolved.

The beginnings of the scientific study of memory can be traced to Ebbinghaus' now classic memory experiments in the late nineteenth century. Early in his research, Ebbinghaus found that although the stimuli used in each case were the same, recall nevertheless varied across individuals. He realized that because of the unique learning history that each individual brought into the laboratory, the same stimulus did not have the same meaning across individuals and consequently it was recalled differently. To attain maxmium control over the experimental situation and consequently to eliminate the "confounding" meaning effect, Ebbinghaus used only nonsense syllables as stimuli. He reasoned that if the stimuli were meaningless to all individuals they would be interpreted in a similar fashion. This would allow Ebbinghaus to study how recall varied as a function of such variables as list length, word order, retention interval, and so on. This emphasis on maximum control of the experimental situation by conducting laboratory studies with "simple" stimuli, such as lists of nonsense syllables, set the tone in memory research for the next seventy years. Also, it has only been in the last fifteen years or so that memory experiments involving sentences or more complex linguistic units, as well as memory studies with perceptual stimuli have begun to be carried out. (The notable exceptions to this rule are the studies of Bartlett and Piaget which will be discussed shortly.)

Although in such studies the experimenter has a high degree of control over extraneous variables, this advantage may not be worth the price that is usually paid in the process. Thus Bartlett noted that such studies many be criticized as: "(a) It it impossible to rid stimuli of meaning as long as they remain capable of arousing any human response; (b) The effort to do this creates an atmosphere of artificiality for all memory experiments, making them rather a study of the establishment and maintenance of reception habits; (c) To make the explanation of the variety of recall responses depend mainly upon variation of stimuli and of their order, frequency, and mode of presentation, is to ignore dangerously those equally important conditions of response which belong to the subjective attitude and to predetermined reaction tendencies."[1] It is interesting to note that such criticisms may still be applied to much of the verbal memory work that has been carried out in the forty years subsequent to Bartlett's reproof.

Early animal studies in memory also had important consequences for the direction that human memory research would take. To explain the results of such animal research, "trace" formulations of memory became popular. In the late nineteen-twenties such "trace" formulations were extended to human verbal memory research. Such "trace" positions hold that whenever an object is perceived or an event occurs, a perceptial trace of such an object or event is "stored" in the individual's mind. At a later point in time a stimulus re-excites or re-evokes this trace, which results in the experience of recall. As we shall seem such a trace position is antithetical to the reconstructive-schematic approach.

In reaction against such research, Bartlett was concerned with conducting more "natural" studies that stressed the role of the individual's "subjective response" in memory and recall. Consequently, instead of eliminating meaning, the work was characterized by the use of such highly meaningful stimuli as pictures and stories. Bartlett concluded that: "Remembering is not the re-excitation of innumerable fixed, lifeless, and fragmentary traces. It is an imaginative reconstruction or construction, built out of the relation of our attitude toward a whole active mass of organized past reactions or experience, and to a little outstanding detail which commonly appears in image or language form."[2] Bartlett employs the concept of "schema" to refer to this "whole active mass of organized past reactions or experience". The "attitude" which shapes recall results when the organism acquires "... the capacity to turn around upon its own 'schemata' and to construct them afresh. This is a crucial step in organic development. It is where and why consciousness comes in, it is what gives consciousness its most prominent function."[3] Thus during perception, the subject is not passive. Instead, "when material is presented, a subject, perhaps immediately, perhaps by definite analysis, discovers what he takes to be its rule of arrangement. Then the rule becomes predominant and fashions the subject's recall."[4] Therefore, according to this position such rules and not isomorphic traces of the stimuli are "stored" in memory. During recall these rules are used to reconstruct the many additional details that comprise the original stimulus. This reconstruction may lead to distortion particularly by over simplification, however, as Bartlett points out, in ordinary life such distortion is usually not of any great significance.

Bartlett's work represented a radical departure from traditional memory research and theorising. Although one might disagree with details of his methodology or theory, his approach represented the first well formulated attempt to deal with "natural" memory as it occurs outside the laboratory. Nevertheless, his work was largely ignored and researchers continued to conduct artificial memory studies involving lists of nonsense syllables or nouns equated for memorability. Bartlett was partly to blame for this state of affairs as he used the constructs "schema" and "attitude" in a vague, incomplete and often confusing manner. Furthermore, a critical argument in Bartlett's theory is that he attributes to "consciousness" "... the capacity to turn around upon its own 'schemata' and to construct them afresh."[5] One must agree with Anderson and Bower[6] who find this argument "a little hard to follow" and "unconvincing".

Piaget, who also adopts a schematic reconstructive approach to memory, offers a more complete description of the role of the schema in memory and the reconstructive processes involved in recall. Because his work represents one of the most thorough expositions of the schematic-reconstructive approach, an analysis of his position will now be undertaken.

An adequate test of the schematic-reconstructive position will involve assessing the validity of the role to which internal representation is assigned in such a model. However, before this role can be assessed, it will be necessary to give a complete description of the nature of representation in this approach. One of the best ways to accomplish this is to contrast the role of representation in the Piagetian approach with its role in a trace formulation. Indeed, this is the technique adopted by Piaget in setting forth his position. Thus, in the following section, Piaget's work will be contrasted with Paivio's "dual-coding hypothesis". Paivio's work was chosen for contrast as he makes explicit assumptions concerning representation that are <u>implicitly</u> held by many trace theorists. Also, his position is well formulated and has generated a good deal of research.

Paivio views imagery and verbal processes as "alternate coding systems or modes of symbolic representation, which are developmentally linked to experiences with concrete objects and events as well as language. In a given situation they may be relatively directly aroused in the sense that an object or an event is represented in memory as a perceptual image and a word as a perceptual motor trace, or they may be associatively aroused in the sense that an object elicits the verbal label (or image of other objects) and a word arouses implicit verbal associations or images of objects. In addition, it is assumed that chains of symbolic transformations can occur ...

involving either words or images, or both, and that these can serve a mediational function in perception, verbal learning, memory, and language.[7]

Like many trace theorists, when describing the imagery system, Paivio uses representation in a narrow passive configurative sense.[8] Narrow, in the sense that the use of representation is limited to sensorial representation. Configurative in the sense that there is a direct configurative correspondence between the representation and the "real thing". Thus the real thing is the "efficient cause" of the internal representation. Consequently such a conceptualization of the role of representation is also "passive", for as Furth points out, in such a position, ".....knowledge has its adequate source in external reality or internal actions and resides in external representations" (emphasis mine)[9]. Accepting such a view, "... leaves unexplained the active relation of the knowing person to the representation which would be inherent in any true symbol behaviour".[10] By accepting the notion of "efficient cause". Paivio naturally emphasises the external, sensorial (or what Piaget terms the "figurative") aspects of knowledge. This is reflected in the fact that much of the research carried out by Paivio and his co-workers is concerned with determining the relationship between stimuli characteristics and the types of representation "evoked". Only when the "efficient cause" explanation is rejected, as in Piaget's case, is it possible to fully consider the active role of the "knowing person" in the formation of memory images.

Since the "verbal system" serves a sumbolic function for Paivio, here representation is used in a more abstract sense. In this case, representation is not narrow or configurative as the real thing is not the efficient cause of the word, since the word is symbolic in nature. However, representation is still sensorial in a sense as a word is stored as a "perceptual trace".

Unlike Paivio, Piaget does not accept the English-empiricist assumptions or passive-reacting view of the individual described above. Consequently, he does not unquestioningly accept the notion of the memory image as a "perceptual trace" or passive copy of reality. In fact, Piaget is concerned with imagery and memory as an aspect of larger epistemological questions. From his study of the development of imagery and memory in the child, Piaget concluded that the image is not an automatic copy of an object or event. Thus he writes: "Sooner or later reality comes to be seen as consisting of a system of transformations beneath the appearance of things. These transformations cannot be copied unless they are actively reproduced by being prolonged. This means that there cannot be a copy at all in the strict sense. In order to know objects it is necessary to act on them, to break them down and to reconstruct them. .... Assimilating an object means participating in the system of transformations that go to produce it, entering into a relationship of interaction with the world by acting upon it. Hence the important part played by the operations which are the sole means of apprehending transformations."[11] Thus Piaget found that the adequacy of the image varied as a function of the intellectual complexity of the relations involved. The more complex the relations or transformations involved the less adequate the images will be as such situations are more difficult to "break down" or "apprehend".

Piaget uses representation in a symbolic sense. The image symbolizes the abstract knowledge which results whenever an object or event is assimilated by schemata. In Piaget's words: "The operations carry out the transformations, the image represents them. Now, the representation of an operation remains figurative, and does not merge with the operation itself. However faithful this representation may be, it is still no more than an imitation of the operation. In the same way an imitative gesture imitates an action without being identical with it. Between the image ... and the corresponding cognitive structure, there is, in spite of their increasing close collaboration, all the distance that separates the symbolizer from the thing being symbolized."[12]

Although both Piaget and Paivio use the term "symbol" to describe the image, they are actually employing it in radically different senses. It would be more appropriate to substitute "sign" or "signal" for "symbol" in Paivio's case as in his paradigm the image functions "... as a stimulus substitute that elicits a behaviour reaction similar to the original stimulus."

According to Paivio, images and words are "stored" in memory as images and words or, in his terminology, as "perceptual" and "verbal traces". In such a model remembering simply consists of "re-evoking" or reactivating the relevant images and words and meaning then results when these are "scanned" or "read off". Consequently for Paivio and other trace theorists "mental images" and "mental words" play a central role in cognition as they are viewed as fundamental cognitive elements.

On the other hand, for Piaget "the image then constitutes an auxiliary that is not only useful to, but in many instances necessary for the functioning of the operations. After having structured and fashioned it in their own likeness, the operations in fact come to depend on the image."[13]

Several recent researchers have arrived at similar conclusions regarding the nature of cognition. In a recent article on imagery, Yuille and Catchpole write: "The fundamental form of storage is not in the form of images, words, or sounds, or any other sensory analogue. Rather the flexibility of mental functions demands that we abandon sensory analogues to describe the central operation of cognition and instead describe these operations as occurring in a form and symbolims unique to the mind. Basic knowledge must be in the form of abstract contentless code ..."[14]

Other recent researchers, Anderson and Bower (1974), Kintsch (1975), Norman and Rumelhart (1975), and Pylyshyn (1973) have arrived at similar conclusions. Anderson and Bower's and Norman and Rumelhart's work will be discussed later. Other contemporary researchers, i.e., Loftus (1975), Sachs (1967), Bransford and Franks (1971), and Barclay and Franks (1971) have reported findings that contradict trace notions of representation, but are readily interpreted within a Piagetian reconstructive-schematic model.

From his study of imagery, Piaget cast light upon the relationship between the figurative and operative aspects of cognition. Since he concludes that images and words are not elements of cognition but instead, play an auxiliary role in thought, it follows that in a

Piagetian model of memory, memory cannot be treated as simply the storage of mental images and mental words. Thus as we shall see, for Piaget, the explanation of memory must extend beyond representation.

From his study of the development of memory in children, Piaget found several interesting results which could not be explained by a trace conception of memory. The two that are most relevant to this thesis are summarized below.

Firstly, the child only remembered those stimuli that he was able to "break down" or apprehend during perception. Apparently if the child could not understand the "transformations" underlying the stimuli during perception, he was unable to reconstruct these during recall.

Secondly, in many cases, after a period of six months, the child's memory actually improves. Piaget attributes this surprising result to the role played by the operations in memory: "Hence, if the memory does make progress, it can only be because the model was not registered with the help of the memory image alone, but also with the help of the schema which then develops and finds its own equilibrium, based purely on the subject's actions, during the next recall, the memory image is improved, thanks to the advances of the schema."[13]

Thus Piaget has reduced the problem of memory to the conservation of schemata, which conserve themselves by virtue of their own functioning. The memory image simply symbolizes the abstract information which is conserved in the schemata. In Piaget's words: "The image nevertheless remains distinct from recall: the image is a symbol and recall a mental act which includes (attributional, relational, and existential) judgements because it is not exclusively an image but also comprises a schematism."[16]

Before proceeding, it would be worthwhile to summarize the major assumptions of the schematic-reconstructive position. If the study outlined in this thesis is to represent a valid assessment of this position, it must involve a test of these assumptions.

First, representation is closely linked and dependent on the nature of perception. Thus, the active role of the individual during perception is stressed as representation and recall are determined by how the individual analyses the stimuli, i.e., by the rules he "breaks down" and apprehends. Thus, what the individual does during perception must be understood if one wants to understand the nature of representation and recall. This position contrasts with the traditional trace conception that the stimulus is an "efficient cause" of representation and consequently that memory is simply a passive copy of reality.

Secondly, memory involves conservation of such "rules" in schematic form and recall is characterized by a reconstructive process in which such rules are utilized to reconstruct the original stimulus as adequately as possible. Again this contrasts with the trace notion that recall simply involves a re-evoking and scanning of the stored perceptual memory traces.

In the above discussion the emphasis on the active role that the individual plays during perception, in the schematic-reconstructive position, is contrasted with the passive efficient-cause explanation that characterizes traditional trace conceptions of memory. However, recently several researchers (Craik & Lockhart, 1972; Craik & Tulving, 1975), working within a trace model of memory, do not adopt an efficient cause explanation of representation. Instead, these authors stress the importance of understanding what the individual <u>does</u> during perception. This position will be considered in some detail at it not only provides support for the first tenet of the schematic reconstructive position but also and more importantly, it provides the methodology that make it possible to test this position.

Craik and Lockhart view the memory trace as a byproduct of the perceptual analysis that is carried out by the subject during perception: "Thus we prefer to think of memory tied to levels of perceptual processing. Although these levels may be grouped into stages (sensory analysis, pattern recognition, and stimulus elaboration, for example), processing levels may be more usefully envisaged as a continuum of analyses. Thus, memory, too, is viewed as a continuum from the transient products of sensory analyses to the highly durable products of semantic-associative operations."[17] And, "This conception of a series or hierarchy of stages is often referred to as 'depth of processing' where greater depth implies a greater degree of semantic or cognitive analysis. After the stimulus has been recognized, it may undergo further processing by enrichment or elaboration. For example, after a word is recognized, it may trigger associations, images or stories on the basis of the subject's past experience with the word."[19] Furthermore, deeper levels of analysis are associated with stronger and more enduring traces.

The authors offer a strong case for re-intrepreting much of the verbal learning research within this levels of processing paradigm.

An important area of the verbal learning literature that the authors cite to provide support for their position is the research that has been conducted on "incidental learning". In this experimental situation, how an individual perceives a stimulus is determined by the orienting task that is being used. In this way the experimenter has control over how the subject perceptually and cognitively analyses the stimuli. The results of such studies support the authors' conclusion that retention varies as a positive function of the level of processing that is needed to complete the orienting task. In their final discussion the authors note that "... an important goal of future research will be to specify the memorial consequences of various types of perceptual operations. We have suggested the comparison of orienting tasks within the incidental learning paradigm as one method by which the experimenter can have more direct control over the encoding operations the subjects perform."[20]

Craik and Tulving (1975) conduct ten such studies. The results of their work in conjunction with the results of similar studies (e.g., Hyde, 1973; Hyde & Jenkins, 1969, 1973; Till and Jenkins, 1971, 1974; Walsh & Jenkins, 1973; Shulman, 1971, 1974) lead the authors to conclude that "... it is the qualitative nature of the task, the kind of operations carried out on the items, that determines retention"[21] and, "... the trace may be considered the record of encoding operations carried out on the input, the function of these operations is to analyse and specify the attributes of the stimulus."[22] Finally, the authors note that a broader implication of their work is that their studies "... conform to the new look in memory research that the stress is on mental operations, items are remembered not as presented stimuli acting on the organism, but as components of mental activity. Subjects remember not what was 'out there' but what they did during encoding" (emphasis theirs).[23]

Such statements echo many of the conclusions concerning the nature of memory that were drawn by preponents of the schematic reconstructive position. Thus the conclusion that "... the trace may be considered the record of encoding operations carried out on the input, the function of these operations is to analyse and specify the attributes of the stimulus" is very similar to the statement that memory involves the conservation of rules that have been apprehended by the individual as he "breaks down" the stimulus during perception. Thus both positions stress that if one wishes to understand memory, one must focus upon what the individual is doing during perception. However, the levels of processing position only looks "... at memory purely from the input or encoding and, no attempt has been made to specify either how items are differentiated from one another, are grouped together and organized, or how they are retrieved from the system."[24] This contrasts with the reconstructive schematic position which is also concerned with processes involved in retention and recall.

The "levels of processing" position was presented as it suggests the methodology that can be used to test the schematic-reconstructive position. To test this position, as in the "level of processing" studies, it will be necessary to have control over how the individual perceptually and cognitively analyses the stimuli.

Note it is possible to assess memory by testing either an individual's <u>recall</u> or <u>recognition</u> of a stimulus. In his memory studies with children, Piaget demonstrated that the greater the emphasis that is placed on the figurative aspects of the stimulus the greater the recognition of that stimulus will be. Recall, on the other hand, was found to be related to operative involvement, that is, to the type of rules that were apprehended by the child.

Thus the schematic-reconstructive position predicts that both recall and recognition will vary as a function of the type of analysis performed by the subject.

Recall will vary with the type of analysis for, according to this position, recall is characterized by a reconstructive process, the nature of which is determined by the nature of the rules upon which it is based. Thus, if different analyses of the <u>same</u> stimulus result in different rules being apprehended during perception, then differential recall will also result.

Recognition will vary as a function of the type of analysis performed if different analyses emphasize the figural aspects of the stimulus to a greater or lesser extent. Thus the schematic-reconstructive position would predict that if two different analyses of the <u>same</u> stimulus are performed, the one that emphasises the figural aspects of the stimulus to a greater extent will result in better recognition of that stimulus. (But not necessarily better recall, since recall is determined by the <u>operative</u> aspect of cognition, that is, by the type of <u>rules</u> that are concerned.)

Two orienting tasks were chosen which allowed one to vary both the type of rules that were apprehended as well as the emphasis that is placed on the figural aspects of the stimulus. Before these two orienting tasks can be described in detail it will be necessary to discuss the stimuli that were used in this experiment. The materials were derived from the analogy subsection of the "California short-term test of mental maturity".

This subtest involves presenting the subject with several series of drawings, each series consisting of seven drawings that represent an analogy, which the subject must resolve. Thus in each series, the first two drawings are related in some way; the subject must recognize this relationship and then decide which of the remaining drawings is related to the third drawing in the same way. In this subsection many of the pictures were ambiguous and often the same picture occurred in several series. After the series with either ambiguous pictures or pictures that were repeated in other series, were discarded, thirteen series remained. These thirteen series were then re-copied to a size that was appropriate for use in this study. One of the series was used as a practice run to teach the subject the required analysis; the remaining twelve being employed in the experiment proper. Although twelve series were used for testing, only eleven of these were scored and analysed. The first tray of pictures consisted of series of lines and dots while the remaining eleven were series of common objects. Because recall for the first series was so poor and because it was impossible to use the same criteria in scoring this tray as was used for the other series, this tray was discarded from the analysis. (In Appendix A the thirteen trays of pictures are presented.)

Two different orienting tasks were used: an "analogy" task and a "ranking" task. In the analogy task, the subject was instructed to solve the analogy problem which each series represented. On the other hand, in the "ranking" task the subject was instructed to pick their four favourite drawings from amongst the seven, and rank them according to their order of preference: favourite, second favourite, and so on. At no time was the possibility that each series represented an analogy problem suggested.

These two orienting tasks resulted in two different types of rules being apprehended. Thus in solving the analogy task, the subject's attention is drawn to the relationship that exists amongst the four pictures involved in the analogy. Consequently, the resulting analogy rules emphasize a "unifying" theme as the four pictures are perceived as a unit. Thus to solve the analogy task the individual must "break down" the relationship that exists between the first two pictures. The scanning of the remaining pictures is guided by this conceptual rule. Thus the focus is upon the relationship or rule that exists amongst the pictures and not upon the specific physical characteristics or "figurative aspects" of the stimuli. In solving this task, the individual is more concerned with determining what <u>concept</u> each picture represents than he is in studying their physical qualities.

In contrast the ranking task did not emphasize a unifying rule as the subject's attention is not drawn to the relationship that exists amongst the four pictures. Instead, to perform the ranking task, it was assumed that the individual would have to pay close attention to the specific external or "figural" characteristics of the pictures if he was to rank them in order of preference. The subject had to decide upon a criterion for ranking the pictures and it was assumed that such critera would be related in some way to the physical appearance of the pictures. When compared to the analogy task, the ranking task was assumed to place relatively more emphasis on the figurative aspect of cognition.

Thus these two orienting tasks provided the means to exercise control over the "processing" employed by the subjects, such that the reconstructive schematic position could be examined. Note also that by using pictures this study is a test of the generalizability of the conclusions that have been drawn from incidental learning studies involving verbal materials to visual stimuli . This is in keeping with Craik and Lockhart's suggestion that "... an important goal of future research will be to specify the memorial consequences of various types of perceptual operations."[25]

Six groups of seventeen subjects per group were involved in this study. Three groups performed the ranking task and three groups performed the analogy task. One of the goals of this study was to create as faithfully as possible a situation that paralleled natural memory. Consequently one week after completing the orienting tasks all groups were tested for free recall. It was felt that one week was more typical of the interval usually involved in natural memory than is an interval of seconds or minutes which characterises most verbal memory research. This also provides the opportunity to test the generalizability of the findings of incidental learning studies that use retention intervals of a few seconds, to longer intervals.

In addition to being tested after one week, an analogy group (AImm) and a ranking group (RImm) were tested for free recall immediately after completing the orienting tasks. These two groups were included in the study for two reasons. Firstly, as mentioned above, most incidental learning studies test for recall immediately after the orienting tasks have been completed. Thus if the results of this study are to be compared to the findings of such studies, it is necessary to have at least two groups that are characterized by similar short-term retention intervals.

The second reason for including an immediate recall test was to examine the effect of "retrieval practice" on recall. Yuille (1973)[26] demonstrated that retrieval practice immediately following learning of paired associates had a significant facilitative effect on subsequent recall a week later. Thus an additional consideration of the study was to test the generalizability of this "practice effect" to the long term retention of visual material is an incidental learning paradigm.

Four of the six groups (groups AImm and Rimm as well as an analogy and ranking group that did not receive an immediate free recall test but were tested for free recall a week later, AWK and RWk) also received a "probed recall" test which immediately followed the free recall test conducted a week after the orienting tasks had been completed. This test involved presenting the subjects with the first drawing of each series and instructing them to give the names of as many drawings from the rest of the series which were brought to mind. The next drawing in the series was presented, and any additional drawings recalled by the subjects were recorded. This procedure was repeated until all the drawings in the series were shown. The next series of drawings were then presented in a similar fashion.

The reason this probed recall test was included in this study was to examine whether or not recall could be characterized by a reconstructive process, as was predicted by the reconstructive-schematic position. Thus if given part of the series, could the subject using the rule that was involved in that series, reconstruct the rest of the series?

The probed recall test described above tests for reconstruction using the analogy rules as the first three probes are always the first three pictures that were involved in the analogy problems. It would have been possible to examine the reconstructive process using either the analogy or ranking rules. The reason reconstruction using the analogy rules was examined is described below.

Because the analogy rule emphasized a unifying theme amongst the four pictures involved in the analogy problem and the ranking rule did not, it was expected that the analogy groups would be characterized by greater reconstruction during recall. That is, since the analogy rules stressed the structured relationship that existed amongst the four pictures involved in the analogy problems, it was expected that if one (or more) of these pictures was shown to the subject, he could use the analogy rule to reconstruct the remaining pictures. Although a similar reconstructive process could occur using the ranking rules, because a unifying theme was not involved it was not expected that reconstruction would be as successful. Thus a probed recall task that would test for reconstruction using the analogy rule was chosen as such a reconstructive process was expected to characterize the analogy condition.

The remaining two groups (RRec and ARec) did not receive a probed-recall test but instead were given a recognition test. Subjects in these two groups were presented with a stack of drawings which contained all those pictures presented a week earlier randomly combined with an equal number of drawings they had never seen. The subjects had to separate those drawings they felt they had seen a week earlier from those they had never perceived. Such a test was included to test the prediction that the ranking orienting task would emphasise the figurative aspect of cognition more than the analogy orienting task. If this were the case it would also be expected that the ranking groups would be characterized by superior recognition scores for as Piaget has shown, recognition should provide an indirect measure of the figurative aspect of cognition.

Now that this study has been outlined, it is possible to be more specific concerning the type of outcome that would be expected if it is to represent a valid test of the schematic reconstrictive position.

If the first assumption is valid, that is, if what the subject <u>does</u> during perception is a critical determinant of the nature of representation, then it is expected that representation will vary as a function of the type of orienting task which the subject performs. Thus it is expected that for the analogy groups recall of those pictures that are meaningful within the context of the analogy problem (i.e., the four that are related by the analogy rule) will be superior to recall of the remaining three pictures that are not meaningful within this context. Similarly, for the ranking groups recall of those four pictures that were chosen as favourites will be superior to the recall of the three that were not so chosen. Also because the ranking task emphasizes the figurative aspect of cognition, it is expected the ranking group will be characterized by superior recognition . Furthermore, since the ranking task emphasizes the figurative aspect, the longer a subject spends solving this orienting task, the better he should do on the recognition test. Since the analogy orienting task does not emphasize the figurative aspect, the amount of time spent on this task should not be related to the individual's recognition score.

To solve the ranking orienting task the subject must pay attention to the figural characteristics of all the pictures in each series if he is to decide which are his favourites. Consequently, it is expected that all the pictures in each series will be equally recognized. On the other hand, in solving the analogy task it is only necessary that the subject pay close attention to the four pictures related by the analogy rule. Consequently, in this situation it is expected that recognition of the four pictures involved in the analogy problem will be superior to the recognition of the three not so involved.

The second assumption states that memory involves conservation of rules in schematic form and recall is characterized by a reconstructive process in which such rules are utilized to reconstruct the original stimulus as adequately as possible. If this assumption is valid then subjects in the analogy groups should score well on the probed-recall task since this test provides them with an opportunity to exercise the analogy rules to reconstruct the rest of the series. Also, if the analogy rules are being used to reconstruct during probed recall, then most of the pictures that are recalled in this test will be those pictures that were involved in the analogy problems. In contrast, subjects in the ranking groups should have a lower probed recall score since the probed recall task that is used in this study does not provide subjects in these groups with the opportunity to use the ranking rules to reconstruct the series. Even if a probed-recall task was used that provided such an opportunity (that is, if the probes were those pictures that were chosen as favourites), it would still be expected that the ranking groups would have lower probed recall scores, since the ranking rules are not characterized by a "unifying" theme which stresses a structural relationship amongst the pictures.

If the analogy rules are used to reconstruct free recall, it is expected that in both immediate and final free recall, pictures from the same series will tend to be recalled together. Thus the free recall of the analogy groups will be characterized by "clustering". Furthermore, if indeed it is the analogy rules that are being used to reconstruct during recall, then most of the clustering should involve pictures that occurred in the analogy problems, that is the first three pictures of each series and the answer. Because it is not expected that the ranking rules will be as successfully used to reconstruct free recall, such clustering is expected much more frequently in the analogy groups.

Because the ranking rules are expected to be less successful in reconstructing recall, it is expected that when they are requested to recall in both the free and probed recall conditions, they would tend to guess more than their counterparts in the analogy groups. Thus more errors should be made by subjects in the ranking groups during both free and probed recall.

Finally since it is predicted that the analogy rules will be more successful in reconstructing recall, it is expected that recall in the analogy groups will be greater than recall in the ranking groups in both the immediate and delayed conditions.

An underlying assumption that is made when the above predictions were generated is that the orienting tasks would be successful in determining how the subjects analyzed the stimuli. However, in any incidental learning study, the possibility always exists that at least part of the time, the orienting tasks may fail to produce the desired results and the subjects may analyse the stimuli in an idiosyncratic manner. Thus in this study it is possible that the subjects may generate their own rules besides those that are encouraged by the orienting tasks. Because of the nature of the stimuli used in this study, it is very possible that this situation could occur in the ranking condition. Thus, even though none of the subjects in the ranking groups would be aware that some of the cards in each tray were related by an analogy rule, it is difficult to ignore the fact that in each tray the cards are related in <u>some</u> way. Thus in tray 4 all the pictures are of animals or insects; tray 6 consists of seven pictures of people and six of them are doing something; several cards in tray 7 are related medically in some way; four of the pictures in tray 9 are related to photography; in tray 6, three of the cards are related to transportation, and so on. The reader has only to causally scan Appendix E to appreciate the large number of possible relationships that exist in each series. Hence, even though an individual might not realize that an analogy rule was involved, he may formulate his own rules that would give meaning to each of the series. Indeed this is what is to be expected in a reconstructive-schematic model, for as Bartlett has concluded from his studies, the individual continuously attempts to "confer meaning" on every stimulus he encounters. The possible role of such idiosyncratic rules will be discussed after the results of the study have been presented.

No predictions will be made concerning the possible effects of retrieval practice as the inclusion of this independent variable in this study was for exploratory reasons.

Before presenting the study that is described above, two recent approaches to the problem of memory that have received a good deal of attention and are relevant to this thesis must be considered. These are Anderson and Bower's "Human Associative Memory" (HAM) model and the approach represented by the "LNR Research Group" headed by Norman and Rumelhart. Anderson and Bower's "Human Associative Memory" model will be considered first.

HAM is relevant to this theses as it represents an attempt to reconcile methodological empiricism (Paivio's position and other trace formulations are examples of this approach) with methodological rationalism (represented in this thesis by the schematic-reconstructive conception of memory). Consequently, aspects of both approaches are represented in HAM. The empiricist influence is apparent in the "strategy free component" of memory which plays a critical role in HAM's operation. The basic assumption underlying this component is that "... long term memory, itself, is strategy-invariant, that probes are always matched to memory in the same way, that identical outputs will be generated to identical probes, and that a given input always is represented and encoded in the same manner. Mnemonic strategies . . . . the picture in terms of the strategic selection of probes and inputs which are sent to memory and in terms of interpretations given to output."[27] And "Despite that technicality about the ideas of the base set being innate, the strategy-free component does passively accept whatever is sent to it by the parsars and does indiscriminately proceed to encode links in that input. During decoding it generates output trees in response to probe tries in a similarly manner."[28]

This passive, reproductive, automatic conception of memory is diametrically opposed to an active, reconstructive, problem-solving approach. Bower and Anderson recognize this as they write: "For example, this attitude appears frequently in assertions that memory is not reproductive but rather reconstructive, or that remembering bears strong resemblances to 'problem solving' or that all sorts of rules and inferential procedures are called in by 'higher mental processes' in order for the person to reconstruct an event from memory. This viewpoint, that memory necessarily implicates diverse inference and problem-solving routines both at the time of input (e.g., comprehending a sentence) and at output (e.g., reconstructing an event), is at direct odds with our proposal that there exists a strategy-free component of memory (as that modelled in HAM) that functions independently of the rest of the mental system ..."[29] They also realize the possible consequences of taking such an approach when they note that: "It is a claim of considerable empirical import to state that there is a core strategy-free memory component common to all memory performances. The claim is equivalent to asserting that memory performance can be analysed into a large set of mnemonic strategies plus this common strategy-free component. If so, the task of analysing a particular memory performance can be divided into two smaller and hence more tractable sub-problems -- that of specifying the memory component and that of specifying the prevailing strategy of the subject.... The reader should appreciate that this decomposition may in fact be impossible for human memory ... both the Gestalters and the reconstructive theorists asserted that it was impossible to extricate memory from such matters as problem solving and inference. If they are right, this whole theoretical enterprise will come crashing down on our heads."[30] (emphasis mine) Thus, to the extent that this thesis corroborates the schematic reconstructive approach to memory, the alternative position represented by HAM will be disconfirmed.

Contrasted to the reductionistic position taken by Bower and Anderson, Norman and Rumelhart adopt a schematic approach to memory and cognition. Hence they write: "One view of the role of world knowledge is to consider it as a structural framework upon which newly acquired information must be fastened. This skeletal or schematic representation then guides both the interpretation of information and the search for new information to fill the gaps left in the structure ... The notion that knowledge is packaged into conceptual frameworks that guide in the interpretation of a person's experiences is not new. Under the name of schema the idea has a long history in psychology, where it is most frequently associated with the work of Bartlett and Piaget. We find the idea valuable, for once an appropriate frame or schema has been established, then it can help provide a meaningful interpretation for a variety of situations. We repeatedly use this notion in our analysis of language in many of the chapters that follow. In addition, we use frames and schemata as the conceptual basis for the analysis of visual perception ... and game playing."[31]

Furthermore, by studying the types of conceptual errors made in recall for such non-linguistic stimuli as buildings the authors were forced to conclude that such errors revealed "... the constructive nature of the retrieval process ... The memory representation is not simply an accurate rendition of real life, but in fact is a combination of information, inference, and reconstruction from knowledge about buildings and the world in general."[32] Similarly, after examining the nature of internal representation after problem-solving by studying memory for board games, it was concluded that "The memory for the board appeared to be more like a reconstruction based upon the conceptual nature of the game than upon an accurate image of the board."[33]

Thus Norman and Rumelhart conclude that recall is characterized by a reconstructive process. Also in agreement with other reconstructionalists but in opposition to the assumption behind the construction of HAM that "... there exists a strategy free component of memory (e.g., that modelled in HAM) that functions independently of the rest of the mental system"[34], they conclude that "A basic tenet of our approach to the study of cognitive processes is that only a single system is involved. In psychological investigations, the usual procedure is to separate different areas of study: memory, perception, problem solving, language syntax, semantics. We believe that a common cognitive system underlies these areas, and that although they are partically decomposable ... the interactions among the different components are of critical importance."[35] Their research on problem solving referred to above will be considered in greater detail as it is pertinent to the study presented in this theses.

The purpose of this work was to study the nature of representation in problem-solving by focusing on representation of board positions in game playing .
Towards this end the authors employed two board games "Go" and "Gomuku". Although both these games are played on similar boards with similar pieces, they are based upon different sets of rules. In the experiment, the subject was shown a board position which ostensibly represented a game of "Gomuku" in progress. The individual's task was to analyze the game and make the best move for black. After making the analysis, the subject was required to reconstruct the board position from memory. Each individual then performed two additional analyses of the same general type but was not required to reconstruct them. Finally, each subject was required to analyse and reconstruct a board position that

represented a transformation on the first board position they were shown. However, this time they were told that it was a game of "Go". (If the board was not transformed the individual might have realized that it was the first position that was shown to him. Although the transformation did change the surface appearance of the board the basic arrangement of the pieces was not altered. Thus both reconstructions were directly comparable.) The author's major finding was that the nature of the board problem determined the types of pieces remembered. Hence, if the individual was told that the board position was a "Gomuku" game, he remembered more pieces that were relevant to winning in "Gomuku" than "Go". The reverse was true if the subject had been informed that it was a "Go" game. Thus the authors write that: "The board reconstruction study demonstrates that subjective organization is affected by the nature of the problem. Thus organization centres around configurations of pieces that are meaningful in the context of the game being played. Thus, internal representations must be able to represent the external world in terms of meaningful or highly familiar segments."[36] And also, "... when we talk about 'what is seen', we are effectively talking about 'what is perceived', and perceptual organization refers to internal representations, <u>which can differ for different analyses of the same scene</u>"[37] (emphasis mine). Such results do not follow from either a trace conception of memory or the neo-associationist model proposed by Bower and Anderson. However, these results are consonant with the schematic-reconstructive approach. This is reflected by the fact that the study corroborates the two tenets of the schematic-reconstructive position that were described earlier in the thesis. Thus, the nature of representation depends more upon the subject's actions during perception (that is, the type of "analysis" he is involved in) than the stimuli. Secondly, recall involves a reconstructive process based upon the rules of the game that was analysed.

Note that the study described in this thesis is similar in many respects to the study just presented. It is similar in the sense that this study is also concerned with problem solving in which two different analyses of the same stimuli are involved. As in the previous study, the intent is to examine representation and recall as a function of the type of analysis undertaken by the subject. However, this study also represents an improvement over the previous work. Firstly, the stimuli involved are familiar pictures of people and objects and not game board positions. Such stimuli as pictures of people and objects are more representative than board positions would be of the type of stimuli usually involved in natural memory.

Secondly, the type of problems involved are different. Instead of analysing basically the same board positions under two different sets of instructions, each subject must solve either an analogy or a ranking problem. Because different groups of subjects were used for each type of analysis, it was not necessary to transform the stimuli in any way. Thus, across the two analyses the stimuli were truly identical. This allowed for a more adequate study of how representation and recall would "... differ for different analyses of the <u>same</u> scene." (Although the board positions used in the previous study were identical as far as the arrangements of pieces were concerned, the second position did represent a transofrmation of the first. Thus in the second board position the colours of the pieces were reversed, and the board was rotated counterclockwise 90^{o} and reflected across the vertical axis. Consequently, both positions were not truly identical.) Thirdly, in the previous study recall was tested immediately after analyzing the problem. In this study both an immediate and a delayed test of one week are used.

Finally, this study also involves a manipulation and test of the figurative aspect of cognition.

METHOD

Scoring Procedure

The procedure that was used to determine if a subject's responses during free and probed recall were correct or incorrect is described below.

To be scored correct, a response given during free recall had to be specific enough to identify one of the pictures that were presented, in any of the eleven series. It should be noted that if a subject gave a vague response, he was questioned by the experimenter in order to make his description more specific.

During free recall a response was scored incorrect if: (1) It identified a picture that had not occurred in any of the eleven series, (2) the description was so vague that it could apply to several pictures, e.g., "a person", "scenery", etc., (3) the response described a "composite" of two or more pictures.

To be scored as correct during probed recall a response had to describe a picture which followed the probe picture in the series under consideration. Thus if the subjects' response referred to a picture that occurred in one of the ten series not being considered, it was scored as incorrect.

Subjects

All but two of the subjects were undergraduate students enrolled in either first or second year psychology courses. The remaining two were senior students enrolled in a fourth year education program. All subjects were volunteers and were assigned randomly to groups before they were contacted. No attempt was made to equate the groups according to sex of the subjects (except, of course, by random assignment). The composition of each group according to the sex of the members is presented below.

	AImm	RImm	AWk	RWk	ARec	RRec
Male	7	7	5	8	9	9
Female	10	10	12	9	8	8

Procedure

Because the study has already been discussed in some detail in the Introduction, it is only necessary to include here a consideration of several aspects of the study that were not previously mentioned.

Before taking part in the experiment proper, all groups had to complete a practice run. The instructions that were given in this practice session and in the rest of the study are presented in Appendix B.

In groups AImm and RImm, in order to prevent rehearsal before the immediate recall test was given, each subject had to complete a brief distraction task. This involved counting backwards out loud by threes from an assigned random number for thirty seconds.

Two different orders were used to present the twelve series of drawings to the six groups. In each group half the subjects received one order and the other half received the second order. To avoid possible "order-effects", this order was reversed in the probed-recall test that was conducted a week later. The time required to complete the free-recall test was recorded for each subject. Also, during probed-recall the interval between presentation of each "probe" drawing and the completion of the individual's recall was recorded.

Thus each subject completed either an analogy or a ranking orienting task. If an individual was to be tested for immediate recall he had to first complete a distraction task which involved counting backward by "threes" from an assigned random number for thirty seconds. The individual then wrote down as many of the pictures that he could recall as possible. One week later, all individuals returned and once again would attempt to freely recall as many drawings as possible. Then, depending on the group he was in, the subject would complete either the probed recall test or the recognition test described above.

Summary

Six groups of seventeen subjects per group were involved in this study. Three of the groups ("A" groups) solved the analogy orienting task while three groups ("R" groups) solved the ranking orienting task. All six groups were tested for free recall one week after performing the orienting tasks. Two groups (AImm and RImm) were tested for free recall immediately after completing the orienting tasks. Four of the groups (AImm and RImm as well as Awk and Rwk, two groups that were not tested for immediate free recall) were tested for probed recall immediately after completing the delayed free recall test. Finally, two groups (ARec and RRec) received a recognition test instead of the probed recall task.

RESULTS

Overview

To adequately test all the predictions that were generated by the reconstructive-schematic approach it was necessary to subject the data to different phases of analyses.

The first phase of the analysis was concerned with testing several predictions that follow from the first and second assumptions of the schematic-reconstructive position. Thus, if the second assumption is valid -- that recall is characterized by a reconstructive process -- it is expected that the analogy rules will be more successfully used in reconstructing recall. This should be reflected in superior: overall free recall, probed recall, clustering scores, and fewer errors in the analogy groups.

If the first assumption is valid -- that the nature of representation is closely linked and dependent on the nature of perception -- then it is expected that recognition scores will be higher in the ranking group since the figurative aspect of cognition was emphasized in this group. Also for subjects in the ranking group there should be a positive correlation between the time spent on the orienting task and their recognition scores. For subjects in the analogy group no such correlation should be found since the figurative aspect is not emphasized in this group.

Phase II involves a more <u>detailed</u> analysis of the data and is concerned with testing those predictions that were not evaluated in Phase I. A more complete description of Phase II will be given when that part of the analysis is considered.

Results -- Summary

Immediate and Final Free Recall

Table 1 shows the mean immediate free, final free, and probed recall scores for the six groups. Table 2 summarizes the results of the one-way ANOVAs that were conducted for each of the listed comparisons. (Note: In carrying out the listed comparisons a "pooled" error term was not used, as the experimental manipulation also affected the within cell variability. For example, the Mean Square Error (MSe) for the comparison AImm and RImm is 58.46, but is only 16.32 for the comparison AWk + ARec vs RWk + RRec. This decision resulted in a smaller number of degrees in the denominator of the *F* ratio and consequently a more conservative test. The decision to use independent error terms for each comparison and consequently a more independent test, should be kept in mind when evaluating those comparisons that just fail to reach significance.)

Also note that groups AWk and ARec are collapsed together and compared with groups RWk and RRec similarly collapsed, on the dependent variable of free recall. This practice of collapsing two or more groups over one or several dependent variables will be repeated whenever possible, throughout the remainder of the analyses. Groups are collapsed only when there is neither a theoretical nor a statistical difference between the groups on the dependent variable on which they are being combined. The comparison for the groups being combined is always presented under the "equality of Groups Being

Table 1

Mean Immediate, Final, and Probes Recall Scores for All Groups

Group	Immediate Recall	Final Recall	Probed Recall
AImm	28.30	17.06	18.18
RImm	24.53	19.65	9.18
AWk		8.47	12.12
RWk		8.24	4.12
ARec		8.89	
RRec		8.41	
AWk + ARec		8.68	
RWk + RRec		8.33	

Table 2

Summary Table for One-Way ANOVAs Constructed for the Listed Comparisons on the Dependent Variables: Immediate, Final, and Probed Recall

Comparison	df	MSe	*F*	*p*
Immediate Recall				
AImm vs RImm	32	49.25	2.45	n.s.
Final Recall				
AImm vs RImm	32	58.46	.9740	n.s.
AWk + ARec vs RWk + RRec	66	16.32	.1298	n.s.
Probed Recall				
AImm vs RImm	32	24.21	28.43	<.0000
AWk vs RWk	32	26.74	20.35	<.0001
Equality of Groups Being Collapsed				
Final Recall				
AWk vs ARec	32	21.88	.07	n.s.
RWk vs RRec	32	11.73	.02	n.s.

Collapsed" section of the summary table.

Neither the differences in immediate free recall or final free recall between groups AImm or RImm was significant. Although the main effect of orienting task was not significant, the interaction of orienting task X recall test was, $\underline{F}(1,32) = 10.2$, $\underline{p} < .003$, MSe = 16.79. The significant orienting task X recall test interaction is depicted in Figure 1. This interaction reflects the percent decrease in recall that was calculated for both groups. Thus recall in group AImm decreased 38% from immediate to final recall, while recall in group RImm only decreased 24%. This 14% difference is significant, $\underline{F}(1,32) = 4.79$, $\underline{p} < 2.03$, MSe = 3.28.

The above results are paralleled by the insignificant difference between groups AWk and ARec, and groups RWk and RRec.

Probed Recall

Table 1 displays the probed recall scores for the groups AImm, Rimm, AWk, and RWk. Table 2 summarizes the results of the listed comparisons.

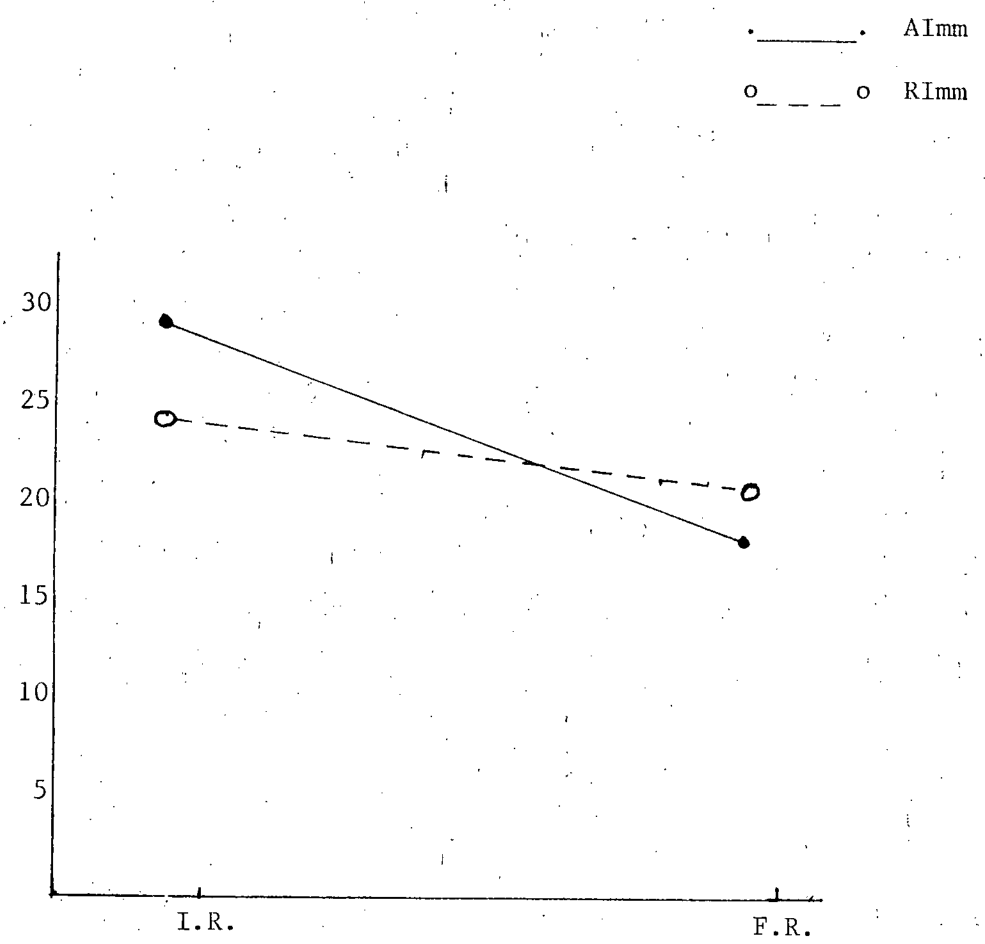
As predicted the comparison between group AImm and RImm was highly significant, $\underline{F}(1,32) = 28.53$, $\underline{p} < .0000$, as the analogy group had a mean probed recall score of about twice that of the ranking group. Similarly, the comparison between groups AWk and RWk was very significant, $\underline{F}(1,32) = 20.35$, $\underline{p} < .0001$. In this case the recall score of the analogy group being almost triple that of the ranking group.

Immediate and Final Free Recall

"Clustering" was operationally defined as follows: if two

Figure 1

Mean Number of Recalled Pictures as a Function of Time of Recall



I.R. = Immediate Free Recall

F.R. = Final Free Recall

pictures from the same series were recalled together, such a combination was given one point. If three pictures were recalled together, two points were assigned, and so on, to a maximum possible of six points per series. In practice, the maximum point total attained was five points in immediate recall and four points in final recall.

Table 3 displays the mean clustering scores obtained by all groups on both immediate and final free recall. Table 4 summarizes the results of the listed comparisons.

As expected, there was significantly more clustering in the analogy groups than in the ranking groups. In immediate recall the analogy group's mean clustering score was more than twice the ranking group's score, $F(1,32) = 28.13$, $p < .0000$. For the comparison involving groups AImm and RImm, in final free recall, the difference was still in the predicted direction, although the effect was somewhat reduced, $F(1,32) = 4.30$, $p < .04$; with seventy percent more clustering occurring in the analogy group.

The comparison involving the groups that did not receive retrieval practice (AWk + ARec vs RWk + RRec) was also significant, $F(1,66) =$ 12,40, $p < .0009$, with the analogy group scoring about three times as many clustering points as the ranking group.

Next it was of interest to examine in detail the differences in clustering between the analogy and ranking groups. Towards this end, the number of one, two, three, four, and five point groupings was determined for all six groups. This analysis was conducted to determine if the analogy groups were superior on all point groupings or if the superiority in the overall clustering score could be attributed

Table 3

Mean Clustering Scores in Both Immediate and

Final Free Recall for All Groups

Group	Immediate Free Recall	Final Free Recall
AImm	13.77	5.77
RImm	6.00	3.47
AWk		3.12
RWk		1.29
ARec		3.47
RRec		1.00
AWK + ARec		3.29
RWK + RRec		1.15

Table 4

Summary Table for One-Way ANOVAs Conducted for the

Listed Comparisons on the Dependent Variable of Clustering

Comparison	*df*	*MSe*	*F*	*p*
Immediate Recall				
AImm vs RImm	32	18.22	28.13	<.0000
Final Recall				
AImm vs RImm	32	10.42	4.30	<.04
AWk + ARec vs RWk + RRec	66	6.32	12.40	<.0009
Equality of Groups Being Collapsed				
Free Recall				
AWk vs ARec	32	11.38	.09	n.s.
RWk vs RRec	32	.16	.46	n.s.

to one or two groupings. Thus it could be possible,for instance, that the analogy and ranking groups actually had an equal number of one, two, four, and five point clusterings, and the superior overall clustering score found in the analogy group was only due to a larger number of three point clusterings.

Table 5 displays the mean number of one, two, three, four, and five point clusterings found in the six groups in both immediate and final free recall. Table 6 summarizes the results of the one-way ANOVAs that were carried out for the listed comparisons.

All differences between groups AImm and RImm in terms of the mean number of the five possible point combinations in immediate recall were in the expected direction. However, only three and four point combinations achieved significance, $F(1,32) = 8.39$, $p < .07$ and $F(1,32) = 9.26$, $p < .005$, respectively.

For the same groups in final free recall, the difference for the one, three, and four point combinations were in the expected direction, but only the difference on the three point combination reached significance, $F(1,32) = 6.1$, $p < .02$. The difference in the two point combination was in the opposite direction than expected, but the difference was not significant, $F(1,32) = 0.76$, $p < .39$.

These results sharply contrast with the results of the comparison involving the ranking and analogy groups that did not receive retrieval practice. In this case all of the differences except the three point combination were in the expected direction and were significant, $F(1,32) = 13.95$, $p < .0005$; $F\ (1,32) = 5.80$, $p < .02$; $F(1,32) = 4.4$, $p < .04$, respectively.

Table 5

Mean Number of Component Clustering Scores in Both Immediate and Final Recall for All Groups

	Component Clustering Score				
Group	1	2	3	4	5
Immediate Recall					
AImm	3.94	1.47	1.05	.52	.34
RImm	3.25	.71	.24	0	.11
Final Recall					
AImm	2.41	.47	.58	.18	0
RImm	1.62	.77	.12	0	0
AWk	1.65	.24	.18	.12	0
RWk	.47	.24	.12	0	0
ARec	1.59	.33	.12	.12	0
RRec	.83	0	.06	0	0
AWk + ARec	1.62	.38	.15	.12	0
RWk + RRec	.65	.12	.09	0	0

Table 6

Summary Table for One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variable of Component Clustering Score

Comparison	df	MSe	F	p
Problem Effect				
1. Immediate Recall				
AImm vs RImm				
1	32	4.85	1.03	n.s.
2	32	1.29	3.28	n.s.
3	32	.68	8.39	<.007
4	32	.26	9.26	<.005
5	32	.24	1.97	n.s.
2. Final Recall				
AImm vs RImm				
1	32	2.19	2.63	n.s.
2	32	.62	.76	n.s.
3	32	.31	6.10	<.02
4	32	.06	2.13	n.s.
AWk + ARec vs RWk + RRec				
1	66	1.15	13.95	<.0005
2	66	.21	5.80	<.02
3	66	.06	.72	n.s.
4	66	.05	4.40	<.04

Error Made During Free and Probed Recall

Table 7 displays the mean number of errors made in both final free and probed recall. Table 8 summarizes the results of the one-way ANOVAs that were performed for each of the listed comparisons. (Immediate recall is not considered, as no errors were made in either group AImm or group RImm during immediate recall.)

The difference between groups AImm and RImm is in the expected direction, with the ranking group making a mean of 0.6 more errors than the analogy group. However, this difference only approaches, but does not reach, significance, $F(1,32) = 2.93$, $p < .09$. When groups AWk and ARec are collapsed and compared with groups RWk and RRec similarly collapsed, the orienting task effect is in the expected direction and is significant, $F(1,32) = 6.75$, $p < .01$, with subjects in the analogy groups making on the average one less error during free recall than subjects in the ranking groups.

In the case of probed recall, the orienting task effect for both comparisons, AImm vs RImm, and AWk vs RWk, is in the expected direction, but only the former comparison reaches significance, $F(1,32) = 6.18$, $p < .02$, with the analogy group making about half as many errors as the ranking group.

Recognition Scores

The recognition scores for groups ARec and RRec were subjected to a signal detection analysis. The resulting d' values, percentage of hits and percentage of false alarms, are presented in Table 9. As predicted, the difference in the d' scores was in the direction of increased detectability for the ranking group and is significant,

Table 7

Mean Number of Errors Made in Final and Probed Recall

Group	Errors Made in Final Free Recall	Errors Made in Probed Recall
AImm	.41	4.71
RImm	1.00	8.18
AWk	1.18	5.06
RWk	2.53	7.65
ARec	1.65	
RRec	2.59	
AWk + ARec	1.41	
RWk + RRec	2.56	

Table 8

Summary Table for One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variables: Number of Errors Made in Final and Probed Recall

Comparison	*df*	*MSe*	*F*	*p*
Problem Effect				
1. Final Free Recall				
AImm vs RImm	32	1.00	2.93	n.s.
AWk + ARec vs RWk + RRec	66	3.31	6.75	<.01
2. Probed Recall				
AImm vs RImm	32	16.56	6.18	<.02
AWk vs RWk	32	31.40	1.81	n.s.
Equality of Groups Being Collapsed				
Free Recall				
AWk vs ARec	32	52.35	1.41	n.s.
RWk vs RRec	32	5.14	.006	n.s.

Table 9

Mean Percentage of Hit and False Alarm Scores and

Mean d' Scores for Groups ARec and RRec

Group	% of Hits	% of False Alarms	d'
ARec	63	12	1.76
RRec	80	15	2.23

$F(1,32) = 4.08$, $p < .05$, MSe = .4498.

Correlation Between Time Spent in Orienting Task and Recognition Score

Table 10 shows the mean time in minutes spent by the six groups in completing the analogy and ranking orienting tasks. For groups ARec and RRec the time that was taken by subjects to solve the eleven problems was correlated with their d' scores. These two variables were significantly correlated in the ranking group, $r = .60$, $p < .005$. However, in the analogy group the correlation was not significant ($r = .19$, $p < .24$).

Before leaving this section, it should be noted that the differences in time spent on solving the task between the two conditions is significant, $F(1,100) = 19.58$, $p < .0000$. Thus, subjects in the ranking groups spent on the average one and a half minutes longer performing the ranking orienting tasks than did the subjects in the analogy groups in solving the analogy orienting tasks.

Retrieval Practice Effect

To examine the possible effects of retrieval practice it will be necessary to compare groups AImm and RImm, on all dependent variables, with the other analogy and ranking groups that did not receive retrieval practice.

Table 11 summarizes the results of such comparisons that have been carried out for the dependent variables: immediate and final free recall, probed recall, clustering in both immediate and final free recall, component clistering, and errors made in final free and probed recall. The effects of retrieval practice for each dependent variable will be presented separately below.

Table 10

Mean Time in Minutes Spent on the Problem Solving Tasks for All Groups

Group	Time
AImm	2.29
RImm	3.89
AWk	2.84
RWk	4.09
ARec	2.84
RRec	4.18
AImm + AWk + ARec	2.67
RImm + RWk + RRec	4.10

Table 11

Summary Table for the One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variable of Time Spent in Problem Solving

Comparison	df	MSe	F	p
AImm + AWk + ARec vs RImm + RWk + RRec	100	2.54	19.58	<.0000
Equality of Groups				
AImm vs AWk vs ARec	48	1.46	1.16	n.s.
RImm vs RWk vs RRec	48	3.74	.10	n.s.

1. Final Free Recall. The retrieval practice effect was found to be both powerful and consistent. Thus group AImm differed significantly from the combination of groups AWk and ARec, $F(1,49) = 26.75$, $p < .0000$. Hence for the analogy groups, the effect of retrieval practice was to almost double the final probed recall score.

The effect of retrieval practice in the ranking groups was even more powerful. Thus the difference in recall between group RImm and groups RWk and RRec combined is highly significant, $F(1,49) = 47.81$, $p < .0000$. For the ranking groups the effect of retrieval practice is to more than double the final free recall score.

2. Probed Recall. The effect of retrieval practice on probed recall is also significant. For the analogy comparison, AImm vs AWk, the effect was significant but was not of the same magnitude as the increase in free recall described above, $F(1,32) = 8.52$, $p < .0063$. Thus retrieval practice increased probed recall by approximately fifty percent. Similarly, in the ranking condition, RImm vs RWk, retrieval practice also significantly increased probed recall, $F(1,32) = 15.19$, $p < .0005$. In this case, retrieval practice more than doubled the probed recall score.

3. Clustering. In both the analogy and ranking conditions, retrieval practice significantly increased clustering. Thus, for the analogy groups, AImm vs AWk + ARec, retrieval practice increased the amount of clustering by a factor of one and a half, $F(2,48) = 5.90$, $p < .02$. For the ranking groups, RImm vs RWk + RRec, retrieval practice tripled the amount of clustering found in free recall, $F(2,48) = 16.99$, $p < .002$.

4. Component Clustering Scores. In the analogy condition, AImm vs AWk + ARec, retrieval practice significantly increased the number of three point clusterings, $F(2,48) = 10.56$, $p < .002$, by a factor of five. However, it had no significant effect on any of the other point combinations.

On the other hand, in the ranking condition, RImm vs RWk + RRec, retrieval practice increased the one and two point clusterings significantly, but failed to increase the number of three point clusterings, $F(2,48) = 11.21$, $p < .0017$, and $F(2,48) = 12.76$, $p < .0007$, respectively. In both cases the number of clusterings is increased by a factor of four.

A discussion of the results that have been presented in the first phase of the analysis will be delayed until the second phase has been presented.

Phase II

Overview

In Phase II a more detailed analysis of the data is carried out. Two "stages" are involved in this part of the analysis.

Stage 1

In Stage 1, the scores in each of the dependent variables were collapsed across subjects, resulting in a mean score for each of the eleven trays. Analysing the data in this way allowed one to study the position of the pictures in the series as a dependent variable. This type of analysis was required if the "pattern" or organization of free recall, probed recall and clustering scores is to be examined.

The predictions to be tested in this stage of the analysis are:

Prediction 1: The free recall "pattern" will be determined by the orienting task. This means that (a) in the analogy groups, of the seven pictures in each series, the four that were involved in the analogy problem will be remembered best, and (b) in the ranking groups, of the seven pictures in each series, the four that were chosen as favourites will be remembered best.

Prediction 2: In the analogy groups, most of the pictures recalled during probed recall will be those pictures that were involved in the analogy problems.

Prediction 3: In the analogy groups most of the clustering scores can be attributed to clustering of the pictures that were involved in the analogy problems.

Prediction 4: Pictures involved in the analogy problems should be recognized better than those pictures not so involved.

If the above predictions are verified, this would support the conclusions that (a) what the subject <u>does</u> during perception, that is, the orienting task that is involved, determines the organization of recall and recognition, and (b) recall in the analogy groups is characterized by a reconstructive process involving the <u>analogy</u> rules. That it is the <u>analogy</u> rules that are being used to reconstruct during free and probed recall would be reflected by the fact that most of the clustering and probed recall scores would be made up of pictures that were involved in the analogy problems.

To test Prediction 1(a), it will be necessary to compare the recall of pictures that have been involved in the analogy problems ("A" pictures) with the recall of pictures not involved ("NA" pictures). To test Prediction 1(b), it will be necessary to compare the recall of those pictures that were chosen as favourites ("F" pictures) with the recall of pictures not so chosen ("NF" pictures).

When comparing the recall, probed recall, clustering, and recognition scores of A and NA pictures, it was necessary to use the ranking groups as controls and consequently carry out the same comparisons in the ranking groups. Thus, as in the analogy groups, the recall, probed recall, clustering, and recognition scores of the A and NA pictures were calculated and the same comparisons were carried out.

Without such controls it could not conclusively be concluded that the "patterning" of scores in the analogy groups was due to the analogy orienting task. Thus, since the same pictures were always involved in the analogy problems, it is possible that these four differed from the remaining three in a manner that could produce such patterning, e.g., they could be more "memorable." If this was the case then it would be expected that the same "patterning" effect would be found in the ranking groups when scores from the A and NA positions are compared. If this is not the case, that is if there is no difference in recall, probed recall, clustering, or recognition scores between A and NA pictures in the ranking groups, then it can be concluded that the organization found in the analogy groups is due to the analogy orienting task.

The table below displays the frequency with which pictures from each of the seven positions were chosen as favourites.

	Position						
Group	1	2	3	4	5	6	7
RImm	107	108	106	105	101	111	110
RWk	109	107	110	105	108	107	102
RRec	104	112	107	110	105	109	101

Scanning this table, it is clear that pictures from all the positions were chosen as favourites, equally often. Consequently, because <u>different</u> pictures are involved in the ranking orienting task, it is not necessary to employ the type of control groups described above. Thus, any differences in recall or recognition between the F and NF pictures can be attributed to the effect of the ranking orienting task.

The description of Stage 2 and the predictions it is designed to test will not be presented until the reaults of Stage 1 have been summarized.

The results of Stage 1 of the analysis will be organized according to the predictions described above.

Free Recall "Pattern" in the Analogy Groups

The first step in this part of the analysis involved determining for each tray the number of pictures that were recalled from the four positions that were involved in the analogy task and the three positions that were not so involved. In each series the first three positions were always part of the analogy task while the fourth position, the answer, varied with the analogy problem. Since more positions were involved in the analogy task than not, the recall scores were converted to percentages of total possible recall. Because the scores for each tray are collapsed across the seventeen subjects, the total possible recall in each group for the four positions involved in the analogy task was 4 x 17 = 68 pictures. For the three positions not so involved the total possible recall was 3 x 17 = 51 pictures/group. Hence, for the four positions involved in the analogy task, the percentage of total possible recall is

$$PA = \frac{\text{number of pictures recalled from four positions}}{68}$$

For the three positions not involved in the analogy, percentage of total possible recall is

$$PNA = \frac{\text{number of pictures recalled from the three positions}}{51}$$

This procedure was followed for both immediate free and final free recall. The same procedure was repeated with the three ranking groups in order to have control groups with which meaningful comparisons could be made.

Table 12 displays the mean percentage immediate, final, and probed recall scores obtained by all groups for those positions involved in the analogy problems ("A" positions) and those positions not so involved ("NA" positions). Table 13 summarizes the results of the one-way ANOVAs that were carried out for the listed comparisons.

As expected in group AImm, immediate recall of pictures from those positions involved in the analogy far exceeded immediate recall of pictures frim the remaining positions, $\underline{F}(1,20) = 22.73$, $\underline{p} \leq .0001$, recall from the A positions being thirty percent greater than recall

Table 12

Mean Percentage Immediate, Final, and Probed Recall Scores Obtained by All Groups for Both the A and NA Positions

Group	Immediate Recall		Final Recall		Probed Recall	
	A	NA	A	NA	A	NA
AImm	50	20	30	10	43	14
RImm	30	29	25	25	11	13
AWk			18	5	13	8
RWk			12	7	9	6
ARec			18	5		
RRec			12	8		
AWK + ARec			18	5		
RWk + RRec			12	9		

Table 13

Summary Table for the One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variables: Immediate, Final, and Probed Recall for Both the A and NA Positions

Comparison	*df*	*MSe*	*F*	*p*
1. Immediate Recall				
a. Analogy Condition				
AImmA vs AImmNA	20	.0024	22.73	<.0001
b. Ranking Condition				
RImmA vs RImmNA	20	.0132	.03	n.s.
2. Final Recall				
a. Analogy Condition				
AImmA vs AImmNA	20	.0070	30.00	<.0000
AWkA vs AWkNA	20	.0018	45.90	<.0000
ARecA vs ARecNA	20	.0031	31.70	<.0000
AWkA + ARecA vs AWkNA + ARecNA	42	.0024	77.30	<.0000
b. Ranking Condition				
RImmA vs RImmNA	20	.0018	.004	n.s.
RWkA vs RWKNA	20	.0038	4.20	n.s.
RRecA vs RRecNA	20	.0029	2.30	n.s.
RWkA +RRecA vs RWkNA + RRecNA	42	.0032	6.70	<.01
3. Probed Recall				
a. Analogy Condition				
AImmA vs AImmNA	20	.0197	23.46	<.0001
AWkA vs AWkNA	20	.0104	1.62	n.s.
b. Ranking Condition				
RImmA vs RImmNA	20	.0093	.41	n.s.
RWkA vs RWkNA	20	.0070	.71	n.s.

from the NA positions. Also as expected, there was no significant difference in recall across the same positions in group RImm.

A similar pattern was found in the final free recall of all the analogy groups. The mean percent recall in the A positions for groups AImm, AWk, ARec, and AWk + ARec was respectively .30, .18, .18, and .18. In contrast, the mean percentage recall for pictures in the NA positions for the same groups was .10, .05, .05, and .05. The differences between these means were all significant at the .0000 level (see Table 13).

As expected in the ranking groups, none of the single comparisons within groups RImm, RWk, or RRec reached significance. However, when groups RWk and RRec were collapsed, the difference in recall between the A and NA positions did reach significance, $F(1,42) = 6.7$, $p < .01$, with recall of pictures from the A positions being three percent greater than recall from the NA positions. Although this difference is in the same direction as the difference in the analogy groups, it only reaches significance when the groups are collapsed, and the difference is only three percent compared to a difference of thirteen percent for the analogous comparison in the analogy condition.

Free Recall "Pattern" in the Ranking Groups

The first step in this part of the analysis involved determining for each tray and for all ranking groups the percentage of both the pictures that were chosen as favourites ("F" pictures) and those not so chosen ("NF" pictures) that were recalled. For the pictures chosen as favourites the total possible recall for each tray and each group was 4 x 17 = 68 pictures. For those pictures not so chosen, the total possible recall was 3 x 17 = 51 pictures. Thus, the percentage of total possible recall for each tray for those pictures chosen as favourites was

$$P(F) = \frac{\text{number of favourite pictures recalled}}{68}$$

Similarly, the percentage of total possible recall for those pictures not so chosen was

$$P(NF) = \frac{\text{number of pictures not chosen as favourites and recalled}}{51}$$

This procedure was repeated for all trays and all ranking groups.

Table 14 displays the mean percentage recall scores obtained by all ranking groups for both F and NF pictures. Table 15 summarizes the results of the one-way ANOVAs conducted for the listed comparisons. As predicted in all ranking groups in both immediate and final free recall, recall of those pictures that were chosed as favourites is significantly greater than recall of those pictures not so chosen. All comparisons are significant at the .009 level or beyond (see Table 15).

<u>Probed-Recall Pattern</u>

In calculating the percentage of total possible probed recall for the A and NA positions, the same procedure used in calculating the percentage of total possible <u>free</u> recall was used. However, because the first card in each series was always presented to the subject as a probe, in probed recall, the total possible recall for the <u>three</u> remaining positions involved in the analogy was 51. Thus for probed recall in calculating the percentage of total possible recall, the divisor was 51 in both cases.

Table 14

Mean Percentage Immediate and Final Recall Scores Obtained by All Ranking Groups for Both the F and NF Positions

Group	% Recall of Pictures Chosen as Favourites	% Recall of Pictures Not Chosen as Favourites
Immediate Recall		
RImm	36	20
Final Recall		
RImm	28	16
RWk	13	5
RRec	16	8
RWk + RRec	14	7

Table 15

Summary Table for the One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variables: Immediate and Final Recall for Both the F and NR Positions

Comparison	df	MSe	F	p
1. Immediate Recall				
RImmF vs RImmNF	20	.01	10.16	<.005
2. Final Recall				
RImmF vs RImmNF	20	.008	10.79	<.004
RWkF vs RWkNF	20	.003	10.71	<.004
RRecF vs RRecNF	20	.004	8.31	<.009
RWkF +RRecF vs RWkNF + RRecNF	42	.004	18.48	<.0001

Table 12 displays the mean percentage of probed recall scores obtained by groups AImm, RImm, AWk, and RWk for A and NA positions. Table 13 summarizes the results of the one-way ANOVAs which were carried out for the listed comparisons.

As expected in group AImm the difference in recall for pictures from the A and NA positions was in the expected direction and was significant, $\underline{F}(1,20) = 23.46$, $\underline{p} < .0001$, with twenty-nine percent greater reacll of pictures from the A position.

In group AWk, although the difference was in the expected direction, with a mean of .13 and .08 for the A and NA positions respectively, this difference failed to reach significance. None of the differences between the A and NA positions in the ranking groups reached significance.

Clustering in the Analogy Groups

As in recall, the raw clustering scores were converted to percentages of total possible clustering. Since there were four positions involved in the analogy, a maximum of three points per series could be earned if all four pictures were remembered correctly. Thus, the total maximum clustering score for the A positions for each tray was 17 x 3 = 51 points/group. For the NA positions, tht total maximum clustering score per tray per group was 2 x 17 = 34 points. These two divisors were used in calculating the percentage clustering scores for the A and NA positions respectively.

Table 16 shows the mean percentage clustering scores for all groups in both the A and NA positions. Table 17 summarizes the one-way ANOVAs conducted for the listed comparisons.

Table 16

Mean Percentage Clustering Scores for All Groups in Both the A and NA Positions

Group	Immediate Recall		Final Recall	
	A	NA	A	NA
AImm	36	14	15	7
RImm	12	13	8	8
AWk			10	2
RWk			3	2
ARec			8	5
RRec			3	2
AWk + ARec			9	3
RWk + RRec			3	1

Table 17

Summary Table for the One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variable of Clustering for both the A and NA Positions

Comparison	df	MSe	F	p
Immediate Recall				
AImmA vs AImmNA	20	.0244	11.25	<.003
RImmA vs RImmNA	20	.0108	0.05	ns
Final Recall Analogy Condition				
AImmA vs AImmNA	20	.0072	6.10	<.02
AWkA va AWkNA	20	.0024	14.90	<.001
ARecA vs ARecNA	20	.0053	1.40	ns
AWkA + ARecA vs AWkNA + ARecNA	42	.0038	9.85	<.003
Final Recall Ranking Condition				
RImmA vs RImmNA	20	.0087	0.002	ns
RWkA vs RWkNA	20	.0009	1.30	ns
RRecA vs RRecNA	20	.0029	0.35	ns
RWkA + RRecA vs RWkNA + RRecNA	42	.0018	1.20	ns

As expected, clustering during immediate recall in group AImm was significantly greater for those pictures in the A positions than for those pictures in the NA positions, $F(1,20) = 11.23$, $p < .003$. Thus clustering was twenty-two percent greater for positions recalled from the A positions than for pictures recalled from the NA positions. The difference in clustering scores for pictures from the A and NA positions in group RImm was not significant.

In final free recall, in group AImm, there was still significantly more clustering amongst pictures recalled from the A positions than from the NA positions, $F(1,20) = 6.1$, $p < .02$. But this difference decreased from twenty-two percent in immediate recall, to eight percent in final recall. In group AWk the difference was also in the expected direction and was significant, $F(1,20) = 14.9$, $p < .001$. Surprisingly, in group ARec, although the difference was in the expected direction, it did not reach significance. When groups AWk and ARec were collapsed the difference was also significant, $F(1,42) = 9.85$, $p < .003$.

Recognition

As in Phase I, it was necessary to carry out a signal detection analysis on the subjects' hit and false alarm scores. However, now it was necessary to "break down" the d' scores in both the analogy and ranking conditions. Thus when examining the recognition pattern in the analogy groups separate d' scores were calculated for both the A and NA positions. Similarly, when looking at the recognition pattern in the ranking groups, separate d' scores were calculated for the F and NF positions.

In calculating d' scores, a score was calculated for each subject and in the process it was necessary to collapse each subject's hit and false alarm scores across the 11 trays. Thus in contrast to the other variables analyzed in Phase II. mean scores per tray were not calculated and scores were not collapsed across subjects. Consequently, there were 32 degrees of freedom ((2 x 17) - 2) for each of the comparisons.

Table 18 displays the mean percentage of hit and false alarm scores as well as the mean d' scores for groups RRec for both the F and NF positions. As predicted the pictures that were chosen as favourites were not recognized better than those pictures not so chosen, $F(1,32) = 1.18$, $p < .29$. Table 19 displays the mean percentage of hits, mean percentage of false alarms, and mean d' scores for groups ARec and RRec for pictures from those positions that were involved in the analogy problems and those not so involved. Table 20 summarizes the results of the one-way ANOVAs that were carried out for the listed comparisons. As predicted, in group ARec more pictures were recognized from the A positions than from the NA positions, $F(1,32) = 13.41$, $p < .0009$. For group RRec, there was no significant difference in recognition of pictures from both these positions.

Stage 2

From Phase I of the analysis, it was concluded that the analogy groups were characterized by greater clustering and probed recall scores. However, contrary to predictions immediate and final free recall in the analogy groups did not exceed the immediate and final free recall in the ranking groups. Phase I also demonstrated that subjects in group RRec had superior recognition scores when compared

Table 18

Mean Percentage of Hit and False Alarm Scores and Mean *d'* Scores for Group RRec for Both the F and NF Positions

Group	% of Hits	% of False Alarms	*d'*
RRecF	82	15	2.33
RRecNF	80	15	2.04

Table 19

Mean Percentage of Hits and False Alarm Scores and Mean *d'* Scores for Groups ARec & Rrec for Both the A and NA Positions

Group	% Hits	% False Alarms	*d'*
ARecA	70	12	1.97
ARecNA	47	12	1.35
RRecA	83	15	2.35
RRecNA	77	15	2.30

Table 20

Summary Table for One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variable of *d'* Score for Both the A and NA Positions

Comparison	*df*	*MSe*	*F*	*p*
Recognition				
Analogy Condition				
ARecA vs ARecNA	32	.242	13.41	<.0009
Ranking Condition				
RRecA vs RRecNA	32	.896	0.027	n.s.

to their counterparts in group ARec.

Stage 2 of this phase of the analysis is similar to Phase I in the sense that the analogy and ranking groups are compared on the dependent variables of recall, probed recall, clustering, and recognition. However, Phase I was a "general" type of analysis or the comparisons that were carried out involved "overall" scores. Stage 2 of this part of the analysis is more specific as in this stage the focus is on identifying those pictures that are responsible for the differences in probed recall, clustering, and recognition scores that were found to differentiate the two conditions. More specifically, this stage of the analysis is concerned with testing the prediction that the difference in probed recall and clustering scores between the analogy and ranking groups can be accounted for by the superior probed recall and clustering scores of pictures that were involved in the analogy problems ("A" pictures). Also, although the analogy groups are not characterized by greater overall immediate and final free recall scores, it is expected that pictures from the A positions will be recalled better than the same pictures in the ranking groups. These predictions follow from the fact that if the analogy rules are used to reconstruct recall, this will be reflected in greater clustering, probed recall, and free recall of these pictures.

Finally, because the ranking task emphasizes the figurative aspect of cognition, recognition of the pictures from both the A and NA positions in group RRec with exceed recognition of the same pictures in group ARec.

Table 21 summarizes the results of the one-way ANOVAs conducted

Table 21

Summary Table for One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variables, Immediate, Final, and Probed Recall

Comparison	df	MSe	F	p
Pictures in Analogy				
Immediate Recall				
AImmA vs RImmA	20	.02	11.300	<.003
Final Recall				
AImmA vs RImmA	20	.01	1.60	n.s.
AWkA + ARecA vs RWKA + RRecA	42	.0031	12.45	<.001
Probed Recall				
AImmA vs RImmA	20	.01	54.52	<.0000
AWkA vs RWkA	20	.01	.943	n.s.
Pictures Not in Analogy				
Immediate Recall				
AImmNA vs RImmNA	20	.02	3.1	n.s.
Final Recall				
AImmNA vs RImmNA	20	.01	11.9	<.003
AWkNA + ARecNA vs RWKNA + RRecNA	42	.0025	2.8	n.s.
Probed Recall				
AImmNA vs RImmNA	20	.02	.016	n.s.
AWkNA vs RWkNA	20	.01	.53	n.s.
Equality of Groups being Collapsed				
RWkA vs RRecA	20	.0029	.006	n.s.
RWkNA vs RRecNA	20	.0038	.385	n.s.
AWkA vs ARecA	20	.0036	.020	n.s.
AWkNA vs ARecNA	20	.0013	.167	n.s.

for the listed comparisons involving the analogy groups on the dependent variables of immediate, final free, and probed recall. (All mean scores are listed in Table 12.)

Recall of Pictures from A Positions

In immediate recall group AImm recalled twenty percent more pictures from the A position than did group RImm. This difference is significant, $F(1,20) = 11.3$, $p < .003$.

The difference between groups AImm and RImm for final free recall of pictures from the A position was in the expected direction but failed to reach significance. However, for the comparison involving groups AWk and ARec, and groups RWk and RRec, the differences were in the expected direction and were significant, $F(1,42) = 12.45$, $p < .001$.

Recall of Pictures from NA Positions

For immediate and final free recall, recall of pictures from the NA positions tended to be slightly better in the ranking groups. However, only the comparison between group AImm and RImm in final recall achieved significance, $F(1,32) = 11.9$, $p < .003$, with the ranking group recalling fifteen percent more pictures from the NA positions than did the analogy group.

Probed Recall of Pictures from A Positions

For the comparison between groups AImm and RImm, the difference was in the expected direction and was significant, $F(1,20) = 54.52$, $p < .0000$, with the analogy group recalling thirty-two percent more pictures from this position. However, in the comparison involving groups AWk and RWk, although the difference was in the expected direction, it did not reach significance.

None of the comparisons involving pictures from the NA positions reached significance.

Table 22 indicates the results of the one-way ANOVAs conducted for the listed comparisons between the analogy and ranking groups for both immediate and final free recall. (All means are listed in Table 16.)

Clustering of Pictures Recalled from Positions Involved in the Analogues

In immediate recall,group AImm had twenty-four percent more clustering than group RImm for pictures that were recalled from the A positions, $F(1,20) = 17.65$, $p < .0004$.

In final free recall, for the AImmA vs RImmA, and AWkA + ARecA vs RWKA vs RRecA comparisons the differences in clustering scores were in the expected direction, but only the latter comparison was significant, $F(1,42) = 13.0$, $p < .0008$.

Clustering of Pictures Recalled from NA Positions

There was no significant difference between groups AImm and RImm in either immediate or final free recall in terms of mean percentage clustering scores for the NA positions.

Groups RWk and RRec could not be collapsed as there was significantly more clustering in group RWk than in group RRec, $F(1,20) = 4.63$, $p < .04$. Instead the two comparisons ARecNA + AWkNA vs RWkNA and ARecNA + AWkNA vs RRecNA were made. Only the latter was significant, $F(1,31) = 4.4$, $p < .05$, with the analogy groups having three percent more clustering than the ranking groups in pictures recalled from the NA positions.

Table 22

Summary Table for One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variable of Clustering for Both the A and NA Positions

Comparison	df	MSe	F	p
Pictures in Analogy				
Immediate Recall				
AImmA vs RImmA	20	.02	17.65	<.0004
Final Recall				
AImmA vs RImmA	20	.01	3.24	n.s.
AWkA + ARecA vs RWkA + RRecA	42	.0032	13.0	<.0008
Pictures not in Analogy				
Immediate Recall				
AImmNA vs RImmNA	20	.02	.02	n.s.
Final Recall				
AWkNA + ARecNA vs RWkNA	31	.0006	.29	n.s.
AWkNA + ARecNA vs ARecNA	31	.0016	4.4	<.05
Equality of Groups Being Collapsed				
RWkA vs RRecA	20	.0018	.003	n.s.
RWkNA vs RRecNA	20	.0003	4.63	<.04
AWkA vs ARecA	20	.0048	.377	n.s.
AWkNA vs ARecNA	20	.0029	1.24	n.s.

Recognition

Table 23 summarizes the results of the comparisons between groups ARec and RRec on the dependent variable of recognition, for pictures from both the A and NA positions. (All means are displayed in Table 16.)

The difference in d' scores between group ARec and RRec was in the expected direction with group RRecA having a mean d' score of 2.35 and group ARecA a mean d' score of 1.97. However this difference did not reach significance, $F(1,32) = 2.56$, $p < .12$. For those pictures that were not involved in the analogy, the difference was in the expected direction and was significant, $F(1,32) = 11.67$, $p < .0017$. Thus group RRecNA had a mean detectability score of 2.30 compared to a score of 1.35 for group ARecNA.

Table 23

Summary Table for One-Way ANOVAs Conducted for the Listed Comparisons on the Dependent Variable of d' Score

Comparison	df	MSe	F	p
Recognition				
Pictures in Analogy	32	.4849	2.56	n.s.
Pictures not in Analogy	32	.6532	11.67	<.0017

DISCUSSION

Contrary to what was predicted by the reconstructive-schematic position the analogy condition was not characterized by superior immediate and final free recall scores. However, when a more detailed analysis of the results was carried out in Phase II, a dramatic difference in "patterning" of recall between the two conditions was demonstrated. Thus in the analogy groups more pictures were recalled from the A positions than from the NA positions. This effect was not found in the ranking groups when pictures from the same positions were compared. (This conclusion must be qualified by a similar effect, although of considerably smaller magnitude, that was found in the RWkA + RRecA vs RWkNA + RRecNA comparison.)

Similarly in the ranking groups more pictures that were chosen as favourites were recalled than those pictures that were not so chosen. These two sets of results confirm the prediction that the orienting task does indeed determine organization during recall. Hence as predicted by the reconstructive schematic position, it is important to understand what the subject does during perception, if one wishes to completely understand the nature of recall.

Also, as demonstrated in the second stage of this detailed analysis, when the "overall" score was broken down into recall scores for the A and NA positions, definite differences were found. Thus during immediate recall, recall for pictures that had been involved in the analogy problems in group AImm far exceeded recall for the same pictures in group RImm. Similarly, final recall in groups AWk and

ARec was superior to the final recall of the <u>same</u> pictures in groups RWk and RRec. However the difference in final recall between groups AImm and RImm failed to reach significance.

These results suggest that multiple dependent variables should be used in memory research. Using a single dependent variable, such as free recall, may fail to uncover critical differences in the nature of recall amongst the various conditions being studied.

The confirmation of the predictions that the analogy groups would be characterized be greater clustering and probed recall suggests that recall in these groups is based upon a <u>reconstructive</u> process. The hypothesis that the <u>analogy</u> rules are used to reconstruct recall in the analogy groups was examined in the detailed analysis conducted in stages 1 and 2.

The greater probed recall score for pictures from the A position in group AImm supports this hypothesis. The fact that the difference was not significanct in group AWk suggests that to be conserved over a period of a week, such rules must be used at least once in reconstructing free recall. The higher clustering score for those pictures recalled from the A positions in both immediate and final free recall in group AImm, and in final recall in group AWk also supports this hypothesis. That a similar significant difference was not present in group AWk is unexpected, as groups AWk and ARec should not significantly differ on this dimension. The effect found in group AWk needs to be replicated before it can be definitely concluded that without retrieval practice, there is a significant difference in clustering scores in final recall between pictures recalled from the A and NA positions.

Stage 2 of the analysis provides additional support both that it is the <u>analogy</u> rules that are being used to reconstruct recall in the analogy groups and such rules are <u>not</u> being used in the ranking groups. Thus the superior probed recall of those pictures involved in the analogies by group AImm over group RImm supports this hypothesis. However, for the comparison involving the groups that did <u>not</u> receive retrieval practice, the difference is not significant. Retrieval practice had a very powerful and dicriminative effect on the analogy groups. Thus, retrieval practice increased probed-recall of pictures involved in the analogy by thirty percent, but only increased the probed recall of the remaining pictures by six percent. If the analogy rules are to be conserved and used to reconstruct during probed recall, it appears that it is necessary that the subject practice using them. Such practice occured when the individual was tested for immediate recall, and he was given the opportunity to exersice the rules he had learned, to reconstruct each series.

The distribution of clustering scores in this stage of the analysis also supports the hypothesis that the analogy rules are being used to reconstruct recall in the analogy groups. Thus, generally speaking, clustering involving pictures from the A positions in the analogy groups exceeded the clustering involving the <u>same</u> pictures in the ranking groups. Only the comparison involving clustering during final free recall in the two groups that did <u>not</u> receive retrieval practice did not reach significance. The difference was, however, in the expected direction.

Also generally speaking, clustering involving pictures from the NA positions in the analogy groups did not exceed the clustering involving the same pictures in the ranking groups. Clustering was surprisingly low in group RRecNA, and consequently the comparison ARecNA + AWkNA va RRecNA reached significance. However, besides this unexpected finding, the second part of this prediction was supported by the remaining comparisons. Thus the superiority of clustering in the analogy condition can largely be attributed to the superiority of clustering amongst those pictures that were involved in the analogy problems. This is just as would be expected, since clustering during recall reflects reconstruction and such reconstruction, if it indeed involves the analogy rules, generally should be limited to those pictures involved in the analogy problems.

The prediction that subjects in the analogy groups would make fewer errors during free and probed recall than their counterparts in the ranking groups, is only partially supported. When no retrieval practice was provided a greater number of errors were made during final free recall by the ranking groups than by the analogy groups. This suggests that subjects in these ranking groups guessed more than their counterparts in the analogy groups.

A similar effect of orienting task was not found with the AImm and RImm groups on either immediate or delayed recall. The reason this is the case may be related to the possible differential effect of retrieval practice on the two groups. This possibility will be considered when the retrieval practice effect is discussed.

The pattern of greater errors in the ranking group was consistent but only reached significance in the AImm vs RImm comparison.

As predicted, subjects in the group RRec in which the figural aspect was emphasized had better recognition scores than subjects in ARec. However, one cannot definitely conclude that the increased sensitivity of group RRec is due to the greater emphasis on the figurative aspect. Since subjects in the ranking group spent on the average one and a half minutes longer than subjects in the analogy group in completing their orienting task, time spent on orienting task was confounded with the manipulation of the figurative aspect of cognition. That the time spent on the ranking task is an important determinant of recognition is reflected in the significant correlation between these two variables. Thus the greater sensitivity of group RRec could be more parsimoniously explained by a trace position that would predict that recognition would increase as a function of the amount of time spent perceiving the picture. To adequately test the relationship between orienting task and the figurative aspect in cognition, it would be necessary to conduct another study involving two orienting tasks which take the same amount of time to complete (e.g., Nelson, 1977).

Although overall recognition was superior for the ranking group, the prediction that recognition of pictures from both the A and NA positions in group RRec would exceed recognition of the same pictures in group ARec was only partially supported. Thus, only the recognition of pictures from the NA positions in group Rrec was significantly superior to the recognition of the same pictures in group ARec. Although it did not reach significance, the difference in recognition scores between groups ARec and RRec for A pictures was in the expected direction ($p < .12$).

The fact that the analogy group did not recognize pictures from the A positions better than the ranking group suggests that recall and recognition are somewhat independent, since the analogy group did recall these pictures better. Thus better recall does not necessarily imply better recognition.

Also pictures involved in the ranking orienting task were equally recognized, while in the analogy groups, pictures from the A positions were recognized better than pictures from the NA positions. Thus the orienting task determined organization during recognition as well as recall. Such results do not, however, support a Piagetian conception of the dependent role of the figurative aspect of cognition in memory. Such a conception would predict that both recognition and recall of favourite pictures would be greater.

For both the analogy and ranking conditions, retrieval practice had a very powerful effect on all dependent variables except the number of errors made in probed recall. However, retrieval practice appeared to have a more powerful effect on the ranking groups. This differential effect of retrieval practice may help explain why groups AImm and RImm did not significantly differ with respect to the number of errors made during free recall. Thus retrieval practice reduced the number of errors made, by one and a half for the ranking condition, but only reduced it by one in the analogy condition.

When component clustering scores are considered, some interesting differences between the groups that receive retrieval practice and those groups that do not have the benefit of such practice become evident. Thus, for the comparison involving the ranking and analogy groups that did not receive retrieval practice, all differences except the difference in three point groupings were significant. In contrast, in the comparison between groups AImm and RImm only the difference in the three point groupings score reached significance. Once again, it appears that the differential effect that retrieval practice has on the analogy and ranking groups is responsible for these apparently contradictory findings. Thus, for the analogy groups retrieval practice increased, by a factor of five, the number of three point groupings, but had no effect on any of the other groupings. On the other hand, in the ranking groups, retrieval practice significantly increased the number of one and two point groupings. When this differential retrieval practice effect is taken into account, it is not surprising that group AImm differs from group RImm only in terms of the number of three point groupings. Thus it can be concluded that the retrieval practice effect that was found to improve the recall of paired-associates, does generalize to the learning of visual material, within an incidental learning paradigm.

Conclusion

It is possible to draw several conclusions from the study: (1) The schematic-reconstructive position is supported in several respects. Thus what the individual does during perception plays an important role in determining subsequent recall and recognition. This is reflected in the findings that for all groups the type of orienting task a subject is involved in determines the organization of recall and recognition. These results also demonstrate that (a) the conclusions dervied from incidental learning studies conducted with verbal materials also generalize to visual stimuli, and (b) these results also hold for long term recall and recognition.

(2) Recall in the analogy groups does definitely appear to be characterized by a reconstructive process that utilizes the analogy rules. Thus recall in these groups is more parsimoniously explained by the active-reconstructive approach adapted by the L.N.R. research group than by the passive approach posited by Bower and Anderson.

(3) The results confirm that the retrieval practice effect demonstrated by Yuille with verbal material does indeed generalize to visual material. Furthermore, retrieval practice appears to have a more facilitative effect in the ranking condition where the figurative aspect of cognition is emphasized.

(4) The prediction that the immediate and final free recall of the analogy groups would exceed similar recall in the ranking groups was not corroborated. Thus, although recall in the analogy groups appears to be characterized by a reconstructive process, such a process does not , as predicted, result in superior free recall. A hypothesis that might account for these results was suggested in the Introduction. That is, at least part of the time, it is possible that the ranking orienting task failed and the subjects generated their own idiosyncratic rules which may be more successful than the ranking rules in reconstructing recall. However, if this were the case, it would be expected that the ranking groups would be characterized

by greater clustering than was found in these groups. Such clustering would be expected to reflect any rule biased reconstructive process.

A second possibility is that the greater emphasis on the figurative aspect in the ranking groups accounts for the high free recall scores in these groups. This would necessitate attributing a more central, independent role to the figurative aspect in memory that characterizes the Piagetian conception. Thus the figurative aspect may not be simply a direct translation of the operative aspect, as depicted by Piaget, but may play a more critical role in recall.

However, if this were the case all the pictures in each series would be expected to be recalled equally well, since the figural characteristics of all the pictures were emphasized. As had already been pointed out, those pictures that were picked as favourites were recalled better. That those pictures picked as favourites were recalled better could be interpreted as suggesting that perhaps recall in the ranking condition was also characterized by a reconstructive process in which the ranking rules were used to reconstruct recall. However, if this were so, it would also be expected that recall in these groups would be characterized by greater clustering than was found to be the case. To test this hypothesis further it would be necessary to (a) examine the clustering that did occur in the ranking groups to determine more "favourite" pictures were involved, (b) repeat the study using a probed recall task which would test for reconstruction utilizing the ranking rules.

The fact that subjects in the ranking groups spent 54% longer than their counterparts in the analogy groups in solving the orienting task may account for the relatively high recall in these groups. To conduct a fairer assessment of the role of reconstruction during recall, it would be necessary to carry out a study in which the time spent solving the orienting tasks in the two conditions was equated.

FOOTNOTES

[1]Bartlett, F.C. Remembering: A study in experimental and social psychology. London: Cambridge University Press, 1967, p. 4.

[2]Ibid., p. 213.

[3]Ibid., p. 206.

[4]Ibid., p. 52.

[5]Ibid., p. 206.

[6]Anderson, J.R. & Bower, G.H. Human associative memory. Washington, D.C.: Hemisphere Publishing Co., 1973, p. 60.

[7]Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart & Winston, Inc., 1971, p. 8.

[8]Furth, H.G. Piaget and knowledge: Theoretical foundations. Englewood Cliffs, N.J.: Prentice Hall, 1969, p. 72.

[9]Ibid., p. 93.

[10]Piaget, J. & Inhelder, B. Mental imagery in the child. New York: Basic Books, 1971.

[11]Ibid., p. 228.

[12]Ibid., p. 378.

[13]Ibid., p. 378.

[14]Yuille, J.C. & Catchpole, M.J. The role of imagery in model of cognition.

[15]Piaget, J. & Inhelder, B., 1973, op. cit., p. 385.

[16]Ibid., p. 395.

[17]Craik, F.I. & Lockhart, R.S. Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behaviour,

1972 11(6), p. 676.

[18]Ibid.

[19]Ibid., p. 675.

[20]Ibid., p. 681.

[21]Craik, F.I. & Tulving, E. Depth of processing and the retention of words in epsiodic memory. Journal of Experimental Psychology: General, 1975, 104(3), p. 290.

[22]Ibid., p. 291.

[23]Ibid., p. 294.

[24]Craik, F.I. & Lockhart, R.S., 1972, op. cit., p. 682.

[25]Ibid., p. 681.

[26]Yuille, J.C. An analysis of coding processes and retrieval practice. Unpublished manuscript.

[27]Anderson, J.R. & Bower, G.H., 1973, op. cit., p. 140.

[28]Ibid., p. 186.

[29]Ibid., p. 44.

[30]Ibid., p. 141.

[31]Norman, D.A. & Rumelhart, D.E. Explorations in cognition. San Francisco: W.H. Freeman and Company, 1975, p. 7.

[32]Ibid., p. 23.

[33]Ibid, p. 26.

[34]Anderson, J.R. & Bower, G.H., 1973, op. cit., p. 44.

[35]Norman, D.A. & Rumelhart, D.E., 1975, op. cit., p. 159.

[36]Ibid., p. 330.

[37]Ibid., p. 317.

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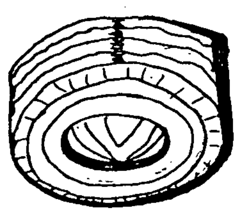
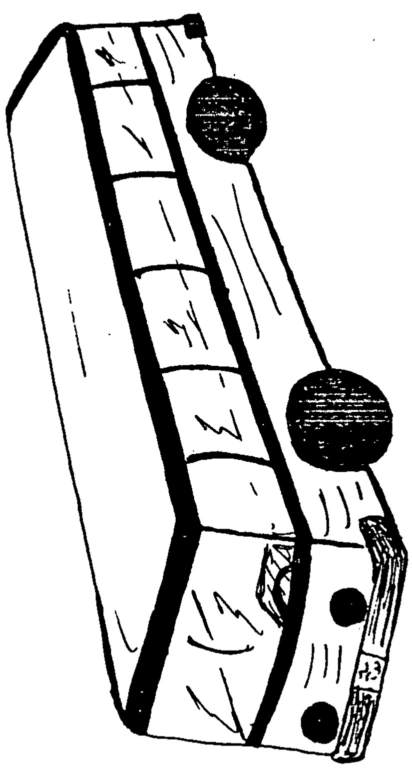
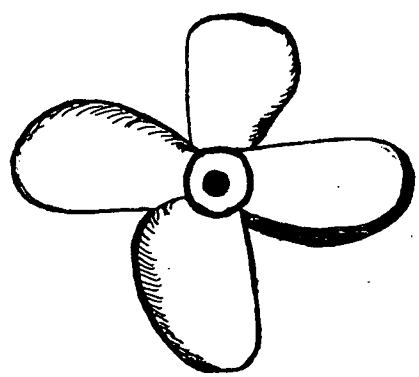
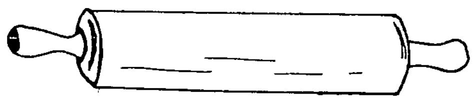
APPENDIX A

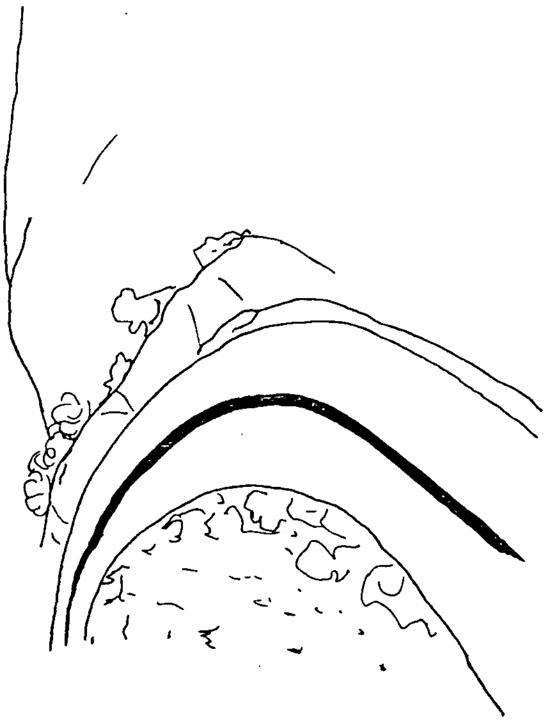
TWELVE SERIES OF PICTURES PRESENTED DURING PROBLEM SOLVING

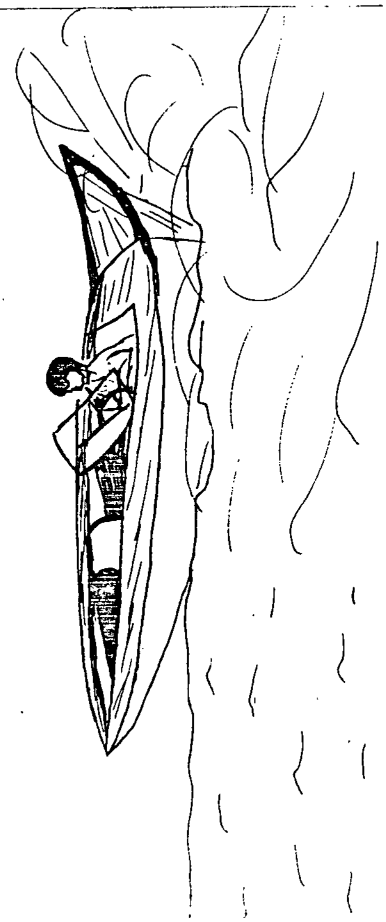


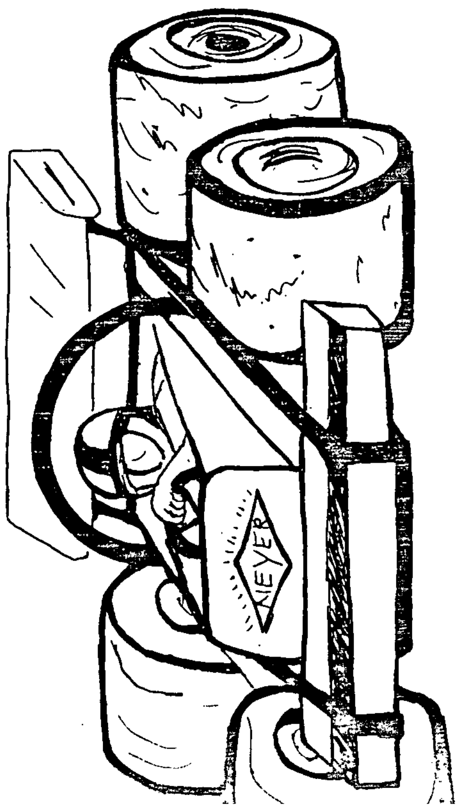








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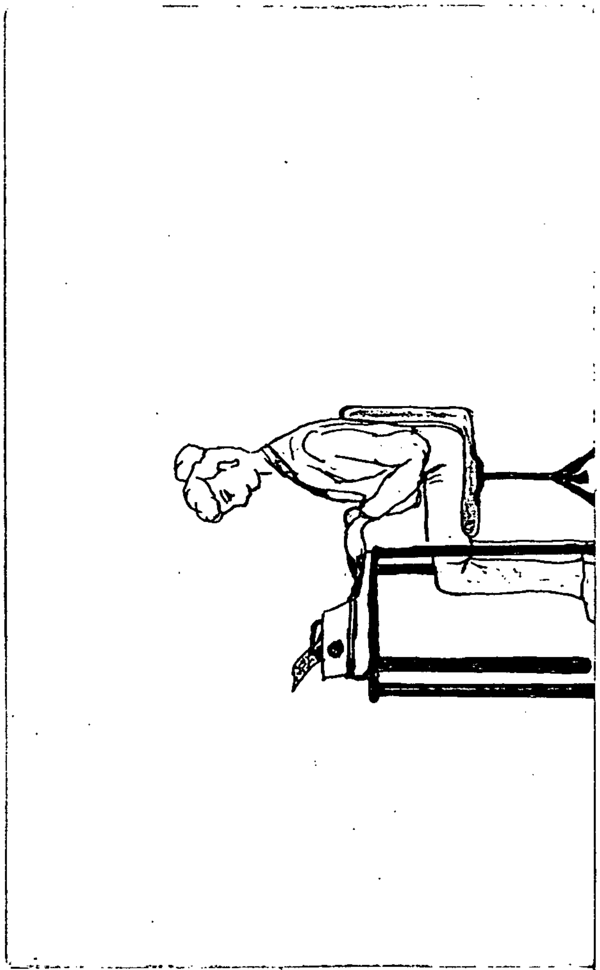

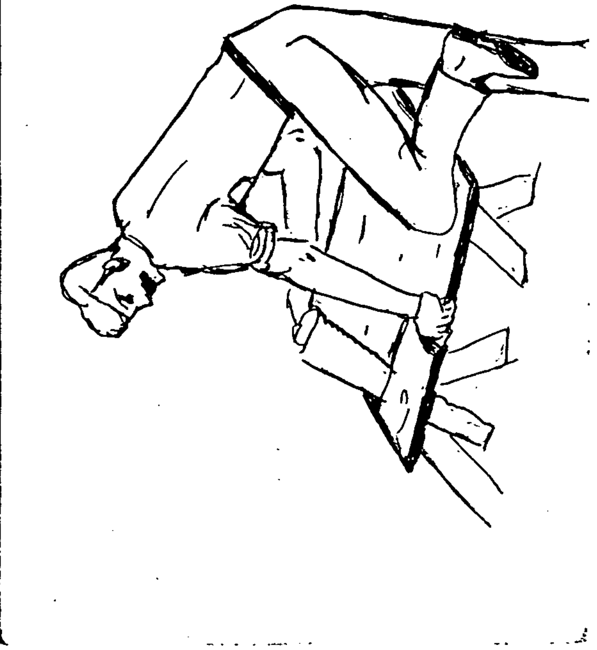

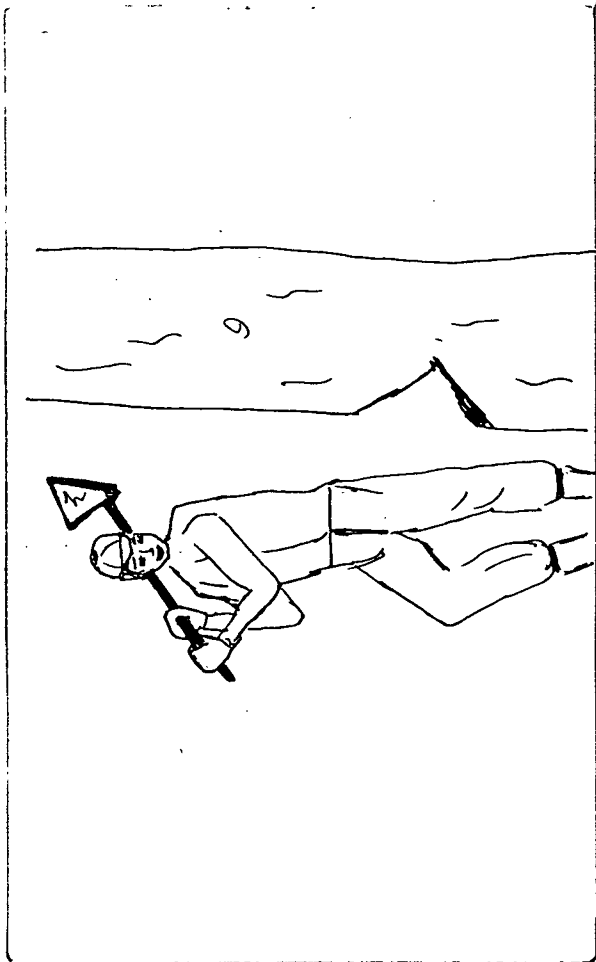

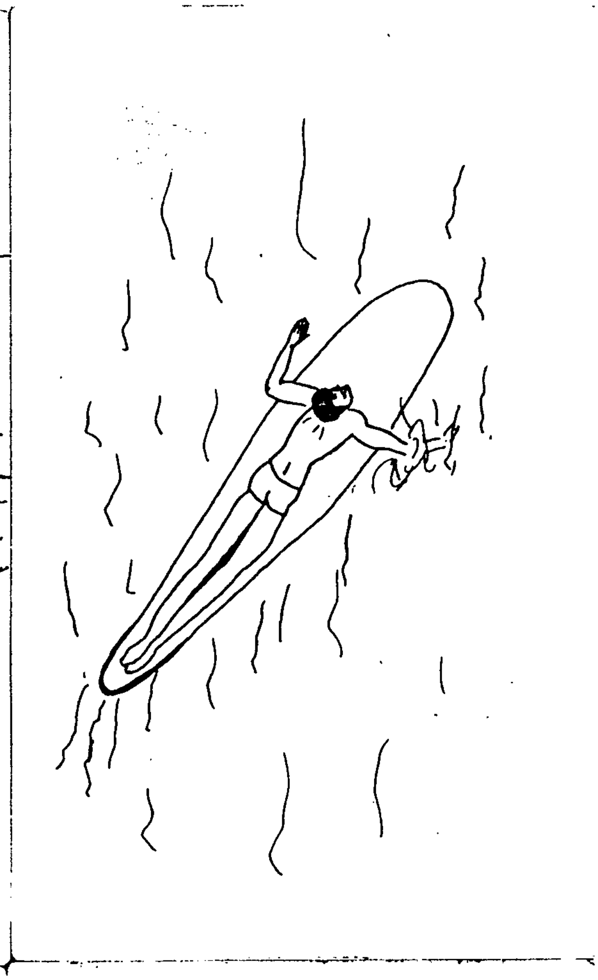

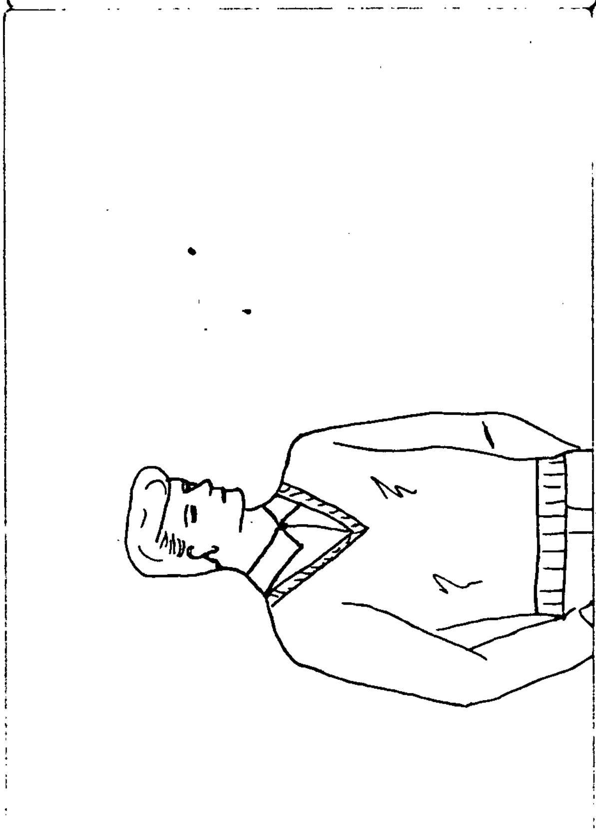

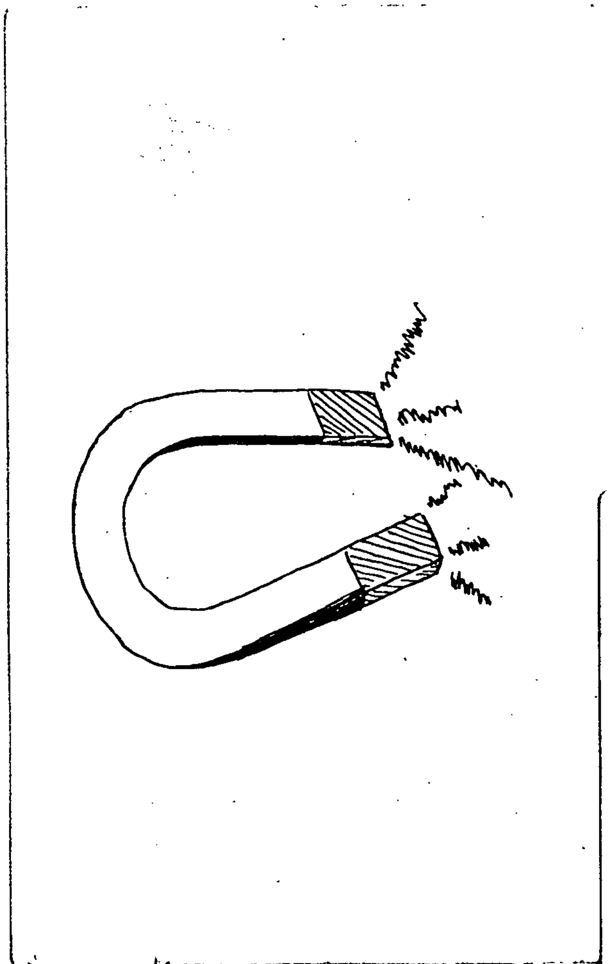

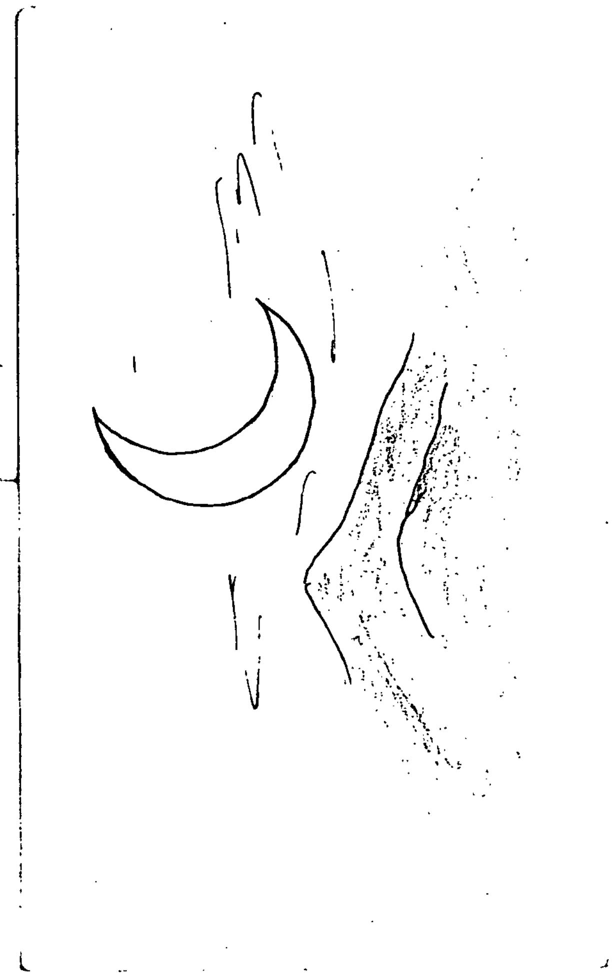

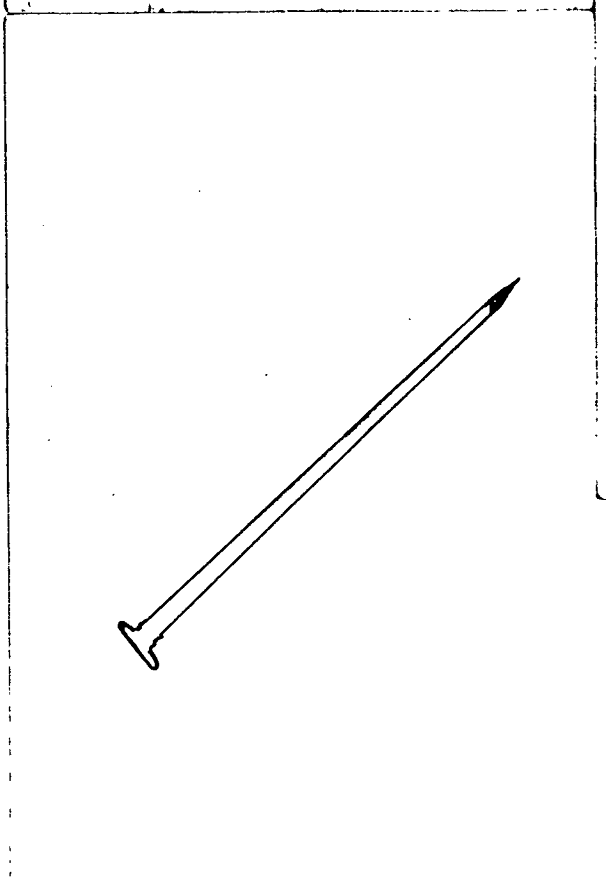

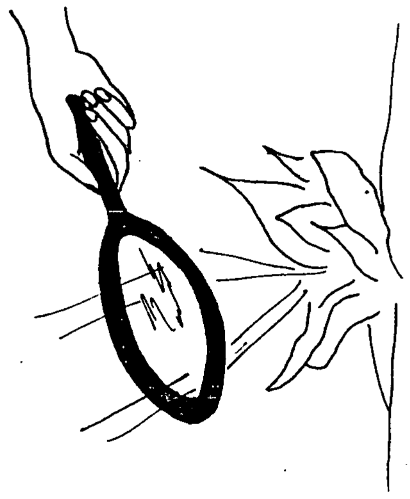

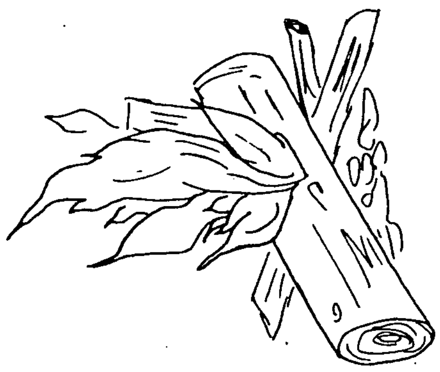

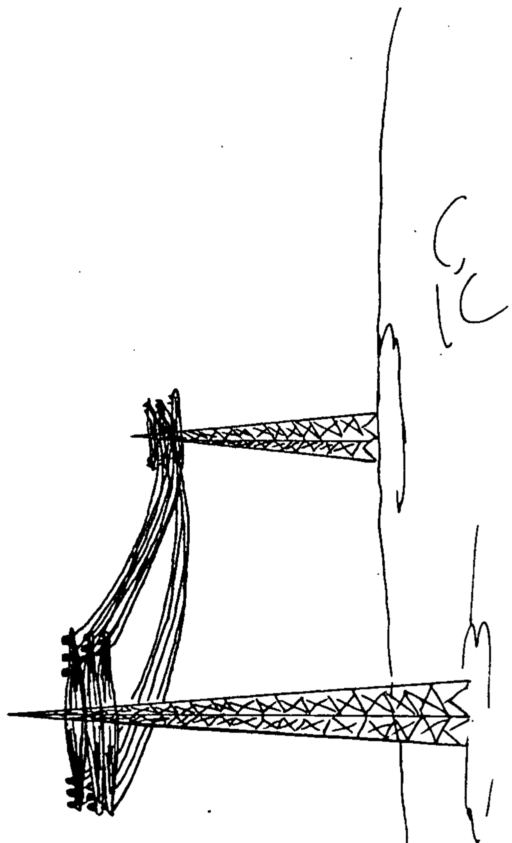

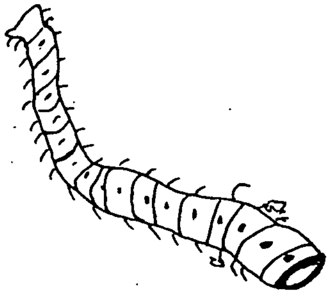

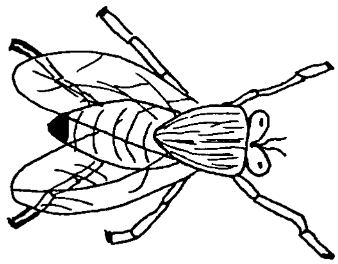

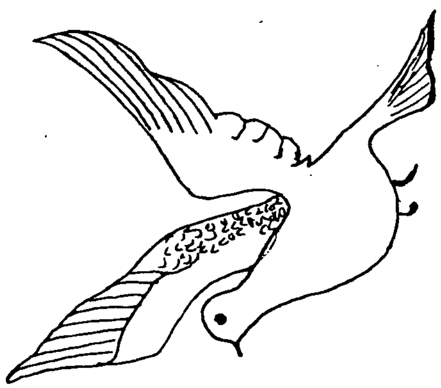

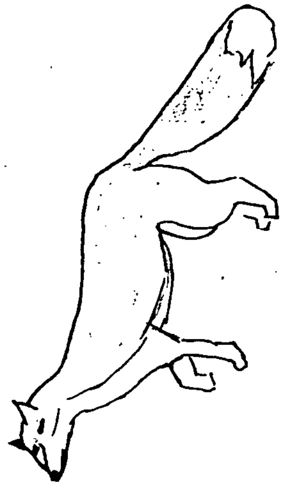

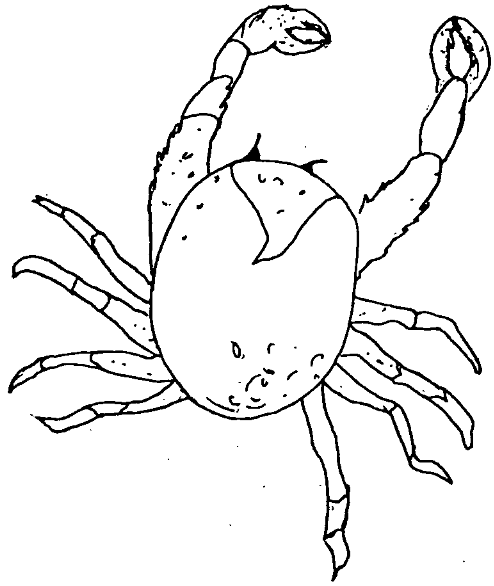

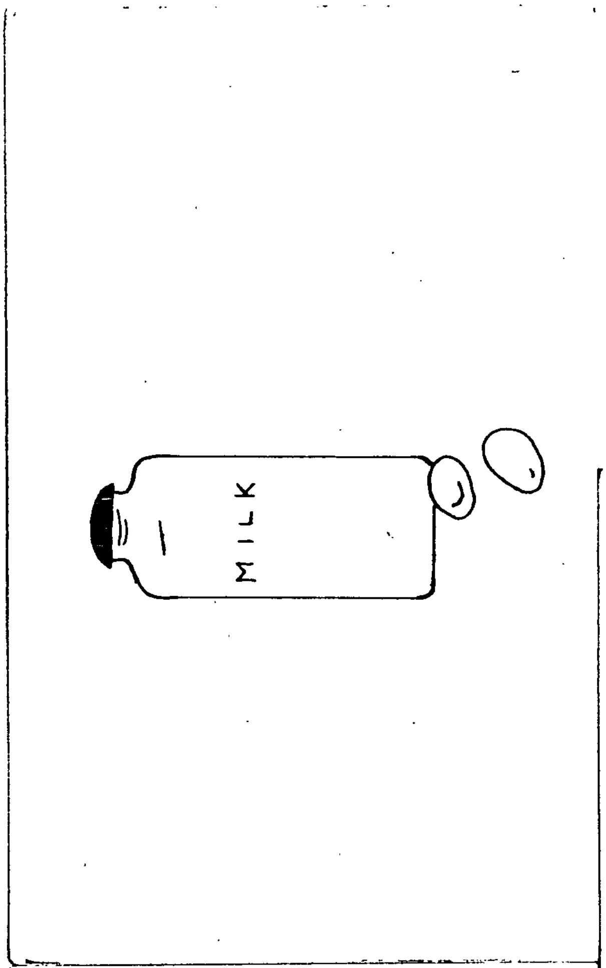
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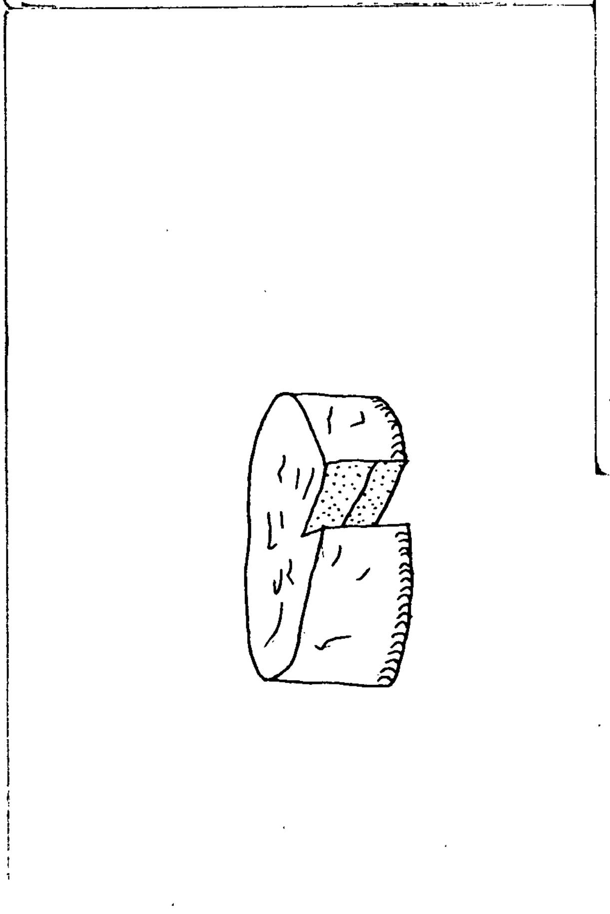

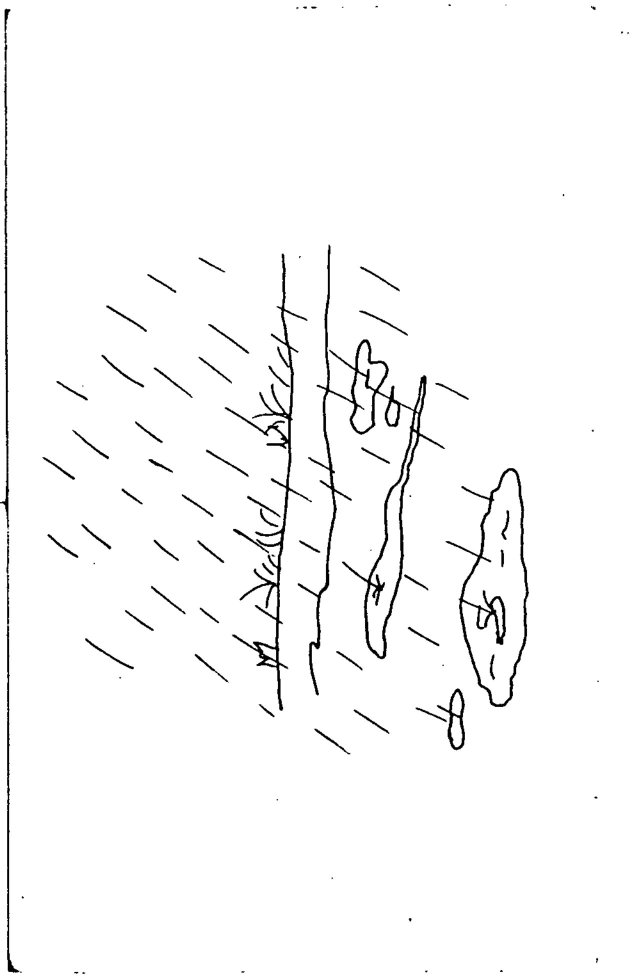

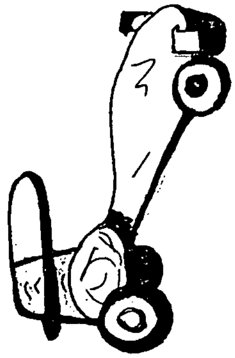

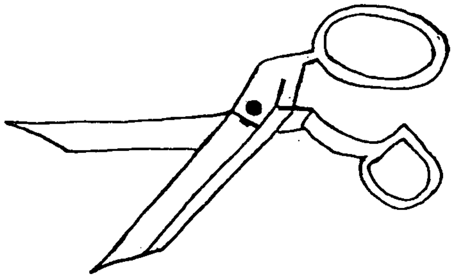

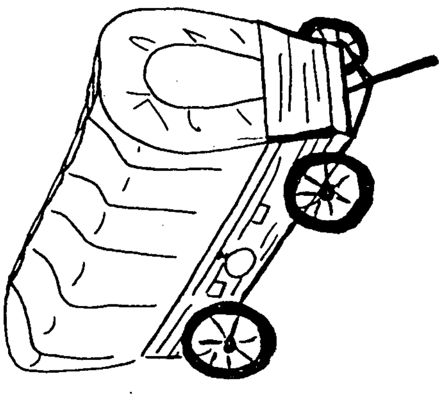

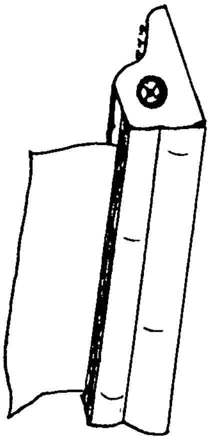

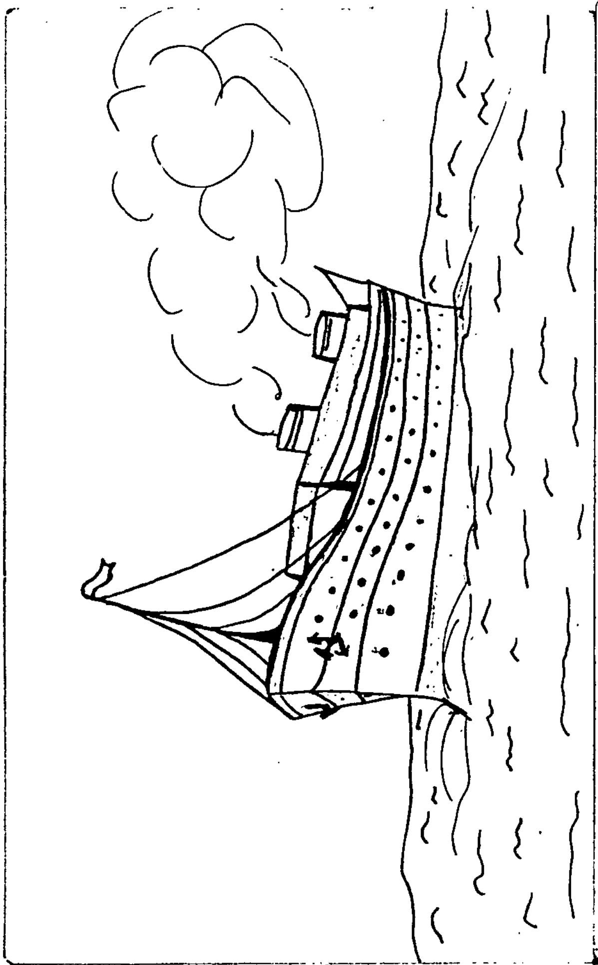

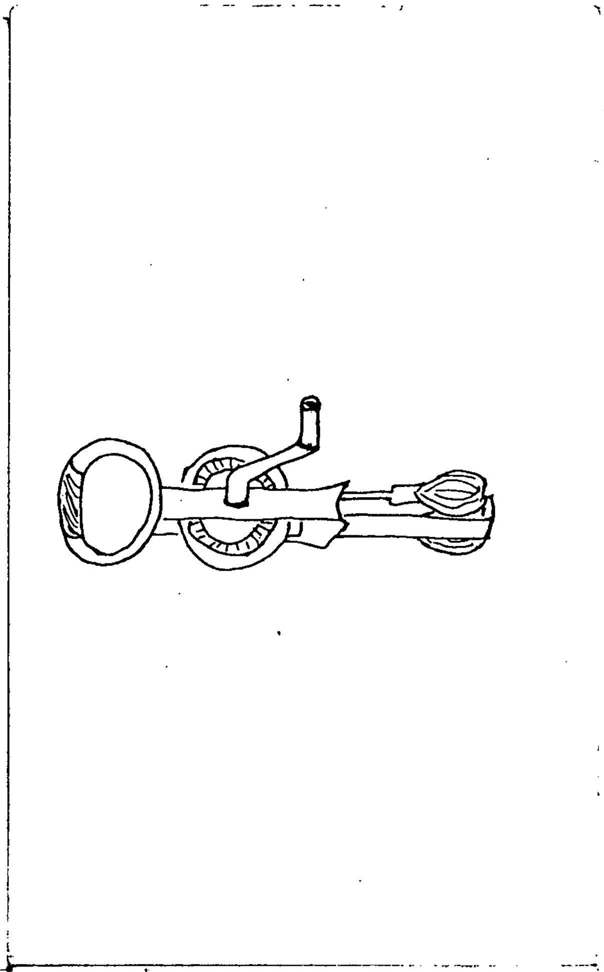

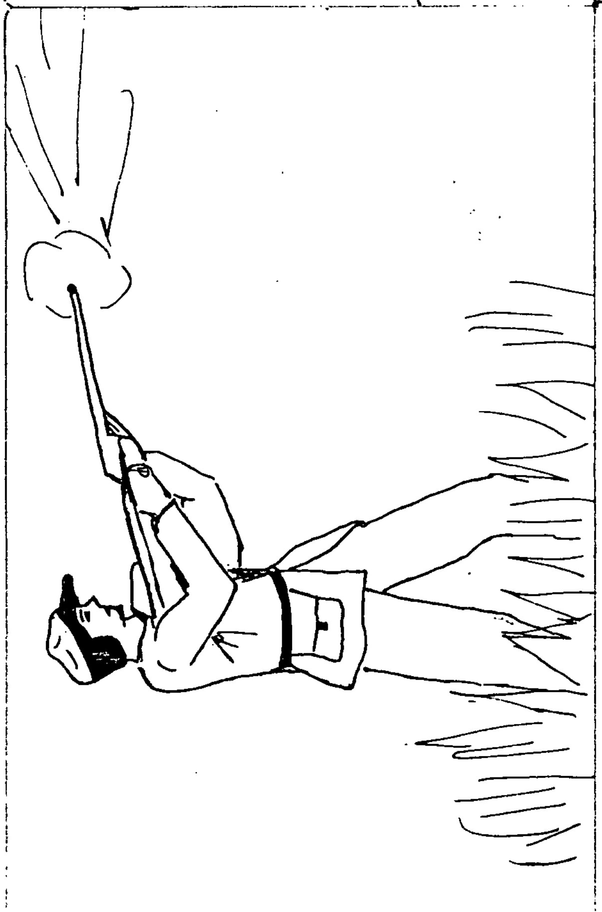

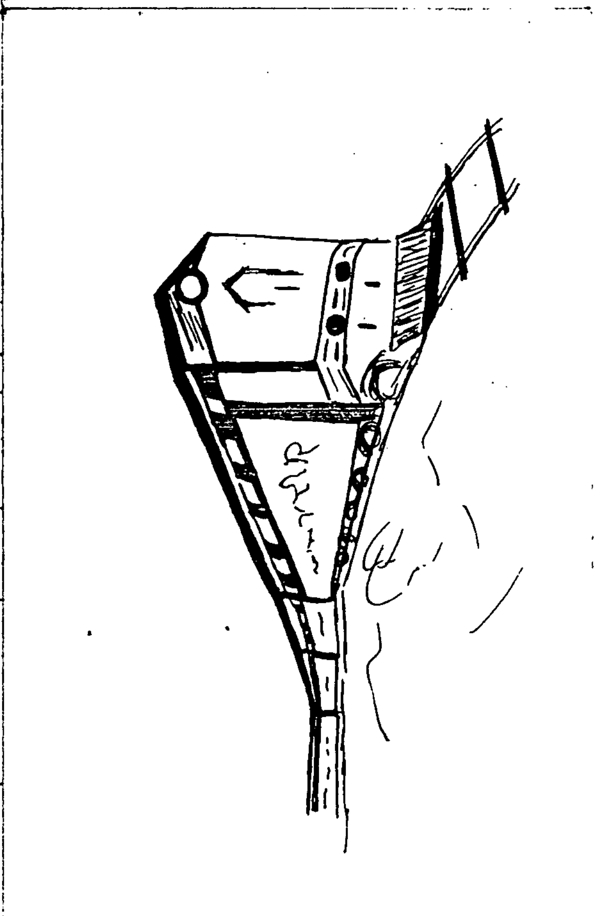

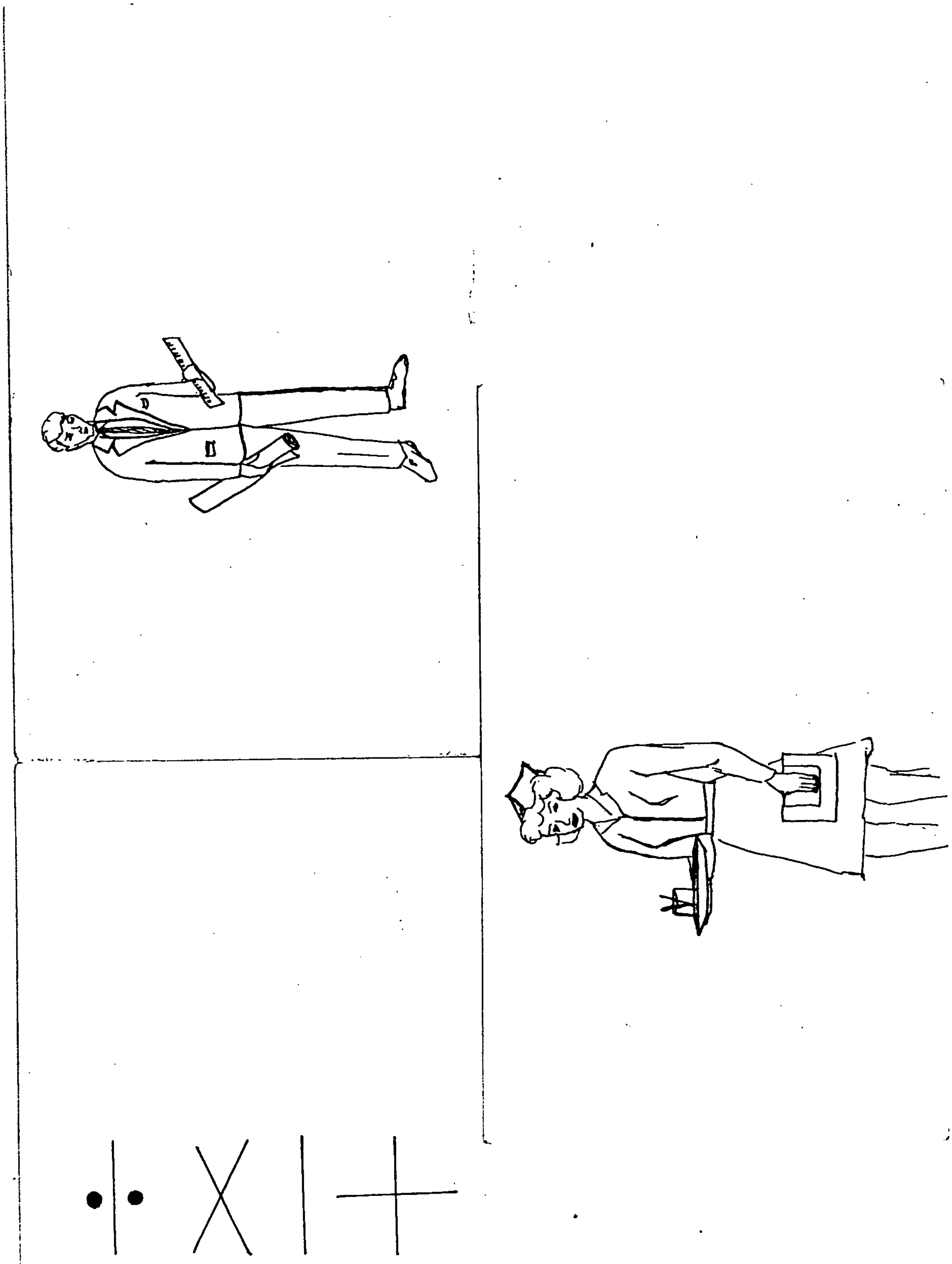

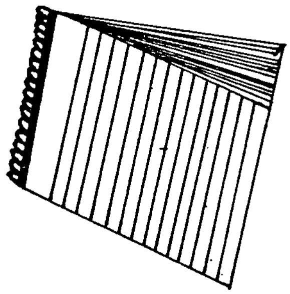

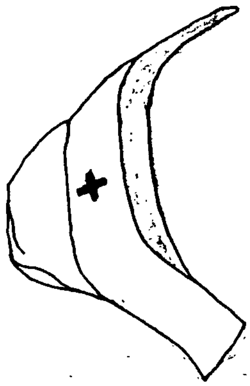

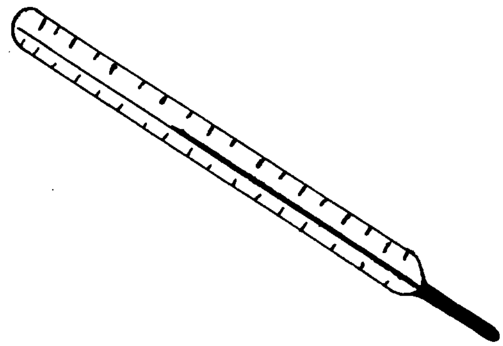

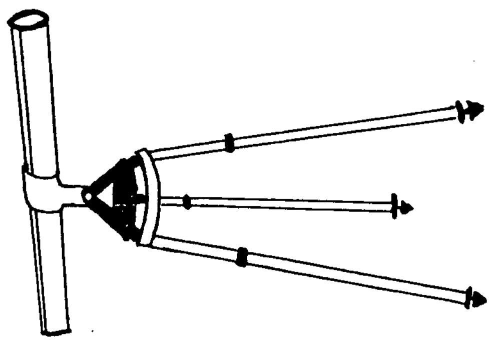

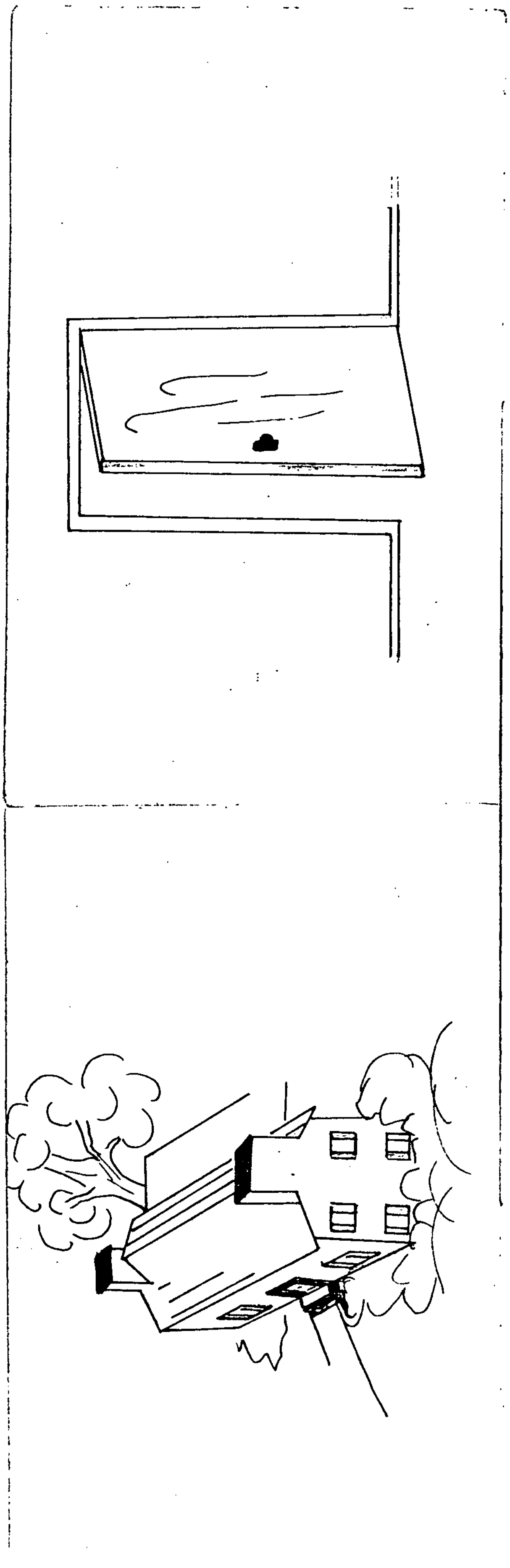

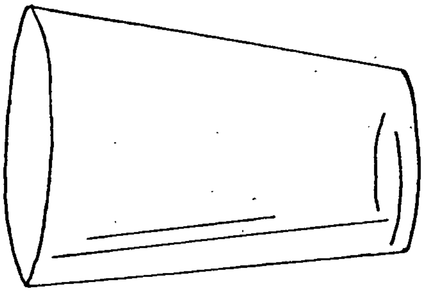

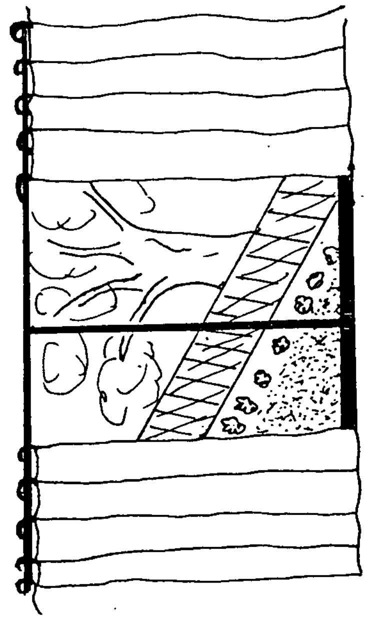

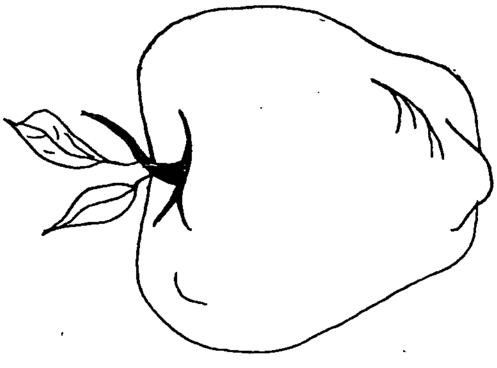

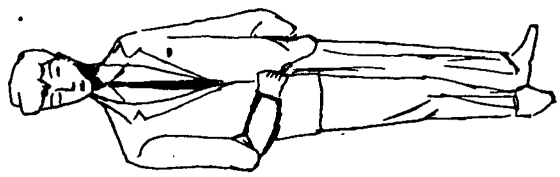

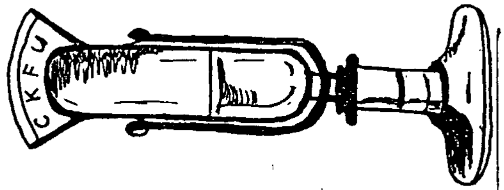
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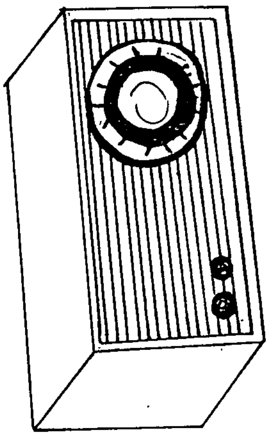

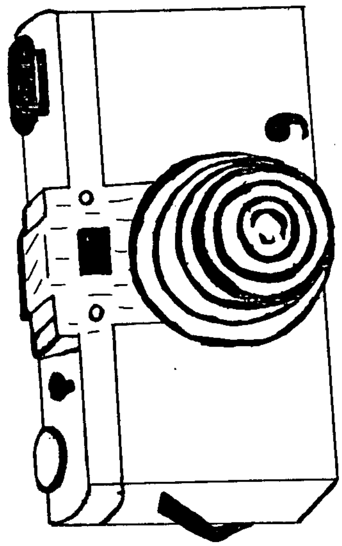

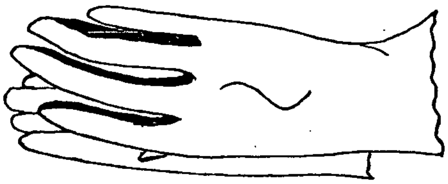

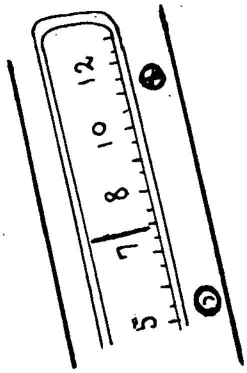
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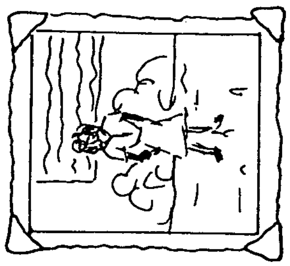

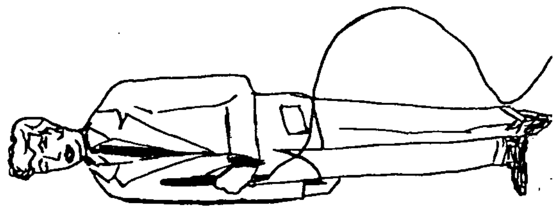

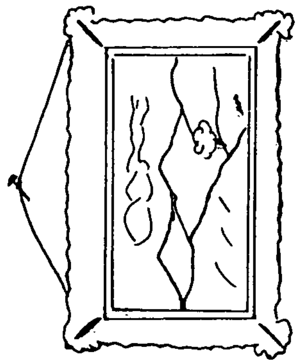

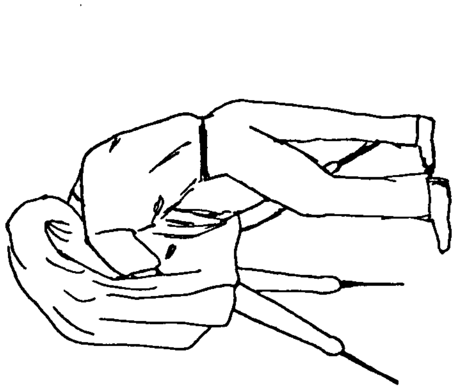

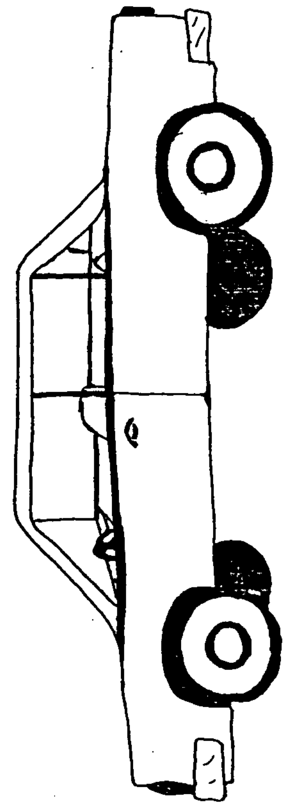

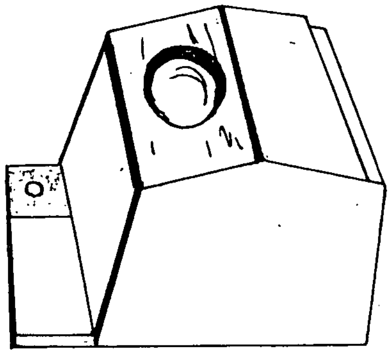

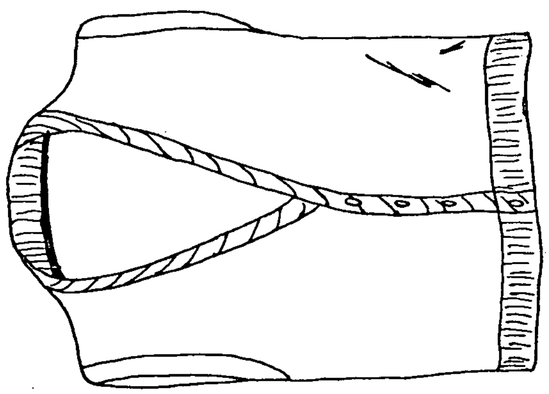

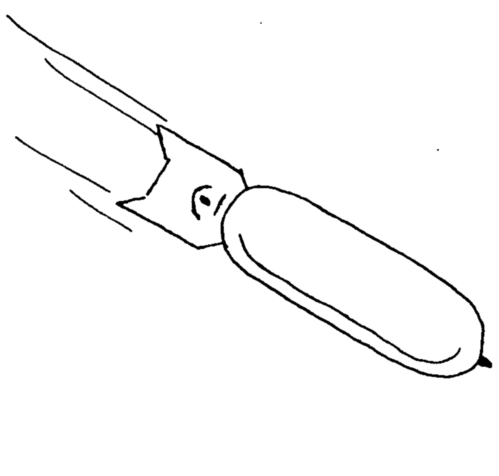

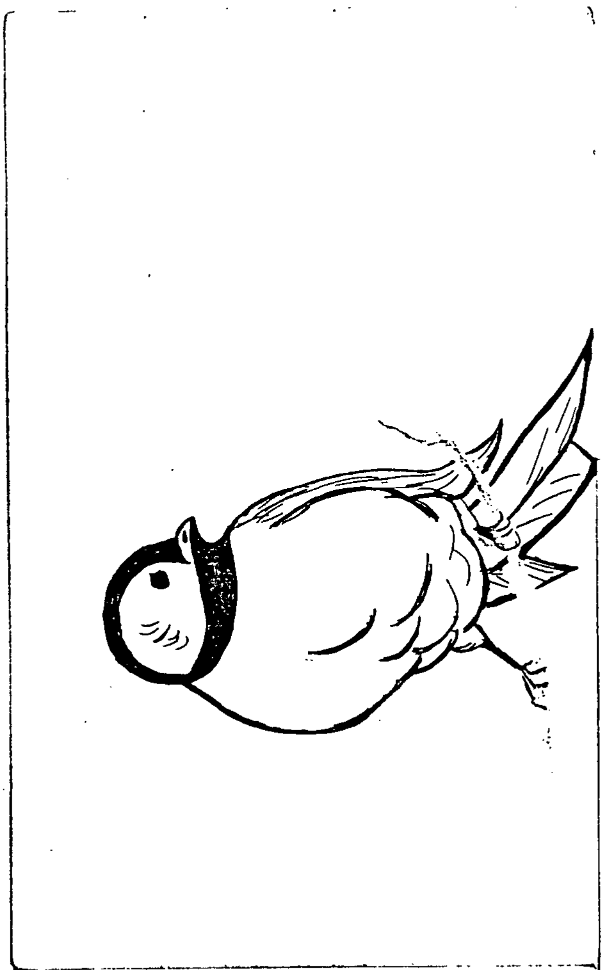

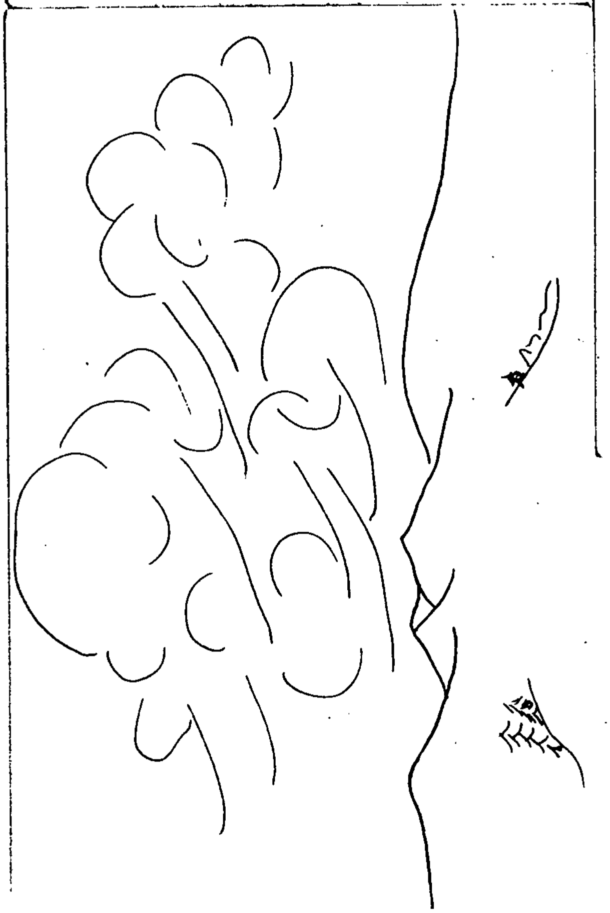

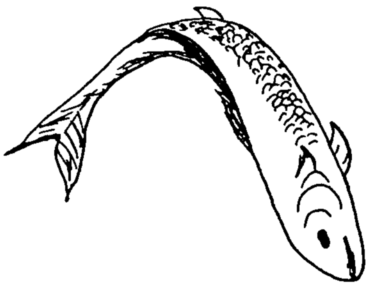

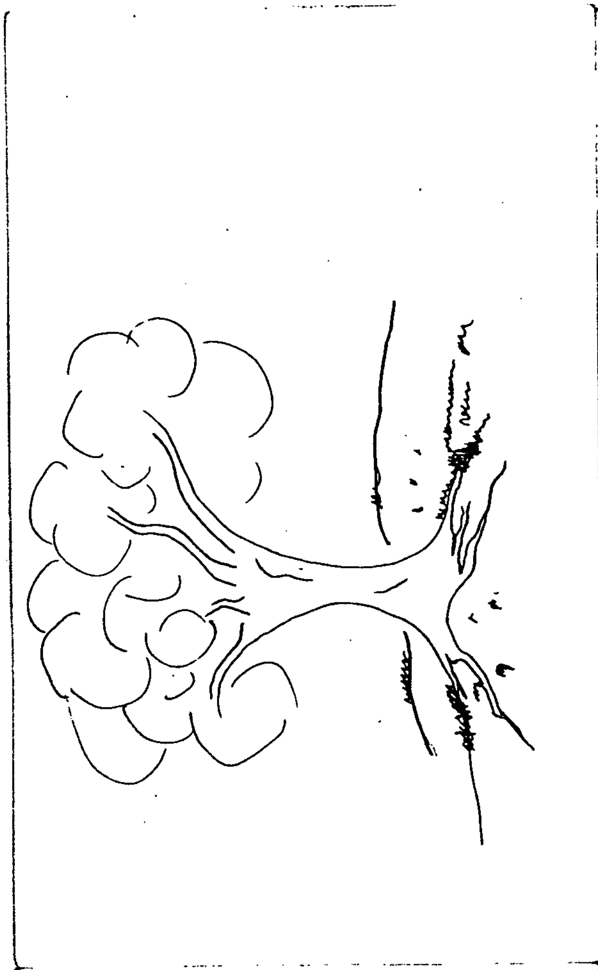

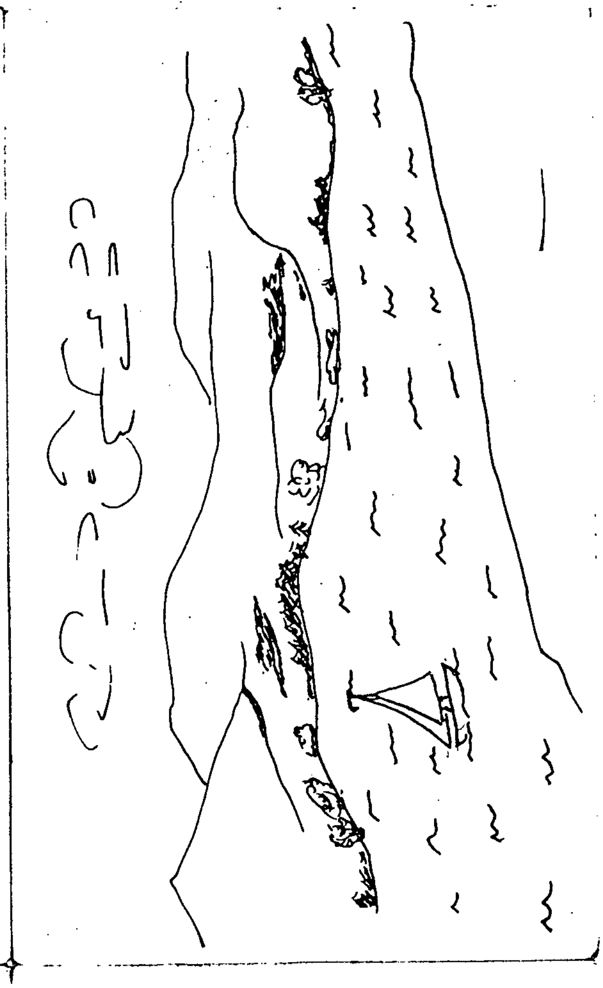

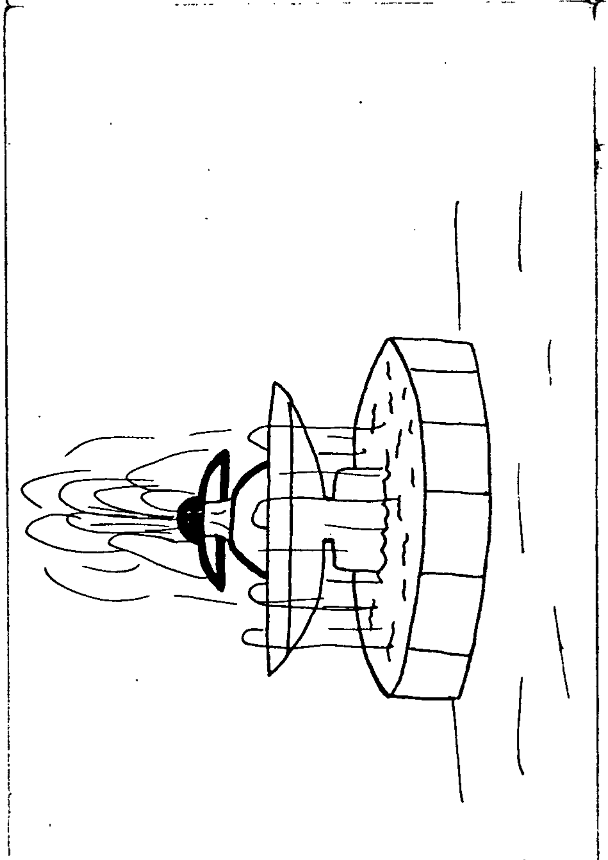

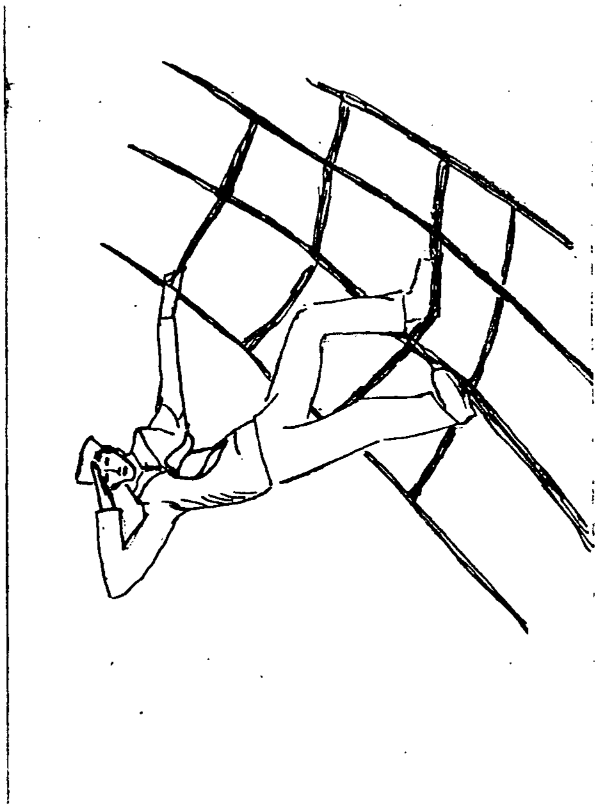

APPENDIX B

INSTRUCTIONS TO SUBJECTS

APPENDIX B

Instructions to Subjects

Instructions Given to Anology Groups Before Problem Solving.

The purpose of this experiment is to study problem solving. I will explain what you are to do by giving you a practice trial. In front of you, you see seven pictures. The first picture is related to the second picture in some way. The third picture goes with one of the remaining four pictures in the same way. You are to find the related picture and tell me its number. (pause) In this example, the answer is number six, the Eiffel Tower. Do you see how it works? Are there any questions?

This was a practice run. The whole experiment will involve twelve more trials like this one. Thus for each trial you will be shown seven pictures. The first two pictures will be related in some way. The third picture will relate in the same way to one of the remaining four. You are to find the related picture and tell me its number. While you are doing this experiment I will record your answer and I will keep track of the time you take. I want to stress that I am recording the time only out of interest. This is <u>not</u> a speed test or an intelligence test. You can take as much time as you need to do each trial as best you can. Are there any questions? O.K. I will begin with the first trial. Are you ready?

Instructions Given to Ranking Groups Before Problem Solving.

This experiment is designed to study the psychology of aesthetics, that is, the preferences people have in making choices.

I will explain what you are to do by giving you a practice trial. In front of you, you see seven pictures. I want you to indicate from amongst these seven pictures the four you like the most. When you pick these four out, tell me the one you like the best, the one you like the second best, the one you like the third best and finally, the one you like the fourth best. (pause) Do you see how it works? Are there any questions?

This was a practice run. The whole experiment will involve twelve more trials like this one. Thus, for each trial you will be shown seven pictures. You are to pick your four favourite pictures and rank them according to your order of preference, that is, first, second, third or fourth.

While you are doing this experiment, I will record your answer and I will also keep track of the time you take. I want to stress that I am recording the time only out of interest. This is not a speed test or an intelligence test. You can take as much time as you need to do each trial as best you can. O.K. I will begin with the first trial. Are you ready?

Instructions Given to Both Anology and Ranking Groups Before Immediate and Final Recall.

I want you to write down the names of as many pictures as you can remember seeing in this experiment. Thus, there were twelve trials and seven pictures in each of these trials for a total of eighty four pictures. Write down the names of as many of these pictures as you can recall. If you cannot name some, describe them as best you can or draw them.