PERCEPTION OF ORGANIZATION IN AN ISOTROPIC STIMULUS

by

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ABSTRACT

This thesis is based on the Gestalt hypothesis that the principles of perceptual organization determine the perceptual groupings the person imposes on the stimulus field, and that these perceptual groupings are also actively grouped in the memory according to the same Gestalt principles of organization. This organization of perception and memory determine the characteristics of recall and reproduction.

A brief review of previous work in this area is discussed with reference to changes in memory as a function of time and as a function of competing traces. The methodology of these studies is criticized for three basic reasons: They begin with an organized stimulus, they use repeated reproductions from the same subjects, and they fail to objectively quantify their results.

The experiment described in this thesis attempted to avoid the problems of the previous methods by using an isotropic (unorganized) stimulus, by employing a method of cascaded subjects, and by objectively quantifying the amount of organization in a subject's reproduction of a stimulus by a psychophysical scaling technique.

It was found that subjects organize the stimulus in

order to remember it and that this organizational process in perception and memory determines the characteristics of the reproductions. Thus the subjects' reproductions were more organized than the stimulus they viewed.

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CHAPTER 1

INTRODUCTION

This thesis examines the hypothesis that the Gestalt principles of perceptual organization determine the perceptual groupings that a person imposes on the stimulus and that these perceptual groupings themselves may further be actively grouped according to the same Gestalt principles of organization. This organization of perception and memory determines at any given time the characteristics of recall and reproduction.

Organizational processes of this kind were first treated by the early Gestalt psychologists, whose approach was epitomized by what came to be known as the law of pragnanz. Quite simply, the law of pragnanz states that there are tendencies to perceive the best, most stable form of a visual stimulus. What constitutes "good form" is characterized by the principles of organization: proximity, similarity, etc. Through various demonstrations the Gestaltists showed how these principles of organization determine the perception of a stimulus field.

For example, a person will see four groups of three in figure 1

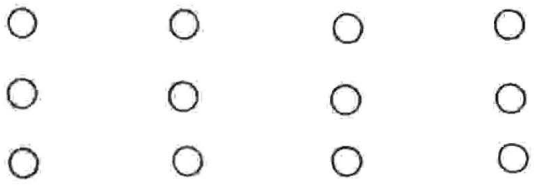

Figure 1

and see three groups of four in figure 2,

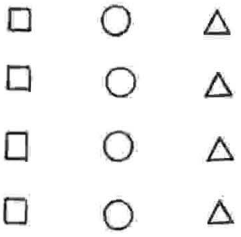

Figure 2

and two groups of six in figure 3

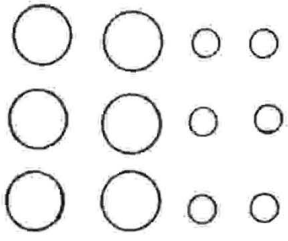

Figure 3

Koffka (1935) extended the same principles of perceptual organization to the organization of memory. He suggested that there were dynamic forces in memory which further shape and organize the gestalten of immediate perception. For example, when a person sees four groups of three in figure 1 he/she may remember an even more organized four-groups-of-three ...the distance or proximity within a group is likely to decrease in memory and the distance between groups is likely to increase.

In Koffka's words "psychological organization will be as good as prevailing conditions allow". In perception, the psychological elements are grouped according to Gestalt principles of organization but these groupings are constrained by the presence of the physical stimuli. In memory, organization of the perceptual units occurs - also on the basis of Gestalt principles - but this organization is constrained by what Kohler (1947) refers to as the memory process, that is the phenomenal representation of the stimulus, rather than by the physical stimulus itself.

This implies that memory is not a static representation of sensory input. It is, instead, an active organizing process; it changes its patterned contents, according to the principles of Gestalt organization, toward the best, most stable form. The specific changes are determined by the perceptual groupings suggested by the properties, relations and stresses of the trace pattern itself.

Koffka (1935) proposes two processes which are active in the organization that occurs in memory. The first is the change of the phenomenal representation of the stimulus field in memory over time. The less organized the immediate perception is, the

more likely it is that its memory traces will undergo changes. The direction of this change is towards more stability and organization in the memory.

The second organizational process in memory that Koffka describes occurs because of competing traces. That is, the memory of the perceptual stimulus, or process trace (to use Kohler's term), competes with other traces, which Kohler defines as "older" processes. A mediational process like language is an example of a competing trace: if the stimulus is associated with a verbal label then the trace of this label exerts a direct influence on the process trace. This distinction between changes due to time and changes due to competing traces, will be useful later in discussing the studies that support the Gestaltists' position.

General Background

Investigation into organizational processes in perception and memory has continued vigorously since the early work of the Gestaltists. A systematic survey of all the literature in this area will not be attempted here, but some representative studies will be reviewed because of their relevance both to the Gestalt theory of organizational processes and to the special concern of this thesis.

The following review is organized along the lines of the two processes of memory that Koffka distinguished. The first is changes in memory as a function of time and the second is changes as a function of competing traces.

Along the first line, the studies have addressed the general question of what happens to memory traces as a function of time. The studies of Wulf (1922), Gibson (1929), Allport (1930) and Perkins (1932) addressed this question. Specifically they were interested in changes that occur between the original stimulus and successive reproductions of it. In each of these studies the procedural method and analysis were similar. A method of repeated reproductions were used in which a subject views the stimuli for a brief period (from 1½ seconds in Gibson's experiment to 10 seconds in Allport's experiment) and is then asked to reproduce them. The same subject reproduces the stimuli several times over varying periods of time. For example Wulf's subjects reproduce the stimuli immediately after viewing, then again after twenty-four hours, then again after a week and in some cases a fourth reproduction was obtained after two to eight weeks. It should be noted that subjects view the stimuli only once, and from then on reproduce the stimuli from memory.

The data of these experiments were the changes from the stimuli in each of the reproductions. The data analysis consisted of categorizing these changes. It is interesting to note that all four investigators commented on the difficulty of categorizing responses because of their great diversity.

Although generally similar, the four studies, Wulf (1922, Gibson (1929), Allport (1930), and Perkins (1932) do vary in the stimuli and in the classification schemes used; these distinctions will be briefly discussed. In general the types of changes they found are in agreement with each other and support the position that the nature of the changes between the reproductions and original stimulus is guided by the principles of Gestalt organization.

Wulf used simple unfamiliar figures as stimuli and asked his subjects to reproduce the forms as accurately as possible and to give a report of their experiences during reproduction - specifically their imagery, and verbal association: also their comments on how well they thought their reproductions corresponded to the original stimulus.

From the 400 reproductions he obtained, Wulf categorized the changes as tending towards 'sharpening' or 'leveling'. Wulf defines sharpening as the

exaggeration or emphasis of a characteristic or pecularity of the form; leveling is defined as the omission, or weakening of a characteristic. In addition, Wulf found that in a series of reproductions from a single subject the changes were always in the same direction (whether sharpening or leveling).

Gibson (1929) criticized Wulf's stimuli on the grounds that they limited the variety of possible changes which could occur. Therefore, Gibson in his experiment used a wider variety of forms, in order to allow a greater array of possible types of changes and directions for change. To further increase type and direction of change he decreased exposure time in order to increase "errors" in reproductions.

The most frequent kind of change Gibson found in the reproductions was the merging of different stimulus figures. The assimilation of stimuli may in part be due to the rapid exposure of a series of different figures. He also noted two general categories of changes; that of completion and disintegration. Completion applies to the examples where gaps or breaks were partially or wholly closed; disintegration, to when gaps and breaks result in a "falling apart" into separate units. Under these two general categories Gibson shows various examples of changes towards symmetry and simplicity and also changes of curved lines to straight lines.

Gibson's results are consistent with Wulf's and in general support the hypothesis that changes occur toward a more stable form as predicted by the principles of organization. In his interpretation of his results, though, Gibson argues that the changes are due to perceptual habits rather than inherent characteristics of the physical form. This, however, is a misunderstanding about the proposed nature of the organizational processes. The Gestaltists' position is not that the tendencies for organization exist in the physical structure of the figure but rather in the phenomenal characteristics the subject perceives in the sensory input. Certainly, the physical characteristics of the stimulus determine and restrict the nature of the reproduction but the perceptual stresses and organization in perception and memory are active in the interaction of the observer and the effective stimulus. The distinction Gibson brings to light is important and forces a clearer articulation of the way in which the principles of organization operate.[1]

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[1] In private communication with Koffka, under whose direction the article by Wulf was written, Gibson reported that Koffka would prefer, instead of the phrase "change caused by the nature of the form itself", some statement emphasizing the fact that in his opinion the change was caused by dynamic processes within the physiological correlate of the percept. (Carmichael, Hogan, and Walter, 1932, p. 83)

Allport's (1930) investigation into the nature of changes in repeated reproductions of a stimulus over time is similar in format to Wulf's and Gibson's. There were however more subjects and the subjects were children. The stimuli used were two unfamiliar designs which were more closed and geometrical than either of the forms used by Gibson or Wulf. Allport hoped to rule out changes due to verbal characterization by not telling the subjects in advance that they would have to reproduce the figures. This makes the assumption that verbalization would be used as a cue only if they were looking at the stimulus in order to reproduce it. He also thought the figures were too complex for verbal characterization by a child. Unlike Wulf and Gibson, Allport did not ask his subjects for a report of their experiences in reproducing the figures. Allport does not report changes due to associations with verbal labels even though there is no evidence subjects did not do so.

Allport reported the forms tended "in general to become smaller, more symmetrical and simpler." More specifically he itemized the changes in a table listing thirty-four types of changes and the percentage of the total number of cases in which they occurred. To mention a few: tendency toward symmetry, equalizing sides, changing rectangles to squares, simplification, elaboration, leveling of features and sharpening of

features. Allport also noted the progressiveness of a direction of change over time, that is if leveling occurs it is continuous over successive reproductions within a single subject.

Perkins (1932) took repeated reproductions from the same subject over a period of 50 days. The stimuli he used were simple, nonsymmetrical figures. Perkin's conclusion about the nature of changes was that the forms underwent changes toward symmetry and simplicity and also that this change was progressive over successive reproductions. More specifically Perkins lists nine categories of ways in which forms become more symmetrical, for example: by complication (adding more parts), by equalization of lines and angles, by standardization (making the forms more like circles, ovals, or squares), by orientation (making the figure vertical or horizontal), etc.

These four studies investigated changes in the memory trace of the perceived stimulus over time. Their results support Kohler's (1947) supposition that "traces are not rigid; there are definite dynamical tendencies in them." The numerous changes that occur, and the progressiveness of these changes over time, in particular, support this position. Although these changes are categorized a number of

different ways, it appears the process of change, both in type and direction, is determined by the principles of organization and is therefore in the direction of pragnanz - i.e. towards a more stable form.

The second organizational process Koffka refers to hypothesizes that various traces, both old and new, interact and cause change to occur in the direction of increased organization. This implies that memory is a dynamic organizing process and evidence for this position has already been discussed, in the form of changes over time. The process of organization that results from the influence of other traces - notably traces representing verbal characterization - will be discussed here.

This line of investigation began with a somewhat secondary observation made by Wulf. He noted in addition to the process of leveling and sharpening a tendency he called "familiarization" by which, if subjects associate a verbal characterization to a percept of a stimulus form, they are inclined to reproduce a stimulus more like the verbal label than the original stimulus. Gibson confirmed this phenomenon and, as mentioned earlier, attributed changes over successive reproductions to this tendency of change towards more familiar objects. In his experimental data he found subjects tended

to remember and reproduce forms the way they described them rather than in the direction he felt the inherent stress of a figure would suggest.

The apparent discrepancy between change towards a familiar object and change towards reducing the stresses in the physical stimulus does not imply a rejection of Gestalt theory, because as mentioned earlier, the forms themselves do not tend towards pragnanz but rather the process of organization tends towards pragnanz.

The stresses are not in the physical stimulus as Gibson suggests, but rather in the perceptual memorial representation of the stimulus. Therefore the change toward familiar objects that Gibson reports is support for Koffka's theory of competing traces. For example, Gibson reports the form on the left in Figure 4 was described by the subject as a pillar with a curve; the subject's reproduction which is more like the verbal characterization than the stimulus, is the right hand figure in Figure 4.

Figure 4

In Koffka's theory of competing traces, "the preservation of a trace is a function of its stability". Therefore in Gibson's example the process trace interacts or competes with the trace of the verbal characterization; and if the reproduction is similar to the verbal characterization the process, or stimulus trace must be less stable than the trace of the verbal characterization or it would have been preserved.

Carmichael, Hogan, and Walter's (1932) work is a systematic test of the influence of verbal mediation on the reproduction of visually perceived forms. The influence of verbal labels was examined by varying the label associated with a relatively ambiguous figure. One group of subjects was shown a series of these figures, each one preceded by the experimenter saying, "the next figure resembles ..." and giving one of the two names associated with the next figure. In the second group the subjects were shown the same figures but the experimenter would give the other of the two names associated with the figure. A third group which acted as a control was shown only the figures, without any labels. So for example, a subject in group one would be told the next figure resembles a crescent moon and would then be shown this figure.  A subject in group two would be told the next figure resembles the letter 'c'

and would be shown the same figure that the subject in group one saw - i.e.  A subject in the control group would be told nothing and shown the same figure -  .

Two of the authors of this study independently rated the reproductions of these figures on a five point scale: One on the scale represented that there was no change from the original; five represented an almost completely changed form.

The reproductions that were classified as fives in this rating scale were then compared to what the experimenters termed the "visual representation of the figure" implied by the label. In a similar method of rating the authors found 74% of the figures in group one were like the visual representation of the labels that that group had been given. From the previous example the reproduction of the stimulus was like a crescent moon. In the second group, which had been given different labels, 73% of the reproductions were like the visual representation of the label - i.e. like the letter 'c'. In the control group only 45% of the reproductions resembled the visual representation of either labels.

Thus, by directly manipulating the verbal labels of what the subjects saw, Carmichael et al. demonstrated

that naming a form is influential in determining the characteristics of the reproduced form.

Bartlett (1932) reported the results of a number of studies concerning the influence of verbal mediation in memory. In his early studies Bartlett noticed that the changes that occurred between the original stimulus and the reproduction of it were in the direction suggested by the subject's verbal characterization of the stimulus. In a systematic investigation of the influence of verbal mediation on the reproduction of a stimulus Bartlett presented his subjects with an abstract portrait of a face with the label "portrait d'homme." He hypothesized that given an unusual figure with a strong suggestion of what it may be (from the label), subjects would tend to reproduce the stimulus figure more like the trace of the label than the trace of the stimulus. Bartlett used a method of cascading subjects, where the first subject in a series views the target stimulus and reproduces it, the second subject views the first subject's reproduction and reproduces it and so on, with each subject in the series viewing and reproducing the previous subject's reproduction.

An example of one of Bartlett's cascades is published in his book and the analysis of the subjects' reproductions are left to the reader to observe what Bartlett feels is a clear change in the reproductions towards a visual representation of the label "portrait d'homme" rather than reproductions remaining like the original stimulus. From this experiment Bartlett concludes that once a name is associated with a form it determines what is remembered and reproduced.

In this experiment and in early work, Bartlett also noted that when he asked subjects to describe the stimulus, they primarily remarked on the general structure, or their overall impression of it rather than being very detailed. Similar findings were also noted by Bower (1972). He showed with serial presentations of nonsense syllables that subjects remember these items by converting the syllables into meaningful words and then remembering the word plus transformation. In both these cases the less meaningful parts of the trace (i.e. the details and transformations) are forgotten first. In Kohler's (1947) words,

> the traces of past events undergo an exceedingly rapid transformation in which the less clearly specified parts of the groups disappear. When this happens, subsequent behavior will

> obviously be determined by the simplified organization which alone is left.

In this context the details and the transformations are the most unstable, less clearly specified parts which disappear.

The point that these studies on mediation processes addresses is that the recall and reproduction of stimuli is the result of many interacting traces. In addition they provide further evidence for the position of memory as an active process. The work of Bartlett and Carmichael et al. experimentally demonstrates the influence of verbal labels in determining the reproduction of relatively ambiguous figures. This evidence supports Koffka's hypothesis of competing traces: traces of familiar objects interact with the process trace of the perceived stimulus and the preservation of one trace or any part of a trace over another is a function of its stability.

In view then, the perception of the visual stimulus and the changes and interaction of memory traces over time is based on the Gestalt principles of organization. These, in turn, determine the reproduction of the stimulus.

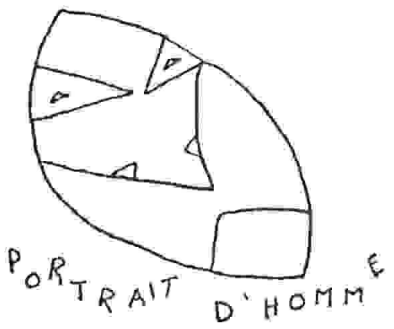
CHAPTER 2

CRITICAL REVIEW OF PREVIOUS METHODOLOGY

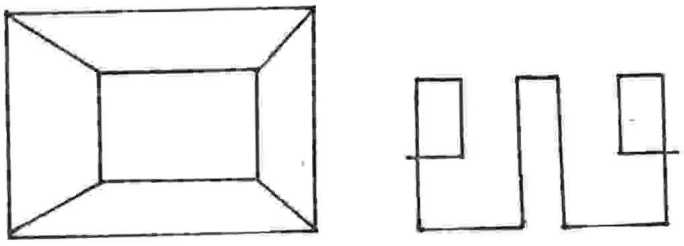
While the studies reviewed in the previous chapter support the general formulations of the Gestalt theory of perception and memory, there are serious methodological problems in those studies which weaken the case they are trying to make. The problems are basically of three kinds: the first is the nature of the stimulus, the second is the procedure of repeated reproductions from the same subjects, and the third is lack of objective and quantitative analysis of results.

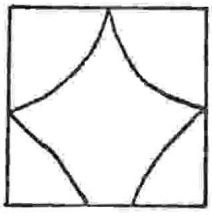
Concerning the first of these problems - the nature of the stimulus - all of the studies listed above used stimuli which were already fairly structured and therefore somewhat organized and stable; for example

Bartlett
(1932)



Allport
(1930)





Carmichael, Hogan & Walter
(1932)

The results of these experiments are therefore less dramatic than they could possibly have been. By beginning with already organized figures, limits are set on the degree of further organization which is possible. In addition, beginning with structured stimuli raises the type of problem Gibson addresses. While the subject's organization is constrained by the inherent characteristics and stresses of the form, it is largely determined by organization factors within the subject. Thus, an unstructured form would better illustrate that the organization is in the subject's perception and memory rather than in the figure.

In Bartlett's experiments it is open to question whether successive reproductions did or did not show a step by step progression towards a more organized stable 'portrait d'homme'. The overall effect, however, (from the original stimulus to the eighteenth reproduction) is clearly in the direction suggested by the label. The difficulty of showing a progression with reproductions within the cascade is probably due to the complexity of the figure. In the first place there is a great diversity in peoples' visual images associated with the label 'portrait d'home'; a less complex stimulus and label would not lend itself to as much variation. In the second place much

of the variation within the series which prevents a clear step-by-step progressiveness is likely to be caused by the difference in people's drawing skills. Again, a less complex figure would not be as subject to as much variation due to peoples' drawing ability.

Carmichael et al. found their results to be weakened through using figures too similar to the visual image or representation of the label. This may occur when the original visual stimulus happens to be similar to the stereotyped image likely to be evoked by the verbal label. Under these conditions difficulties arise in determining whether or not the reproductions have changed in the direction of the label because so little change from the original stimulus has occurred.

One further criticism of the stimuli used is a point made by Gibson concerning Wulf's stimuli. Gibson felt Wulf's stimuli was such as to necessitate changes in only one of two directions.

> The commonest type of figure used was one in which there are two elements, one differing somewhat from the other, such as two triangles of different shape having a common base: two connected forms of the same shape but having a different size etc.

The argument is that if the two elements in the figure were equalized, it would constitute leveling of a characteristic, and if the two elements were further

differentiated it would constitute sharpening - those are the only two alternatives. This is the same point that was made earlier: the complexity and stability of the stimuli used restrict the possible range and direction of modification.

The second of the three methodological problems is the method of repeated reproductions from the same subjects which was used by Wulf, Gibson, Allport, and Perkins. The procedure involved showing subjects the stimulus on one day, asking them to reproduce it immediately, and then asking them to reproduce it again several days, weeks and sometimes months later. That is, the subjects are exposed to the stimulus once and are requested to make a series of reproductions from memory over a period of time. Perkin's subjects, for example, after seeing the stimuli once made 7 reproductions over a 50 day period.

This procedure involves many factors other than just memory-over-time which possibly confound the results obtained. In the first place it would be difficult if not impossible to know if the subject on latter sessions was actually trying to be consistent with what they had done on earlier reproductions. Bartlett reports that a subject commented that he was remembering what he did last time rather than

remembering what he saw.[1] This would suggest that random errors made in earlier reproductions would persist because the subject is reproducing the earlier reproduction rather than the original stimuli. The effect of this type of error is not known. On the one hand if the random errors are cumulative over reproductions, which they may be since subjects do not have the feedback of comparing their reproduction to the original, then the reported progressiveness of changes may be inflated by this process. If on the other hand the random errors remain random, that is the direction of errors may be 'jiggled' one way or the other this may weaken the finding of progressiveness by increasing the error variance.

A second difficulty with the repeated reproduction method is that the results are much more susceptible to idiosyncratic differences than with a method using independent subjects. Because a single subject produces all the reproductions in a series, his own biases, attitudes and experiences will be evident through the entire series.

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[1]This did not occur in the Bartlett experiment discussed earlier where he used the method of cascading subjects. This is from an earlier experiment where he used the repeated reproduction method. (p.60)

The effect of certain biases was noted in the early work on verbal mediation. In subjects' reports, the reasons they saw certain figures one way or another reflected their personal backgrounds and therefore resulted in definite biases. For example the trace of a verbal label used by a mathematician to remember an ambiguous figure may be a more stable trace than the process trace of the stimulus and therefore is reproduced. The reproduction would therefore resemble the visual representation of the label and represent a more stable, organized form. If however the experimenter is unfamiliar with the verbal label (because his background and bias are different from the mathematician's) he might judge the change in the reproduction to be less organized.

The idiosyncratic differences of subjects would not be as much of a source of variance if one subject made only one reproduction whereas in the repeated reproduction method a particular bias will be present in numerous reproductions.

An additional problem with this method is that an effect of practice occurs which causes changes in successive reproduction which are not the result of memory changes. These changes simply result from the subject getting better at drawing the figure because

they have drawn the same form over and over again.

These factors mentioned are not the only possible confounding effects in using repeated reproductions from the same subjects. Evidence that something other than memory operates in this method comes from Perkins (1932). He showed two groups of subjects the same stimulus: one group was asked to reproduce it immediately, then again after 24 hours and again after two weeks; the other group reproduced it for the first time after two weeks. The reproductions after two weeks showed marked differences between the two groups. Therefore Perkins concluded that factors other than memory operate during repeated reproductions. Bartlett also found that in using the repeated reproduction method, the intervals between reproductions influenced the type of changes that occurred

> if the reproductions occur within close temporal proximity, the form becomes fixed . . . while if long intervals are allowed to elapse between successive reproductions the process of gradual transformation may go on indefinitely. (Bartlett, 1932)

This is an unanticipated effect due to procedural factors rather than memory-over-time.

In a review of the literature on Gestalt organization in memory Osgood (1958) proposed two alternative methods which he considers would avoid these problems: The first method is to present a stimulus which has a single dominant stress to a large group of subjects, each of whom would reproduce the figure only once but at varying intervals. While this would eliminate the problems associated with the method of repeated reproductions it would cause a different kind of problem which was mentioned earlier in connection to Gibson's work. It is the problem of creating a stimulus with a dominant stress. The stress is not an inherent characteristic of the physical stimuli, it is in the perception and organization in memory which determines the stresses.

The second method Osgood suggested is to present a figure to a subject in the waking state and have all successive reproductions (from the same subject) drawn in a hypnotic trance. What advantages this elaborate method buys is not clear.

The third methodological problem is the lack of an objective method for dealing with the results. In all of the studies mentioned previously the experimenters were interested in the nature of the changes that occur in the reproduction of a perceived stimulus; in some cases it was change due to time and in others it was due to verbal mediation. The way the data, i.e. changes in

the reproductions, were handled was by a variety of categorizing schemes. The fact that the investigators commented on what a formidable task it was suggests how arbitrary the categories may be. Wulf's system of categorizing has been criticized, by Gibson, as being determined by the stimuli he used. As discussed earlier Wulf's stimuli could only vary in one of two directions and therefore his categorizing system had to be dichotomous. Gibson also criticizes the criteria which Wulf used to decide whether a change fit one category or another. For example, if one of two parts of a figure is not quite equal in size to the other but is reproduced as equal or more nearly equal than in the original stimulus, is this a leveling or sharpening effect? On the one hand if "unequal size" is considered the characteristic of the figure, then the change is leveling. On the other hand if "nearly equal size" is considered the characteristic, then the change is sharpening. A further criticism of Wulf's analysis is in regard to clear progressiveness of changes that he reports. Woodworth (1938) in a review, found that of the 20 individual series that Wulf published (which were presumably his best) only one of the twenty, in his opinion, showed an unequivocal progression.

These criticisms of Wulf's analysis apply equally well to the other studies. The categories are somewhat

arbitrarily and subjectively assigned, the criteria for classifying a change as one type or another is subjective, and the trends - progressiveness for example - that appear obvious to the experimenter are not reliable. Bartlett's cascade of reproductions of the 'portrait d'homme' is, as mentioned earlier, another example of the disagreement over 'clear' progressive trends.

Carmichael, Hogan and Walter were aware of the subjective nature of categorizing the data and attempted to get inter-judge reliability among two of the experimenters and used the third to decide on conflicts. The problems with this are obvious: two judges are not enough, and the experimenters themselves may have biased judgements since they were predicting the direction of change.

In recent years information theory has been applied to Gestalt concepts of organization and figural goodness. Put simply, the theory states that because of the finite capacity of the person for processing information, the information load is reduced by the formation of categories, groupings, and the organization of units (Garner 1962).

One value of information theory is the quantification of stimulus events. Its basic measure, uncertainty, is computable when more than one unit is possible, and

the greater the array of units that are equally possible the more uncertainty there is. The difficulty in applying this measure is in identifying the perceptual unit (MacGregor 1975). The problem is that effective perceptual units are phenomenological entities which are not necessarily easily identifiable physical attributes of the stimuli. Here again is the same problem that occurred in Gibson's interpretation of his results, in Wulf's criteria for assigning changes to one category or another and also in designing a stimulus with a dominant stress as Osgood suggests: the organizational tendencies are not in the physical stimulus but rather in the perceptual and memorial representation of the stimulus.

In summary the methodological problems in the area of organizational processes in perception and memory are in the nature of the stimuli, the method of repeated reproductions from the same subject and the lack of an objective analysis of the changes that occur.

CHAPTER 3

GENERAL DESIGN

The central hypothesis explored by this experiment is derived from the Gestalt theories of perception and memory and proceeds thus: 1) principles of perceptual organization determine the perceptual groups that the person imposes on a stimulus field, 2) these groupings are further organized in memory on the basis of the same principles that govern immediate perception, 3) together, this process of organization of perception and memory determines the characteristics of recall and reproduction of stimuli experienced in the past.

The typical approach of studies in this area has been to present the subject with an already structured stimulus, and to observe changes in the reproduction of it, usually after some delay. The experiment described in this thesis departs from this practice in three significant ways: 1) the stimulus characteristics, 2) the conditions of recall and 3) the quantification of the quality of reproductions.

The stimulus was a "patternless" array of dots distributed on a sheet of paper 12" x 12" in size. The distribution of dots was determined by a quasi-random process. The sheet was divided into a nine by nine grid and each of the 81 squares was randomly

numbered. Working in order from square one to square 81 a single dot was placed in each square. Each square was itself divided into a ten by ten grid and where in the square the dot was placed was determined by referring to a table of random number pairs. Figure 5 is a reduced reproduction of the stimulus actually used in the experiment; it will henceforth be referred to as the "target".

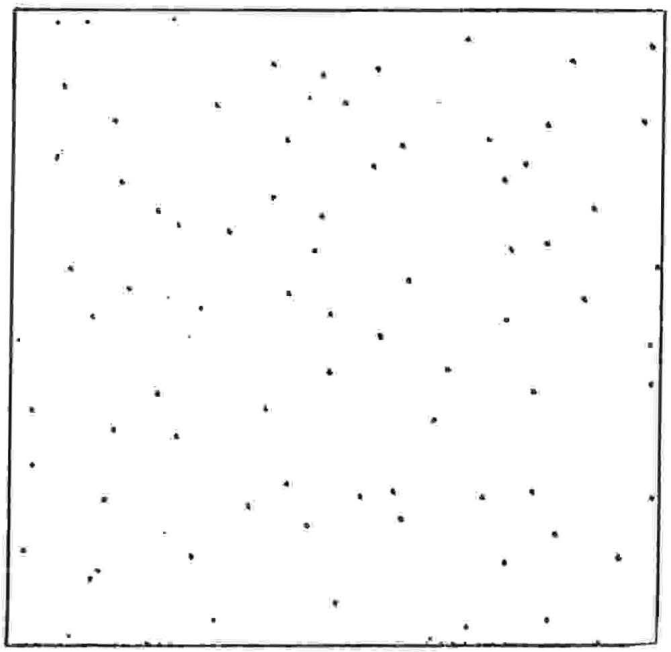

Figure 5

The quasi-random process used (i.e. only one dot in each of the 81 squares) was necessary in order to give the target a "patternless" appearance. A uniform density distribution of this kind is said to have the property of "isotropy"; isotropy represents a characteristic of ideal disorder (Kitaigorodskiy, 1967). A purely random process

of distributing dots, on the other hand, could easily result in clusterings which could be highly suggestive of perceptual groupings.

This method was used in an attempt to produce a stimulus as disorganized as possible so that the extent to which subjects imposed organization would be emphasized. Also since in past work considerable debate has been generated over "inherent" organization of the stimulus, it is important to use a stimulus with a minimum of inherent organization.

Dots were used because they seem to be the simplest perceptual unit. As Koffka (1935) said, a dot

> though geometrically it may be a very small circle or square, has phenomenally no shape at all.

The manner in which the subjects responded to the target indicated that they did indeed regard the dots as essentially the same, even though they were different in 'micro' physical aspects.

Koffka (1935) suggests that a uniform field such as that approximated by the target is maximally unstable. This, in addition to any remaining minimal inherent organization should result in quite marked structuring by the subjects. It should be noted, however, that the perceptual organization would not

be inherent in the physical stimuls; in fact, of all the Gestalt principles that could explain any perceptual organization that might occur, only proximity appears to be present in the target: similarity, colour, size, line of continuation have been essentially eliminated. And as for proximity, there are two expressions of it:
1) the distance between neighbouring dots and
2) the closeness of the dots to the physical border of the sheet itself.

The method of recall was developed in pilot studies to emphasize small changes that subjects made when they were asked to reproduce a single dot on an index card. The method involved cascading subjects in such a manner that 1) each subject makes only one reproduction of the stimulus with no appreciable delay and 2) the stimulus each subject views is the reproduction of the previous subject. That is, the first subject in a cascade views the stimulus sheet of random dots that was prepared by the experimenter and reproduces it. This is the only reproduction which that subject is asked to make. The next subject views the previous subject's reproduction as his/her stimulus sheet and reproduces

it. Similarly, this is the only reproduction which that subject makes. This procedure, of each subject reproducing the previous subject's reproduction, is done five times. By cascading subjects in this way the subjects act as fine detectors of the organization imposed in their stimulus by the previous subject and then they emphasize this organization in their reproductions. This procedure is similar to one Bartlett had used which he called serial reproductions. This serves to amplify small increments of organization that a subject produces in his/her reproduction because the next subject perceives that order and reproduces it as more organized in his/her reproduction.

It is predicted that each subject's reproduction will be more organized than his/her stimulus (which is of course the last subject's reproduction). Therefore, if each subject adds organization, the final subject's reproduction in a cascade should show a dramatic increase in organization from the original target of random dots.

Another interesting point about the cascading method is that when a subject uses a verbal mediator to remember a grouping of dots in order to reproduce

it, that grouping is objectively represented in his/her reproduction. The label itself is not passed on to the next subject but the pattern of it is passed on in the reproduction.

A psychophysical scaling technique was used to quantify a qualitative attribute of the reproductions, namely organization. Different subjects, who will be referred to as judges, were asked to scale a cascade of six pictures (the target and five reproductions) on a physical length of scale).[1]

The amount or degree of organization in a reproduction was determined by the judges' placements of the reproductions on the physical scale. In doing this the judge maps or matches his/her impression of the quantitative value of the stimulus attribute to the appropriate place on the scale.

The method outlines here will be discussed in more detail in the following chapter. The features of the method - specifically the stimulus characteristics, the cascading of subjects and the scaling of

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[1]Levine (1974) proposed that physical length was a natural language for expressing quantitative judgements. For a more detailed background of the scaling technique see J. Bavelas and B. Smith, in press.

reproductions - were introduced in an attempt to avoid the problems of previous methods. The isotropic stimulus array attempts to avoid difficulties associated with a structured stimulus; the cascading of subjects to avoid difficulties with repeated reproductions, and scaling of reproductions to avoid difficulties concerning subjective classification of responses.

CHAPTER 4

EXPERIMENTAL METHOD

Subjects - Sixty undergraduate students at the University of Victoria volunteered to be subjects in the initial experiment. Twenty-four additional subjects, both undergraduate and graduate students at the University of Victoria, volunteered to be judges in the scaling project. The ages of the subjects and judges varied widely and both males and females participated.

Apparatus - The stimulus that the first subject in each cascade saw was a 12" x 12" sheet of paper with a uniform distribution of random dots. As mentioned earlier this was prepared by dividing the paper into a nine by nine grid. Then each of the resulting squares was randomly numbered and starting at square one a black dot was put in each square. Where in the square the dot was situated was determined by a random number pair which corresponded to vertical and horizontal coordinates of the square. It should be noted that the grid was used only in the preparation of the stimulus; the target itself was gridless.

Other apparatus consisted of two copies of each subject's reproduction prepared by the experimenter, one of which had all the dots numbered, two blank 12" x 12" sheets of paper separated by a 12" x 12" sheet of carbon, two pencils, and an eraser for the subject to make his/her reproduction.

For the scaling procedure an eight foot table with ½" unmarked masking tape running the length of the table was used for the physical scale. Index cards with reminders of the dimension were also used. One of the copies of the subject's reproduction (not the numbered one) was reduced in size to 7¼ x 7¼" in order to make more room on the scale to emphasize the intervals between placements.

Procedure - Sixty volunteer subjects were randomly assigned to twelve groups of five, with the following restriction. The first twelve subjects were randomly assigned to the first position in each of the twelve groups, as were the second twelve to the second position, the third twelve to the third position and so on. Each of these twelve groups of five subjects underwent the same experimental procedure.

The subjects were seen individually and were unaware that they were part of a group. When they came in they were told they would be shown a sheet

of paper with some dots on it and that some of the dots were arranged in patterns and some were randomly placed. Subjects were told they would be asked to reproduce the sheet.

The first subject of each group was shown the target sheet of 81 random dots. They could look at it as long as they wanted and when they said they were ready the sheet was taken away and the subject was given two blank sheets, separated by the carbon paper, two pencils and an eraser. They were asked first of all to put down the dots they were sure of; that is, the dots whose position they felt relatively sure of. When subjects had finished, the experimenter took the carbon paper and lower sheet away and asked them how they had remembered where those dots were. They were then asked to fill in the rest of the dots on the remaining sheet; that is, add the dots whose position they were not really sure of but were required so their final product looked as much like the original one as possible. Next, the subjects were given back the carbon sheet with the dots they were sure of and those subjects that had reported patterns when they were asked how they had remembered those dots (all subjects, as it turned out) were asked to connect up the dots to show those patterns. When they had finished this, subjects were shown their

original stimulus sheet and were asked to connect up the dots on that sheet which showed the pattern they had seen in the stimulus and reproduced in their carbon sheets. The subjects had their carbon sheet, with the dots connected in patterns, present when they connected the dots in patterns on the stimulus sheet.

The subject was then shown the copy of the stimulus sheet which had the dots numbered. The subject was then asked to assign numbers to the dots on his carbon sheet in order to identify which dot they were remembering in the stimulus when they produced that dot in the carbon sheet. By doing this the subject identifies the dots in the carbon (i.e. the dots the subject was sure of) as the reproduction of the distinct ones he saw and remembered in the stimulus.

Finally, the subjects were asked what they thought the experiment was about ... this was done to check whether any of the subjects were acting under false assumptions that could have affected their behaviour. From their reports this does not appear to have been the case.

Therefore the data compiled for each subject was as follows:

1) the stimulus sheet they viewed (SnT). On this sheet the subject connected the dots he/she had seen as patterns.

2) a copy of the stimulus sheet with every dot numbered.

3) the carbon sheet which has the dots whose position the subject was sure about (SnC). On this sheet the subject connected the dots he/she remembered and reproduced as patterns and also numbered as many of the dots as possible.

4) the subject's completed reproduction of the stimulus sheet (SnR).

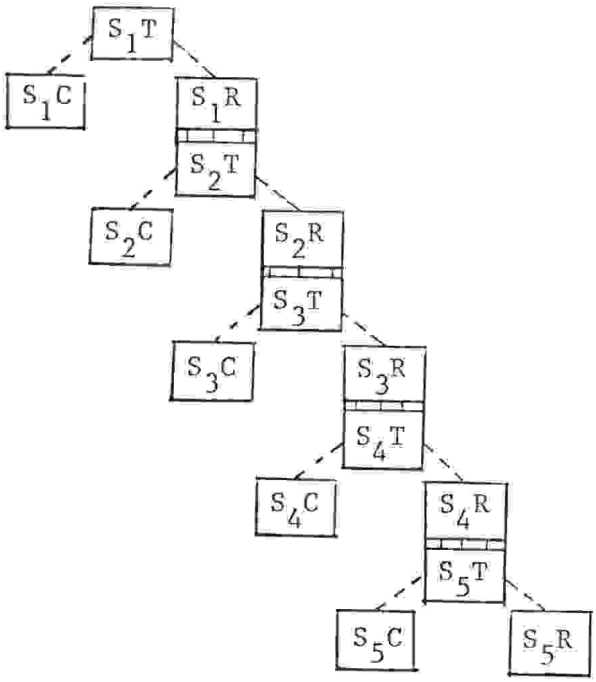
5) the subject's report on how he/she remembered where the dots were.

This is the procedure each subject underwent, the target sheet for each subject was, however, different. The first subject in each group was shown the target sheet of 81 random dots. The second subject in each group was shown a copy of the first subject's reproduction. The third subject viewed the second subject's reproduction and so on. In other words, the first subject in a group always sees the target

sheet with 81 random dots but the other subjects in that group always view the previous subject's reproduction as their target.

Diagrammatically:

GROUP N



The scaling was employed to measure the amount of organization in the pictures the subjects had produced. The people that participated in the scaling project are referred to as judges. As stated earlier, the judges were not the same subjects that were in the experiment.

When volunteers came in to be judges it was stressed that they, themselves, were not being tested, rather it was their opinion or judgement about some pictures that was of interest.

The scale was represented by a strip of ½" unmarked masking tape running the length of an eight foot table. Judges were free to use all or any part of the scale; the endpoints were not fixed.

The scale dimension was defined as one of easiness and difficulty. In other words, stimuli that are very easy to remember, that is they would be very easy to reproduce from memory, go on the left end of the scale. Stimuli that are very difficult to remember and reproduce go on the right end; and stimuli of varying degrees of easiness and difficulty go in between.

Before beginning on a sample set, the definition of easiness and difficulty was elaborated on and the dimension labels were made up to remind the judges which half of the tape was which. The complete definition of the scale (and the resulting labels) is as follows:

- a picture that is easy to remember and reproduce is more organized, less random, more patterned and conveys more information.

- a difficult sheet to remember and reproduce is less organized, more random, less patterned and conveys less information.

Pilot work indicated that the dimension defined in this way is readily understandable to judges.

Judges were told to confine their scaling of the stimuli on easiness and difficulty to the way it was defined for them. Other reasons why a picture may be easy or difficult to remember should not enter into the judgement. For example, the number of elements in a stimulus should not be important in scaling. The judges were also instructed to place the stimuli on the scale so that the intervals between the stimuli reflected the amount or degree of easiness and difficulty the judge perceived.

A set of sample cards was made from Shannon's (1951) analysis of the redundancy of the English language. These cards were used to familiarize the judges with the scale, specifically they were:

- XFOML RXKHRJFFJUJ ZLPWCFWKCYJ FF
- ON IE ANTSOUTINYS ARE T INCTORE ST BE S DEAMY
- IN NO IST LAT WHEY CRATICT FROURE BIRS GROCID PONDENOME OF DEMONSTURES
- REPRESENTING AND SPEEDILY IS AN GOOD APT OR COME CAN DIFFERENT NATURAL HERE HE THE
- THERE IS NO REVERSE ON A MOTORCYCLE

After scaling the set of sample cards each judge scaled three cascades of reproductions, one after the other. The reproductions of each cascade was presented to the subjects in a random order. When the judge had finished placing a set of stimuli along the scale, he/she was asked to review their placements to ensure that the intervals between the stimuli accurately reflected the amount of difference in organization among the stimuli. After this had been checked, the judges' placements of stimuli (especially on the sample cards) was questioned to ensure that they understood the scale and were scaling according to the definition of the scale.

Each cascade of reproductions was scaled by six judges; therefore twenty-four judges were required. The order in which the cascades were scaled was such that each cascade was first out of the three (scaled by one judge) twice; second out of the three, twice; and last of the three twice. This was done to prevent any order effects. In addition the cascades were arranged so that a cascade did not appear with any other particular cascade more than twice.

CHAPTER 5

RESULTS

Each cascade was scaled by six independent judges.[1] The amount of agreement among those judges about each of the reproductions in a cascade was established by use of analysis of variance to estimate reliability. The reliability coefficient by this method expresses the reliability of the mean six judges placements of the stimuli in terms of the variance due to the true scores (mean square within stimuli variance) divided by the sum of the variance due to true score and variance due to error of measurement (mean square between stimuli variance) subtracted from one: 1-(MSwithin/MSbetween) (Winer, 1962).

A high reliability score indicates that of the total variance, the variance within the judges' estimates of the same stimuli is small and the variance between the stimuli is large. That is, the variance is accounted for by the difference between stimuli (i.e. between S_1R and S_2R) rather than by the difference between judges estimates of the same stimuli. Conversely a low reliability coefficient indicates a large proportion

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[1]The target and subjects' reproductions for each cascade are shown in Appendix A.

of the total variance is due to variation among judges estimates of the same stimuli as well as to variation among the stimuli.

Reliability coefficients for each of the twelve cascades are calculated on the raw scores (the distance in centimeters from the edge of the table to the centre of the stimuli); these are listed in Table I.

TABLE 1

The reliability of judges' estimates

Cascade A	r = .97	Cascade G	r = .97
Cascade B	r = .97	Cascade H	r = .89
Cascade C	r = .92	Cascade I	r = .99
Cascade D	r = .98	Cascade J	r = .98
Cascade E	r = .97	Cascade K	r = .89
Cascade F	r = .96	Cascade L	r = .98

Raw scores are reported in Appendix B.

The lowest reliability coefficient is .89, the highest is .99, the mean reliability coefficient is .956, and the median reliability coefficient is .97. These high reliability coefficients indicate that the judges working independently arrived at very similar estimates of the amount of organization in the target and reproductions of each cascade.

Another way of interpreting a high reliability coefficient is as follows: if the scaling was repeated using another random sample of six judges to scale the same stimuli, the correlation between the mean ratings obtained from the two sets of judges would approximate the reliability coefficient. The correlation coefficient would approximate the reliability coefficient because in fact, the reliability coefficient is the predicted correlation between the original group of judges and a second group of judges.

The use of analysis of variance to estimate reliability does not test whether there is an increased organization in successive reproductions. The order in which the stimuli were placed on the scale is not indicated. The reliability coefficient indicates how much the judges agree about where a stimulus (reproduction) should go on the scale to indicate how much of the attribute (organization) it possesses but not whether SnR has more or less of the attribute than S(n-1)R . The high reliability coefficients justify using the mean of the judges estimates to represent the quantity of the attribute the stimulus process. Figures 6 to 18 on the following page, shows the mean quantity of organization of each reproduction in a cascade by means of bar graph.

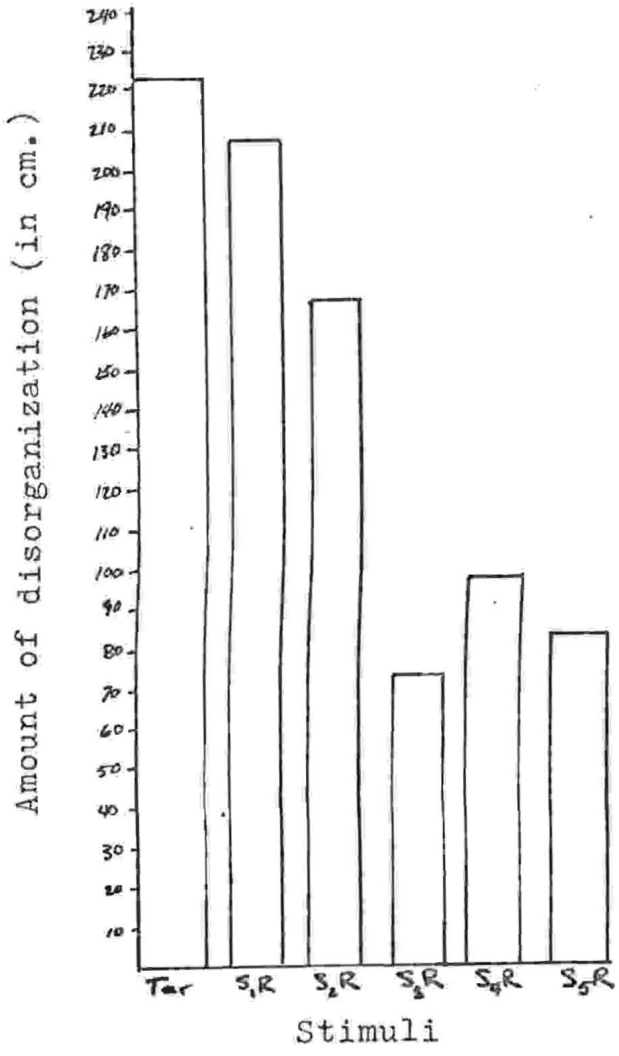

Figure 6- Graph of the mean scores for each stimuli in Cascade A.

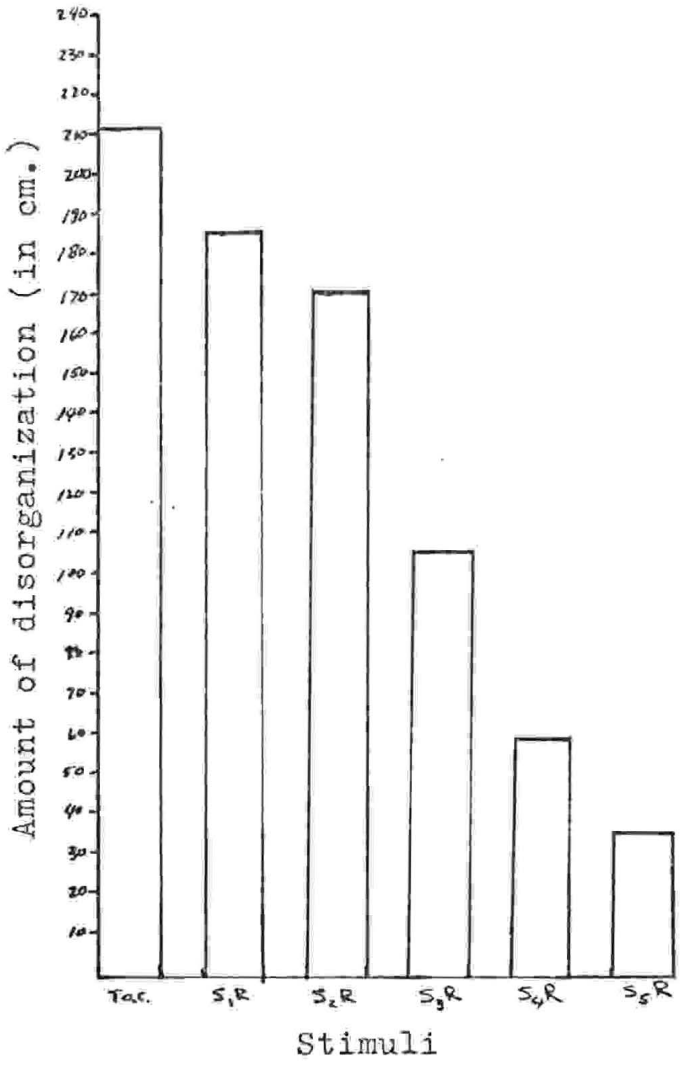

Figure 7- Graph of the mean scores for each stimuli in Cascade B

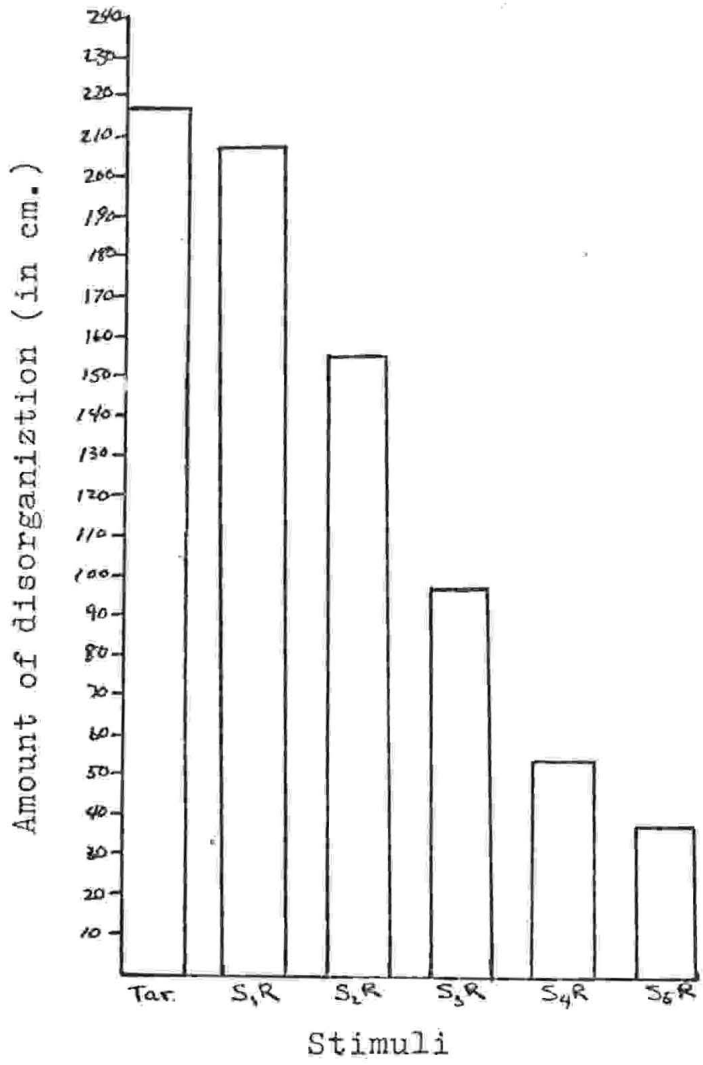

Figure 8 - Graph of the mean scores for each stimuli in Cascade C

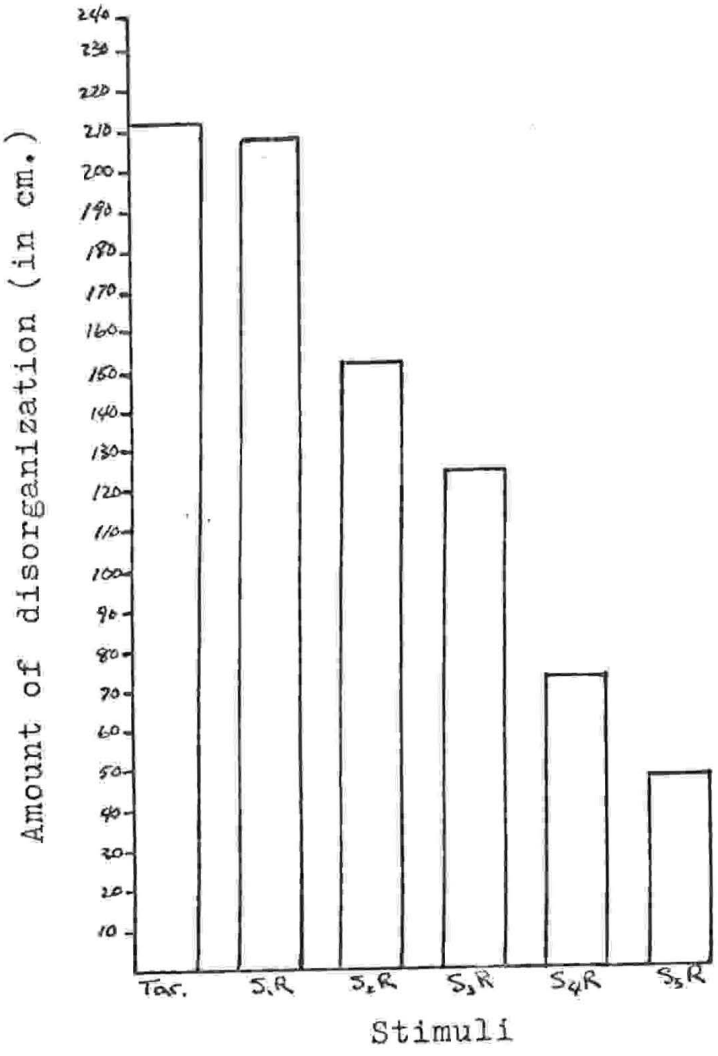

Figure 9 - Graph of the mean scores for each stimuli in Cascade D

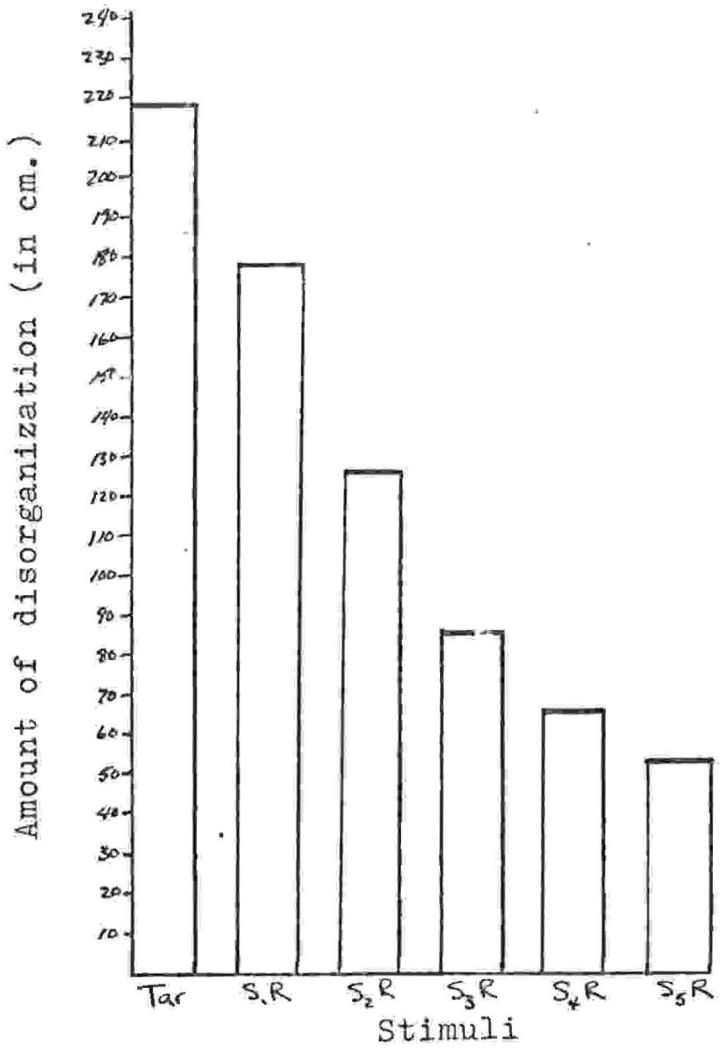

Figure 10 - Graph of the mean scores for each stimuli in Cascade E.

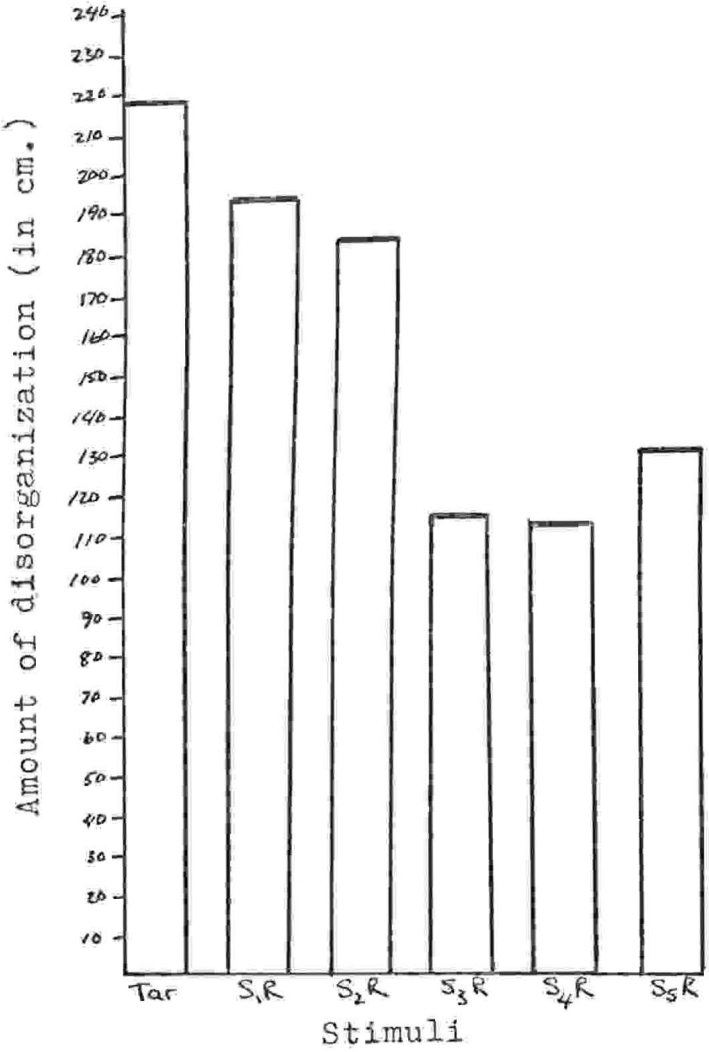

Figure 11 - Graph of the mean scores for each stimuli in Cascade F.

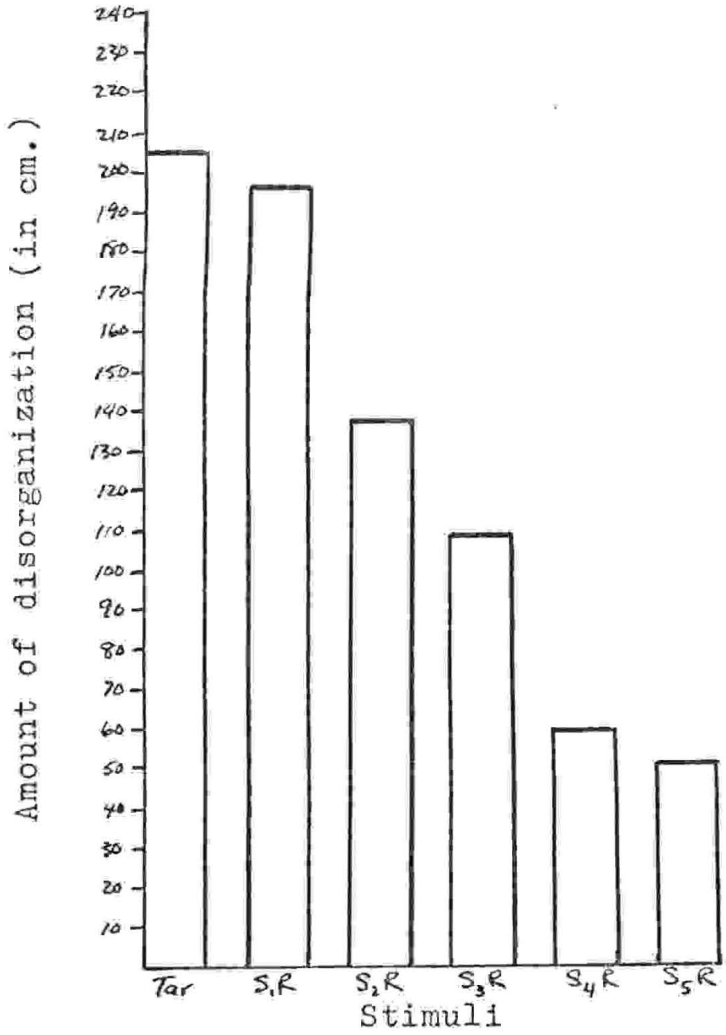

Figure 12 - Graph of the mean scores for each stimuli in Cascade G.

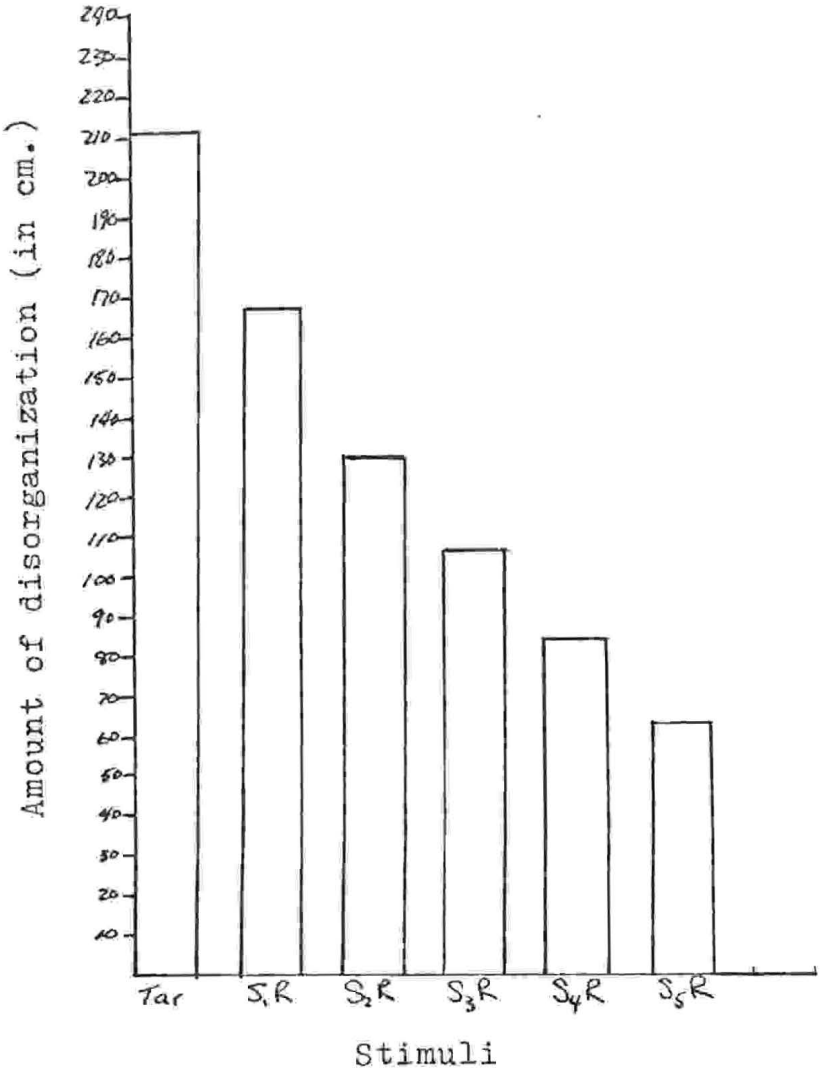

Figure 13 - Graph of the mean scores for each stimuli in Cascade E.

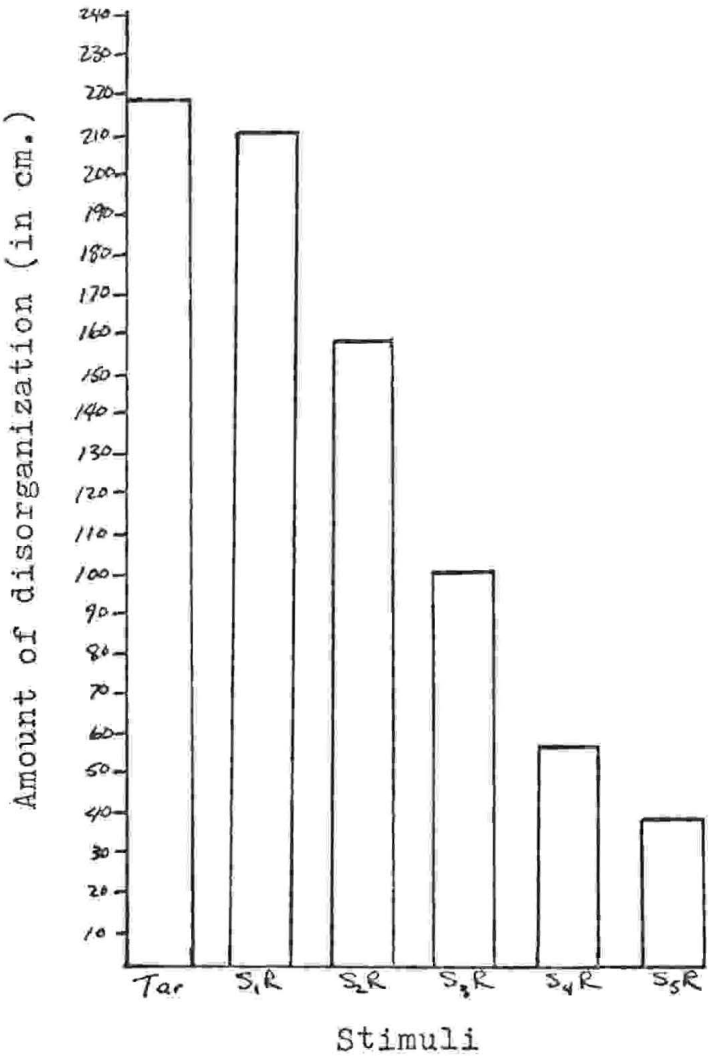

Figure 14 - Graph of the mean scores for each stimuli in Cascade I.

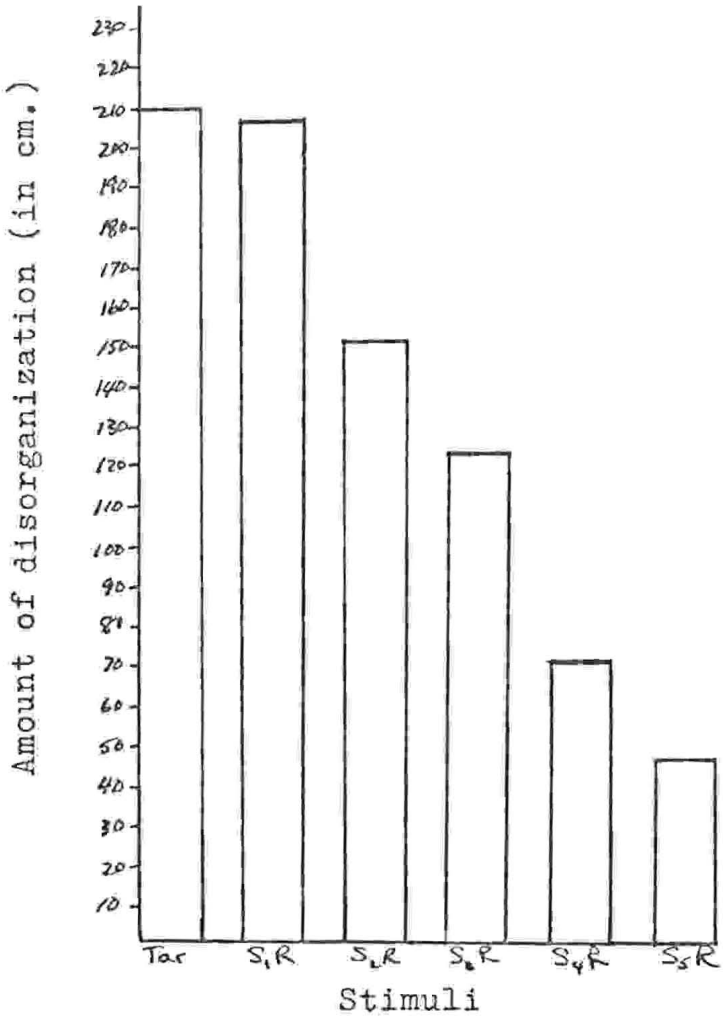

Figure 15 - Graph of the mean scores for each stimuli in Cascade J.

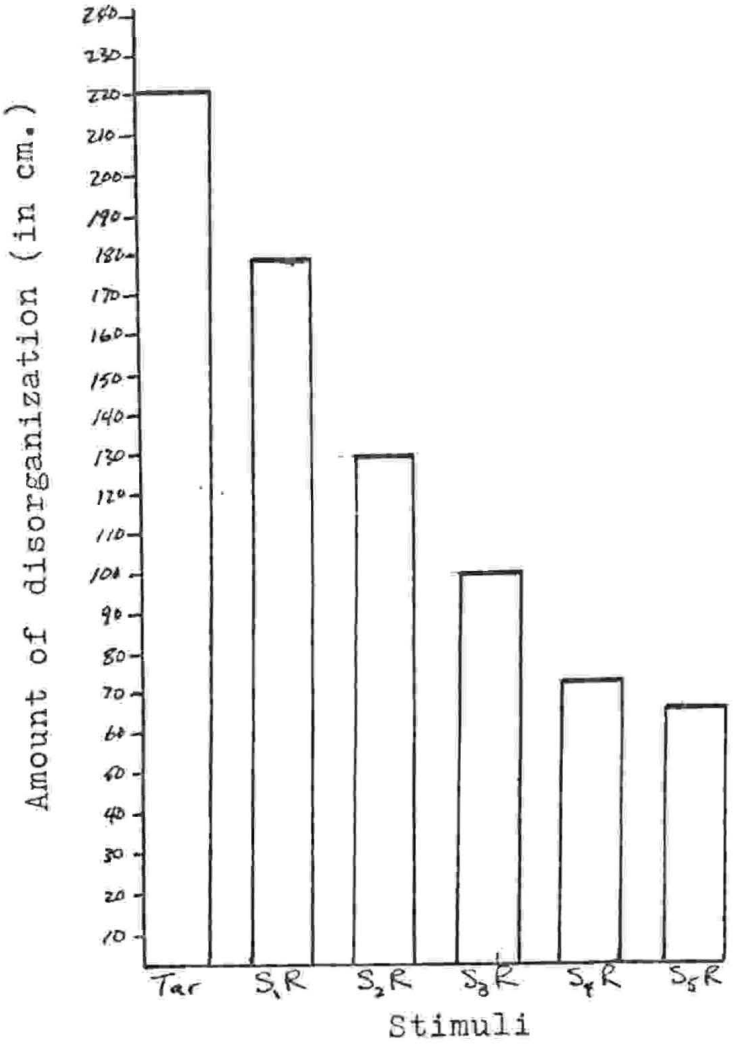

Figure 16 - Graph of the mean scores for each stimuli in Cascade K.

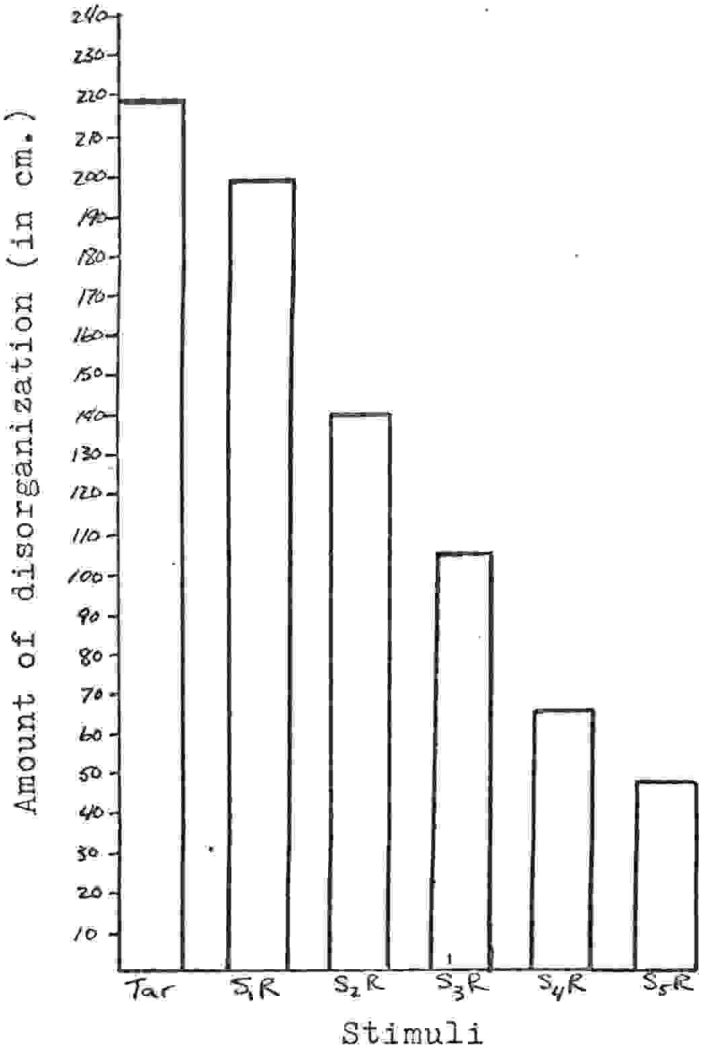

Figure 17 - Graph of the mean scores for each stimuli in Cascade L.

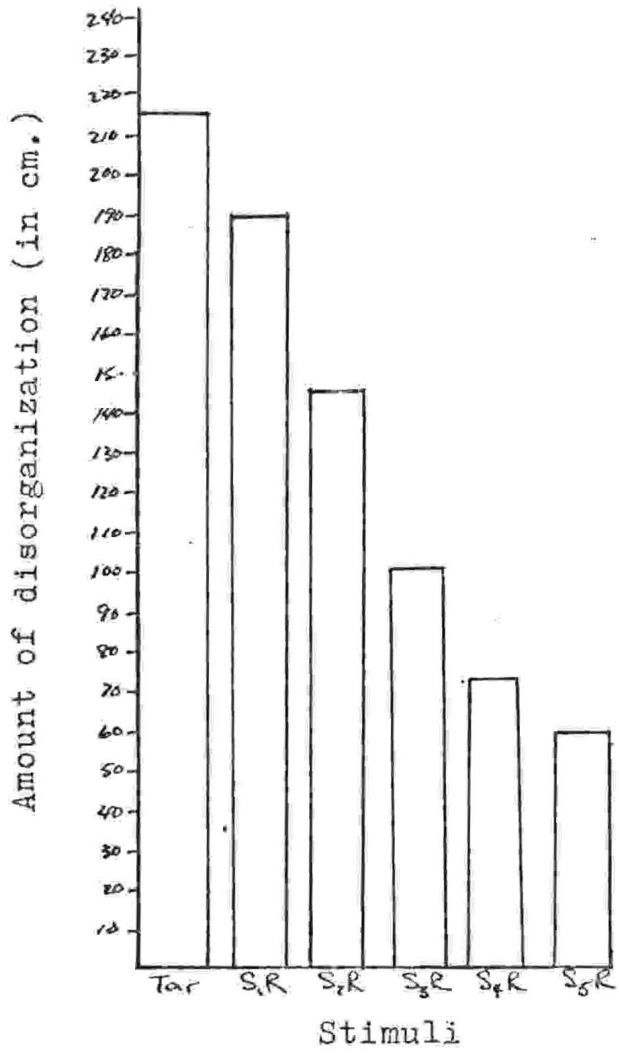

Figure 18 - Graph of the mean scores for each stimuli across all cascades.

The data collected by the scaling technique is interval. The judges were instructed to place the stimuli on the scale so that the interval between them indicated the difference in the amount of organization between the stimuli. The amount of organization is measured by the distance in centimeters from the left edge of the table. The left side of the table represented reproductions that were organized, easy to remember and not very random. Therefore a high score represented a poorly organized reproduction. That is,

The prediction was that the reproductions the subjects make will be more organized than the stimulus they viewed. By the method of cascading, the stimulus they viewed was the previous subject's reproduction. Therefore from the original target to the last subject's reproduction there should be an increase in organization. Because the data is interval and the prediction was for a linear trend of organization a test for linear trend was employed.

Initially the trend test was conducted on each cascade. This was because the stimulus that the subjects viewed in each cascade was different. An overall linear trends test was conducted to see if the linear trend was powerful enough to survive collapsing over the wide variation in cascades. The results are shown in Table II. The trends test uses mean square residual (MSresidual) as in the error term in the F ratio because the design is one of repeated measure. (Winer 1972).

TABLE II

Linear trends tests

Cascade:	$F = \frac{MS_{lin}}{MS_{res}}$	df =	p value ($F_{.99}(1,24)=7.82$)
A	176.52	(1,25)	$p < 2.x10^{-12}$
B	250.03	(1,25)	$p < 1.x10^{-12}$
C	208.51	(1,25)	$p < 1.x10^{-12}$
D	490.14	(1,25)	$p < 1.x10^{-12}$
E	302.34	(1,25)	$p < 1.x10^{-12}$
F	123.06	(1,25)	$p < 4.x10^{-11}$
G	431.87	(1,25)	$p < 1.x10^{-12}$
H	209.23	(1,25)	$p < 1.x10^{-12}$
I	509.21	(1,25)	$p < 1.x10^{-12}$
J	442.16	(1,25)	$p < 1.x10^{-12}$
K	191.26	(1,25)	$p < 1.x10^{-12}$
L	465.65	(1,25)	$p < 1.x10^{-12}$
overall cascades:	1075.84	(1,55)	$p < 1.x10^{-12}$

CHAPTER 6

DISCUSSION

This thesis investigated the hypothesis that organization occurs during perception and memory according to Gestalt principles of organization. The present experimental test of this hypothesis involved showing subjects a random, patternless stimulus and asking them to reproduce it. It was predicted that subjects would organize the stimulus field in order to remember it and that this organizational process in perception and memory would determine the reproduction. Therefore the subjects' reproductions should be more organized than the stimulus. The method of cascading subjects was used to amplify small increments of organization within one subject's reproduction. The amount of organization in a reproduction was determined by a scaling procedure in which a different set of subjects matched their impression of the amount of organization in a given reproduction to a position on a physical scale of length.

The overall prediction of increased organization was confirmed. At each step of the cascade judges agreed that the reproduction made by the n^{th} subject

was more organized than the reproduction of subject n-1. Therefore the conclusion can be made that organizational processes operating in perception and memory impose order on the sensory input and determine recall and reproduction.[1]

The experimental methods employed have several advantages over those used in other experiments in this area. These advantages have been discussed earlier but will be briefly reviewed here in relation to evidence that supports their usefulness.

The original stimulus for each cascade was a sheet of paper with an isotropic distribution of random dots. The progression of organization in a cascade confirmed the Gestalt position that organization occurs in the perceptual and memorial representation of the stimulus and therefore is not inherent in the physical stimulus. Because the stimulus was highly random and patternless the organization that resulted was due to an active impositon of order by the subjects.

The assumption that the stimulus was highly patternless was supported by the diversity of patterns in the resulting reproductions of the fifth subjects. It is assumed that if there has been any inherent patterns in the original stimulus subjects would have detected and reproduced them. This would have led to relatively

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[1]An additional prediction, that subjects would tend to reduce the size of the figure is discussed in Appendix C.

similar reproductions. Therefore since the reproductions are very different one may assume that the original stimulus (S_1T) did not have any perceptually dominant patterns.

The method of cascading subjects avoided such errors within subjects as changes due to practice effects and due to subjects attempting to be consistent with their previous reproduction rather than reproducing the original stimulus. Furthermore cascading subjects is affected less by idiosyncratic differences than the method of repeated reproductions.

In cascading these confoundings are not possible because each subject makes only one reproduction. The results obtained by this method were not thought possible by earlier investigators. They assumed that each subject would change the stimulus in different directions and therefore a progression of organization would not occur.

In addition, a practical advantage of the method of cascading allows the observations of progressive changes across repeated reproductions without the inconvenience of a repeated measures design.

The scaling project was done to objectify the concept of organization. It is a qualitative characteristic which people can agree upon but is poorly dealt with quantitatively. For example, if you work with

density plots and define disorganization as one dot in each of 81 squares, as is the case in the target of random dots, deviation from this would indicate clustering i.e. 7 dots in 13 squares, 6 in 20 squares, 5 in 6 squares, 3 in 7 squares, 2 in 20 squares and 0 in 15 squares. It does not, however, indicate the patterning which is so easy for the eye to see. In other words the same density distribution can apply to two very different arrangements of patterns with very different amounts of organization.

Since organization is a quality perceived by human beings so readily in everyday life it seemed the appropriate and natural solution to use people as instruments to detect the amount of organization in the stimuli.

The evidence that this is an objective replicable method is in the reliability coefficients. Interpreted literally a high reliability coefficient means that the people working independently judging the stimuli agree among themselves about the quantity of organization each reproduction has and also that if six new judges scaled the same stimuli their judgements would correlate highly with the judgement of the first set of judges (the correlation would approximate the reliability coefficient because in fact the reliability coefficient is the predicted correlation between these groups of judges).

In this experiment as in previous experiments, the organization that occurs in perception was indistinguishable from the organization that occurs in memory. Even if a subject were to make the reproduction with the stimulus present memory, in the strictest sense, is involved when the subject goes from the stimulus to the reproduction.

The two processes may indeed by inseparable because the processes are not unique, the difference may only be semantic. In this thesis the distinction of perceptual organization and memorial organization has been honoured for traditional reasons. If a single overall process was discussed the problem of differentiating would be eliminated without any information loss. The distinction does not seem to be useful nor has it been substantiated. Bartlett (1932) and Perkins (1932) noted that the biggest and greatest number of changes occur in the subjects' first reproduction. Changes that were found using the repeated reproductions method are problematic because of serious methodological difficulties with the procedure. In pilot work an index card with a dot was shown to subjects and they were asked to reproduce it. In the subjects' first reproductions the dot was systematically displaced towards the nearest edge but when subjects were asked for reproductions immediately afterwards the subsequent dots varied randomly around the position of

the dot on the first reproduction. Note that the random variation did not occur around the position of the original dot but rather the random variation occurred around the position of the dot that was systematically displaced in the first reproduction.

The suggestion being made is that perceptual and memorial organization are not two separate processes but one.

An additional semantic clarification might be made concerning the use of the word 'decay' to represent the effect of time on memory traces. It may be misleading in that the trace may not disintegrate and disappear since it may be retrieved in recognition and under hypnosis. A process of reshuffling or burying of the memory may be a more accurate metaphor.

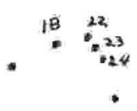
The work of this thesis raises several other interesting research questions of both a methodological and theoretical nature. Concerning the methodology, an alternative method of quantifying the amount of organization in a reproduction will be discussed. Concerning the theoretical questions, the procedure of this experiment may be useful for investigating what patterns are preserved, when and how the progressiveness of a cascade levels off, and how subjects operate under different instructions: that is if subjects did not have their attention drawn to the fact they would

have to remember and reproduce the stimulus they viewed, and also what effect varying subjects' expectation of patterning and randomness in the stimulus has on resulting organization in the reproduction. These interests will also be briefly discussed.

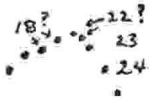
Alternative method of quantifying organization - The scaling technique was used in this experiment because it was the most direct measurement of subjects' perception of organization. Another method of quantifying the organization in subjects' reproductions that could have been used was as follows: have ten subjects view and reproduce each reproduction of a series. The measure of organization would be the measure of variability among the ten subjects' reproductions at each level. A high variability score among the subjects' reproductions would indicate the stimulus they viewed (i.e. one of the original reproductions to be measured) contained a lot of randomness, little patterning and little information (in Garner's 1962 terms little redundancy or consistency). Conversely if ten subjects viewing a reproduction had little variability in their reproductions, the stimulus reproduction must be well defined, contain more information and patterning. This method then uses how variable the reproductions are to measure the amount of organization in a reproduction.

This method assumes that the more organization there is in a reproduction, the easier it will be to reproduce and the more consistently it will be reproduced.

Numbering the dots to preserve patterns - The additional task of numbering the dots was done, not to test the hypothesis of this thesis, but to see if the procedure was feasible for future research questions. As described earlier, the subjects after completing their reproductions and connecting the dots in patterns on the carbon and stimulus, were shown a copy of the stimulus sheet and asked to identify whatever dots they could on their carbon sheet that corresponded to dots on the stimulus. In other words, just as with the patterns they had connected, they were asked to find the dots in the stimulus that they were thinking of when they reproduced them in their carbon sheet. The numbers of those dots which the subjects could identify in the stimulus were assigned to the dots in the carbon. By using this method, particular dots can be traced through the levels of the cascade. Without subjects identifying dots this would not be possible because, while subjects identify the patterns in the stimulus and carbon sheet, the individual dots in the patterns cannot be identified. For example,



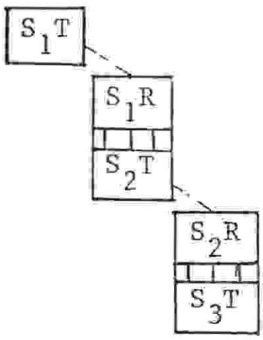
stimulus



reproduction

Even though the dots in S_nR are exactly the same as the dots in $S_{n+1}T$, there is no connection between the dots in S_nR and $S_{n+1}R$.

Diagrammatically,



the connection between S_1T and S_1R is in patterns that the subject identifies and connects. The connection between S_1R and S_2T is that they contain the same dots, but because the dots cannot be identified when the subject matches patterns between the target and reproduction, the chain is not complete. Therefore if there is a second copy of the stimulus which has all the dots numbered, the subject can identify not only the patterns but also the constituent dots.

Of course not all dots on the reproduction may be identified. In many cases extra dots are added in the reproduced case. For example,

stimulus

reproduction

and these extra dots cannot be identified. Also, the dots that the subjects add in the final reproduction - that is, the ones they are uncertain about - are not identified. These 'uncertain' dots are then given a letter and number code by the experimenter. This means that the numbered duplicate of the dots in S_1T were numbered one to 81, the numbered duplicate of S_2T had some numbers between one and 81 (corresponding to the dots the subjects had been certain of) and also new numbers which began at A1 (coded by the experimenter and corresponding to the 'uncertain' dots). The second subject's reproduction which becomes the third subject's target had some numbers between one and 81, and some beginning with the letter 'A'. The new dots added at this stage were numbered with the letter 'B' (e.g. B1, B2, etc.). This continues through the cascade, each group of new numbered dots begins with a different letter to indicate the level of the cascade where they were introduced. Therefore if there are any dots with the numbers between one and 81 in the S_5R it indicates that these dots have been preserved by all five subjects. If there are any dots

beginning with 'A' it means that these dots could not be associated with dots in the preceding target and were thus, introduced at the second level of the cascade, and so on.

By numbering dots in this way it is possible to see which are preserved in a cascade, and also what patterns, of which these dots are a part, are preserved. According to Kohler (1938) the more organized patterns are, the more stable and resistent to change they are and therefore the longer they will be preserved. This method of numbering dots is one method for investigating preservation and stability.[1]

Leveling off of progressive organization - The organization or grouping of dots in a cascade occurs at various rates. By arbitrarily running each cascade to a length of five subjects there should be more cascades which have developed into well organized patterns, that change little in further reproductions, while there will be other series that may still be relatively disorganized after only five subjects. Because the organization does

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[1]For another method of quantifying stability see B. A. Schaefer, 1979.

occur at different rates those series that have not become well organized in five subjects may well become so after a few more subjects because even in those series judges scale them as increasing steadily in organization. However, the intervals between the reproductions on the scale are smaller.

It was found that when cascades became well organized there was little change in successive reproductions and the progressiveness of organization leveled off. In cascade G for example, judges scaled the fourth and fifth subjects' reproductions interchangeably because the major perceptible difference was only the change in pattern size.

The leveling of progressive changes means that further change twards organization is not very great. It implies a stability in the patterning; the next subject readily reproduces the target with only minor changes.

It is interesting to speculate why some cascades are slow in progressing and why others are well organized by the third subject. The amount and type of organization is known to effect what patterns result. For example, if the stimulus the third subject views already strongly resembles a rectangle the next subject is constrained by this structure and organizes it further

in reproduction, making it even more rectangular. The influence of the amount and type of organization that the earlier subject perceives, reproduces and passes on does not appear to be as straightforward as it may initially seem. If the first subjects do not organize the random target very much there should be no reason why the third and fourth subjects cannot produce a larger amount of organization comparable to changes imposed by the first subjects in other cascades. But they may not; a cascade that starts organizing slowly may continue slowly.

If this line of investigation were pursued the procedure of subjects identifying dots in their reproduction by numbers would be useful for determining objectively when a cascade has leveled off.

Intentional memorizing - Throughout this thesis the organization that occurs has always been with reference to the fact that the subjects were told they would be asked to reproduce the stimulus. This instruction itself may account for some of the organization that occurs. In other words, the subjects' attention may be drawn to organizing the dots because they will have to reproduce them. Kohler (1947) suggests that "intentional memorizing amounts to intentional organization". In this thesis it is interesting that organization occurs so markedly when subjects are asked to view a stimulus with the instruction of

reproducing it. It would also be interesting to investigate the organization that occurs when subjects (while viewing the stimulus) are unaware that they will be asked to reproduce it. For example, subjects could be instructed to view the stimulus in order to estimate the number of dots it contained.

Then if the subjects were asked to reproduce they had seen, after the stimulus was removed, the reproductions might be quite different from the ones obtained in this experiment. It is predicted that subjects would organize the stimuli but the rate and type of organization may be different.

The effect of expectations of organization - The method of reproducing a meaningless stimuli may be useful in studying other kinds of problems than those in perception and memory. For example, one area in which this method may be suitably applied is in investigating the behavioral consequences of various levels of expectation of organization. More specifically, by varying the instructions to the subjects, the subjects' expectations of organization in the stimuli can be made the independent variable. There may be qualitative differences in the patterning in reproductions which result from an initial expectation of how many dots

are in patterns and how many are random. There is reason to suspect that from an initial expectation of 65% patterned dots and 35% random dots the reproduction that results will have one or two general patterns; whereas several specific patterns may result from an initial expectation of 95% patterned dots and 5% random dots.

Examining the effects of varying the expectation levels in this way may be a way of looking at some of the factors which influence hypothesis generating. For example, how does the amount of randomness expected (or tolerated) affect how specific or general an explanation of the findings can be? Perhaps if only 5% randomness or error is tolerated it necessarily implies many specific theories (or patterns) to account for the data (or dots) when if 30% or 40% was admissable a single general theory would suffice; or in terms of this experimental design, a single general pattern would be perceived.

The cascade in this sense could be extended to represent successive generations of scientists, each beginning on a problem from where the last scientist left off.

While these research questions are speculative and undeveloped, they suggest possible directions which can be pursued from this work.

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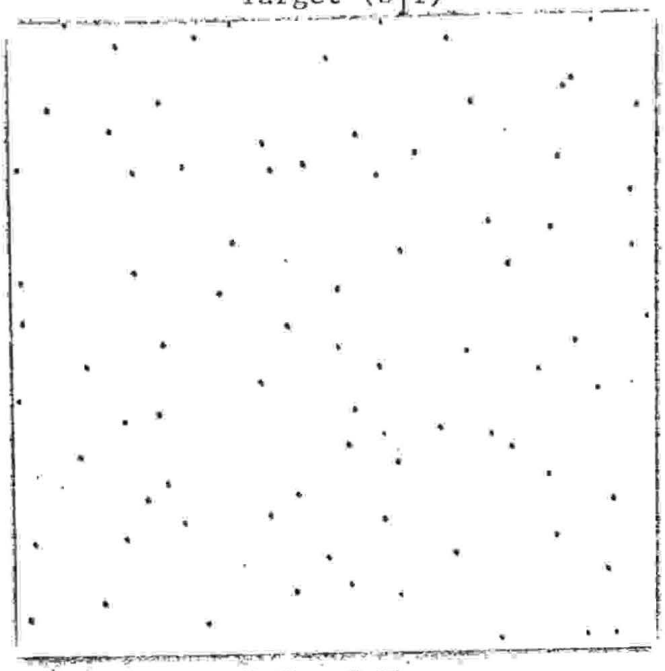
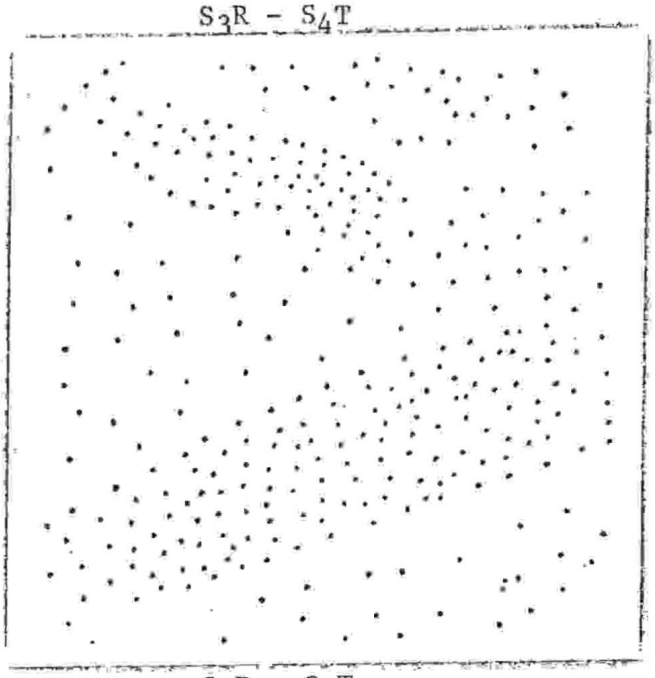
Cascade A

Target (S_1T)



$S_3R - S_4T$



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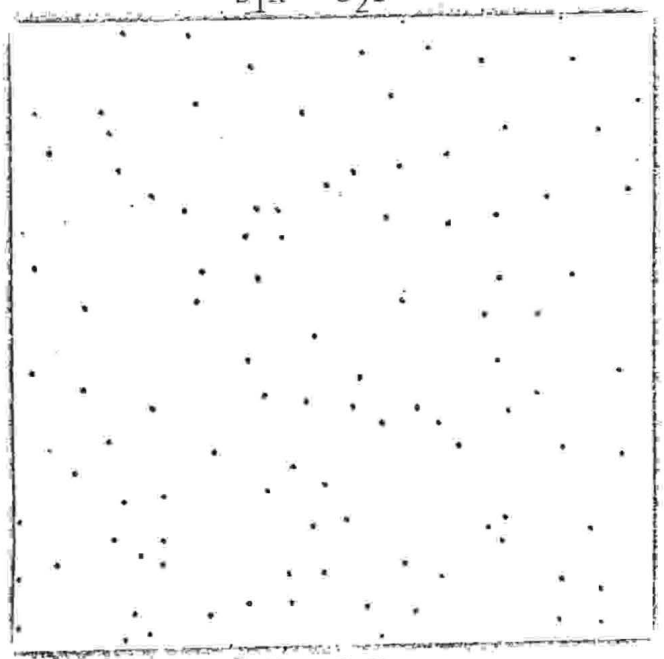

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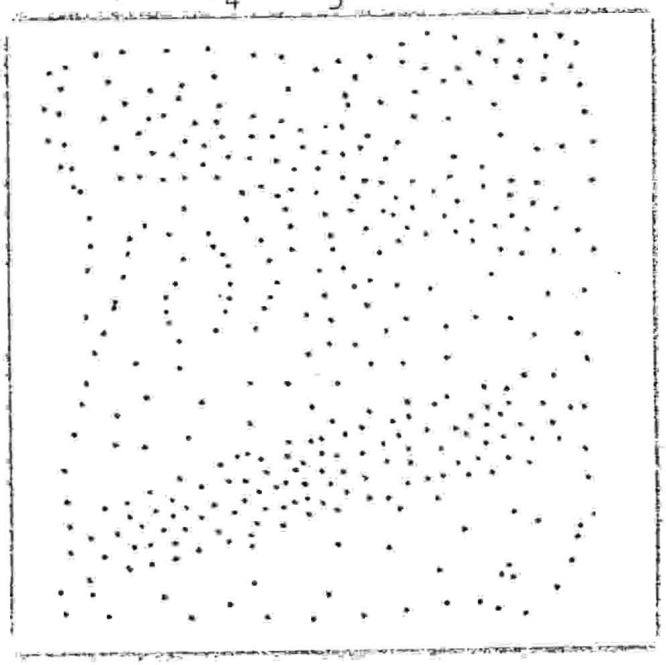

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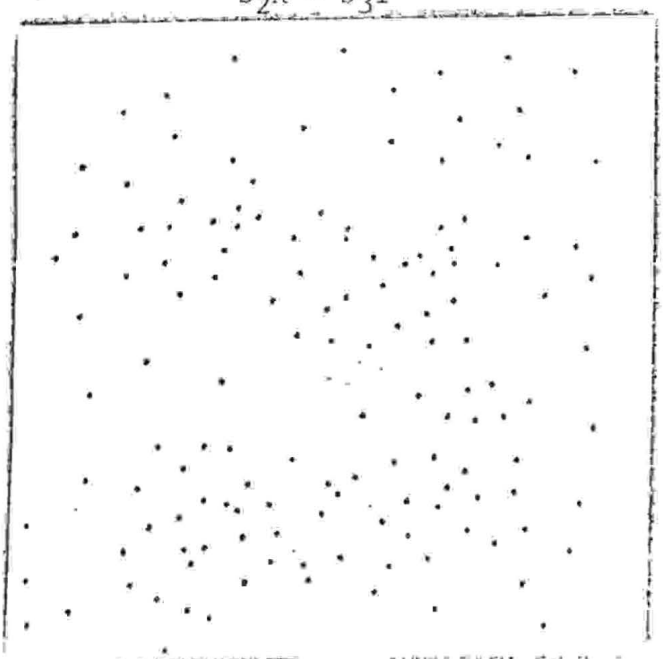

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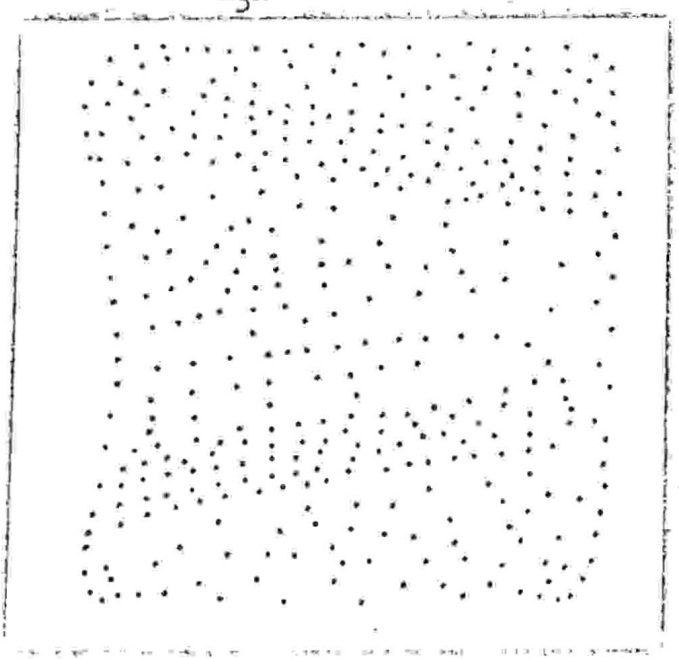

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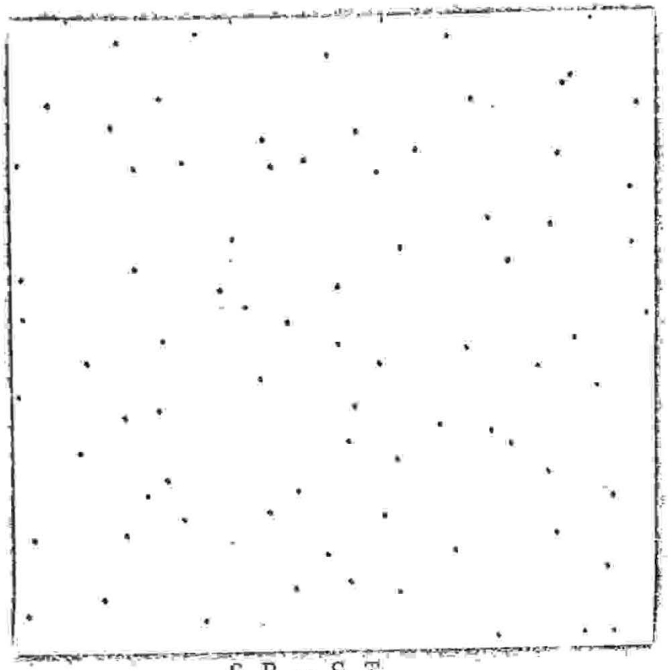

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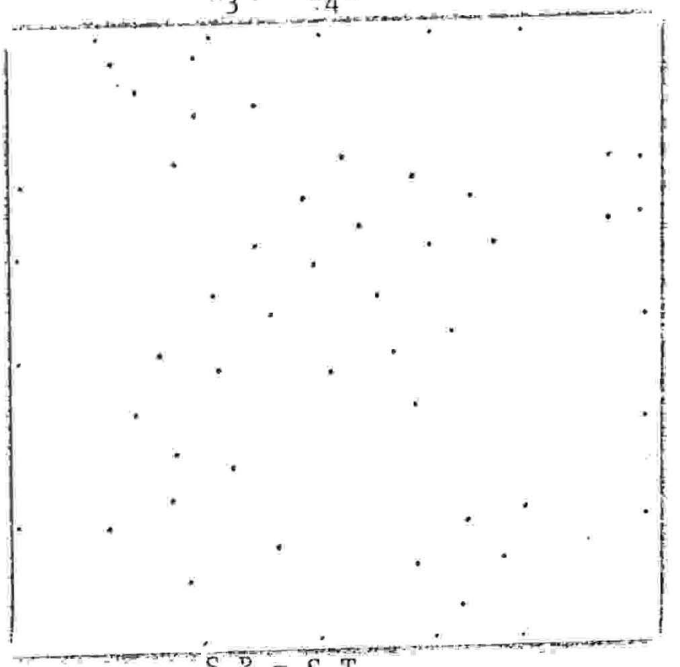

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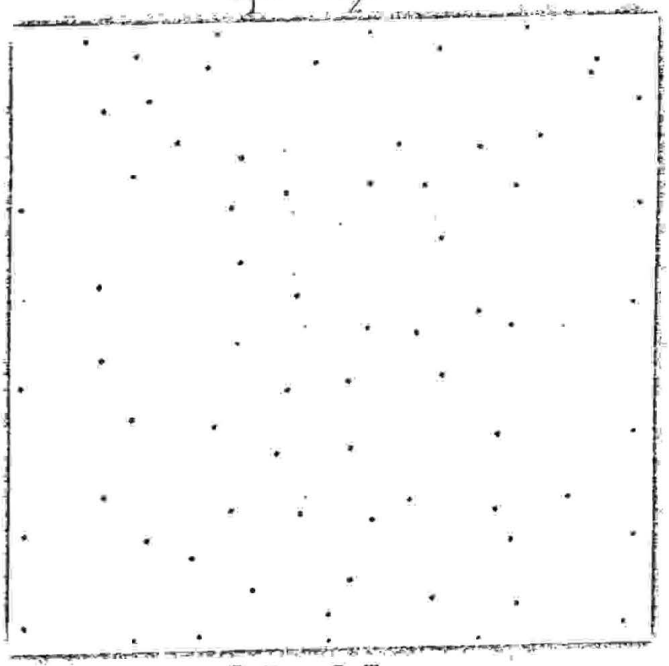

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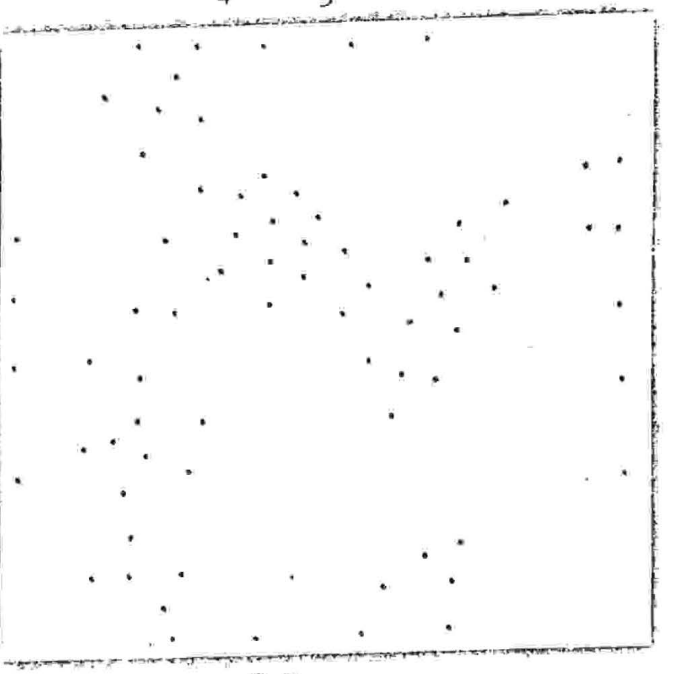

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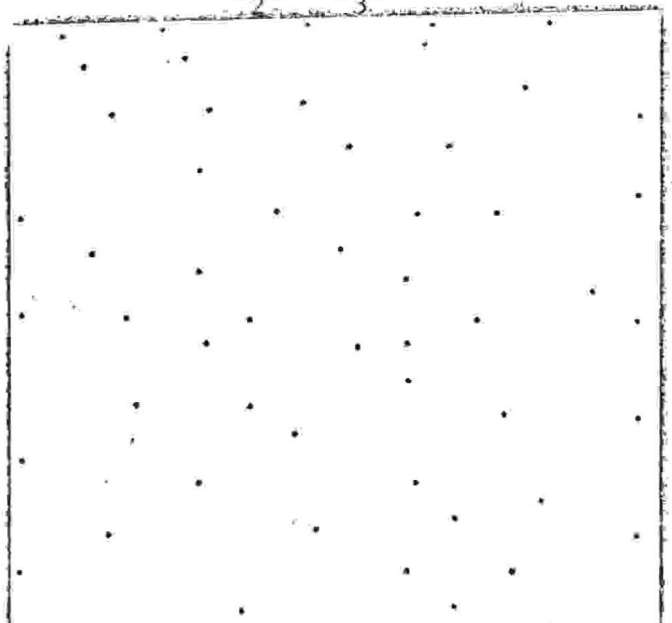

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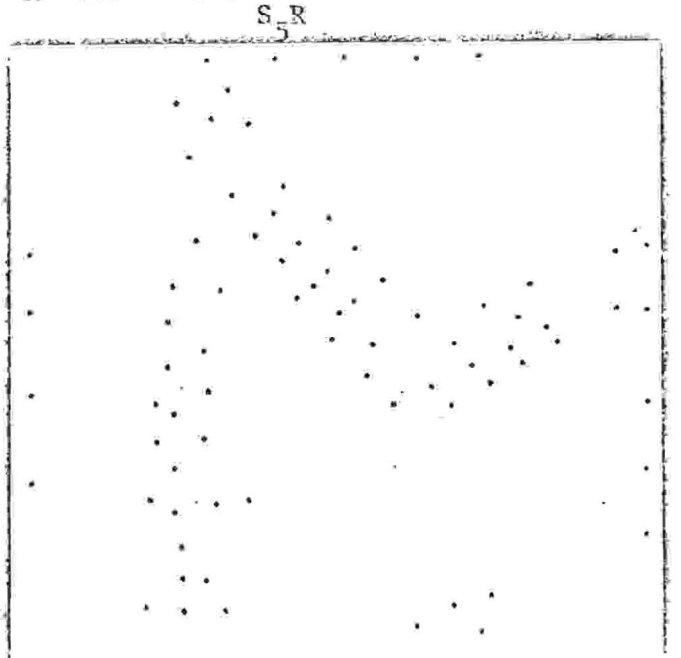

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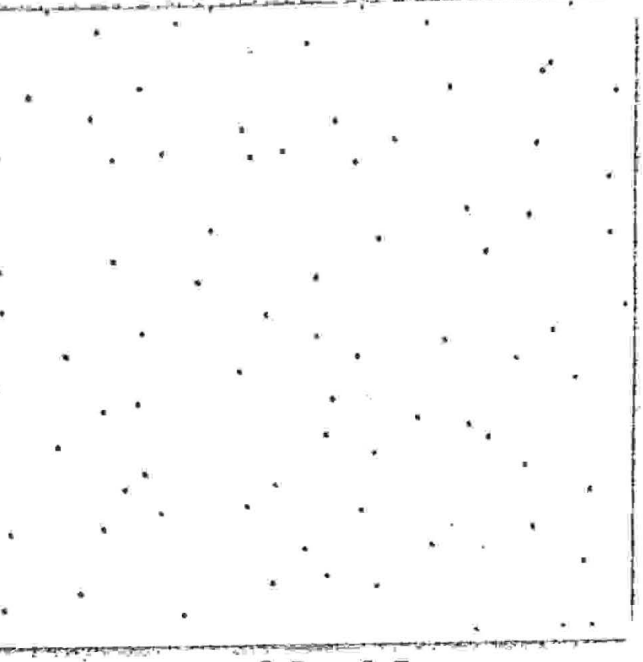

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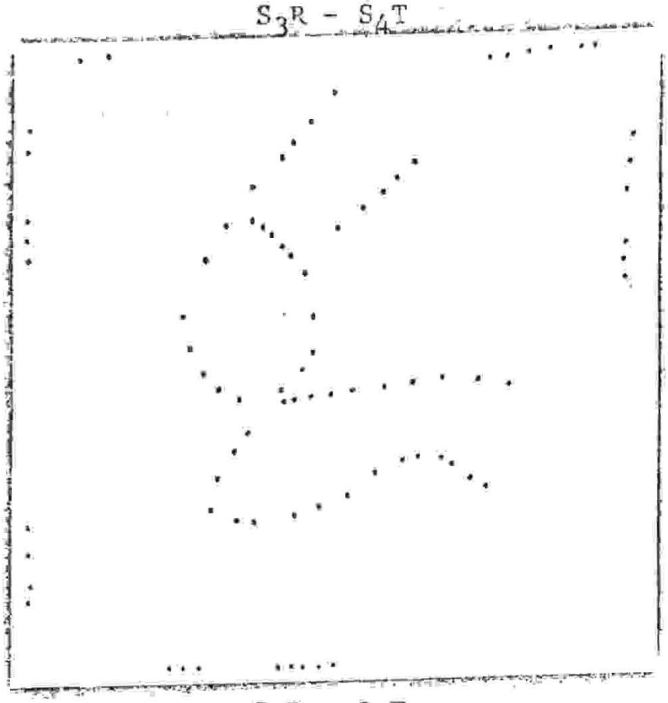

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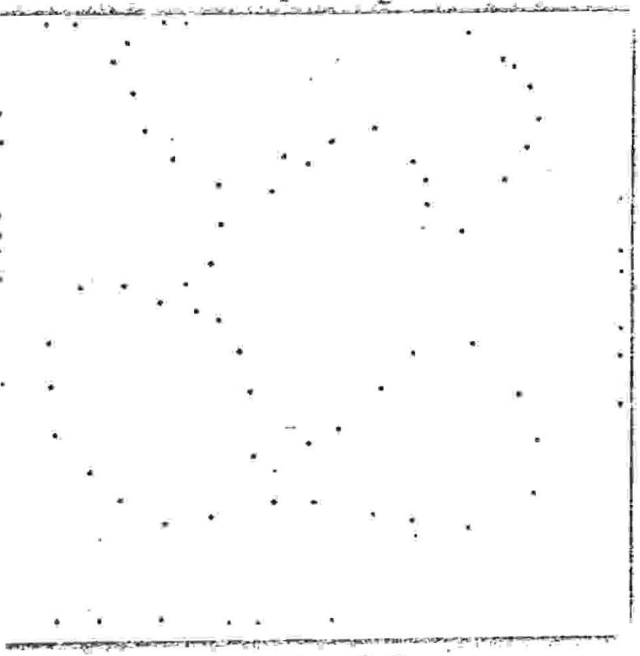

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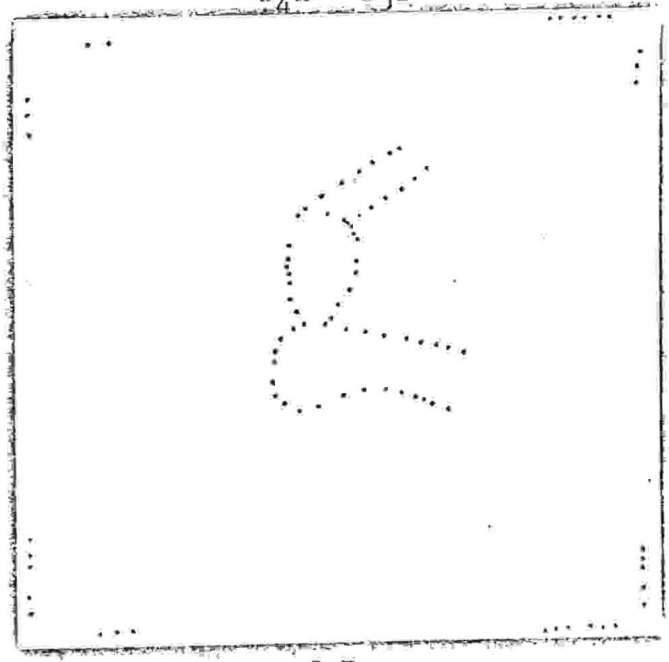

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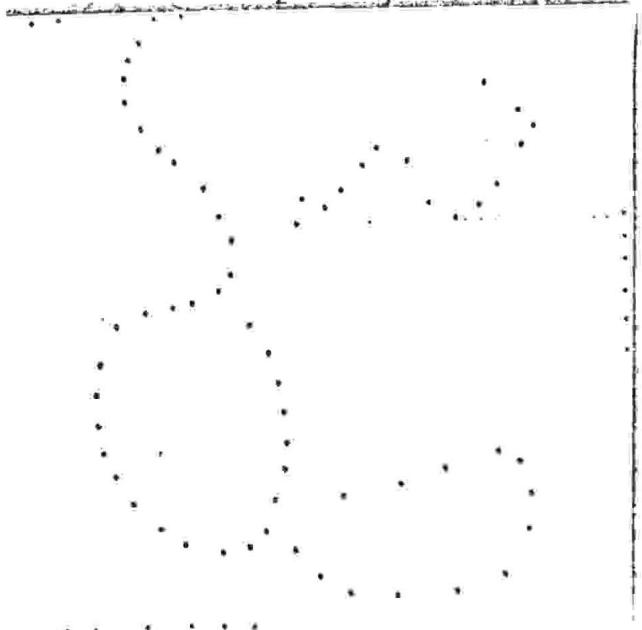

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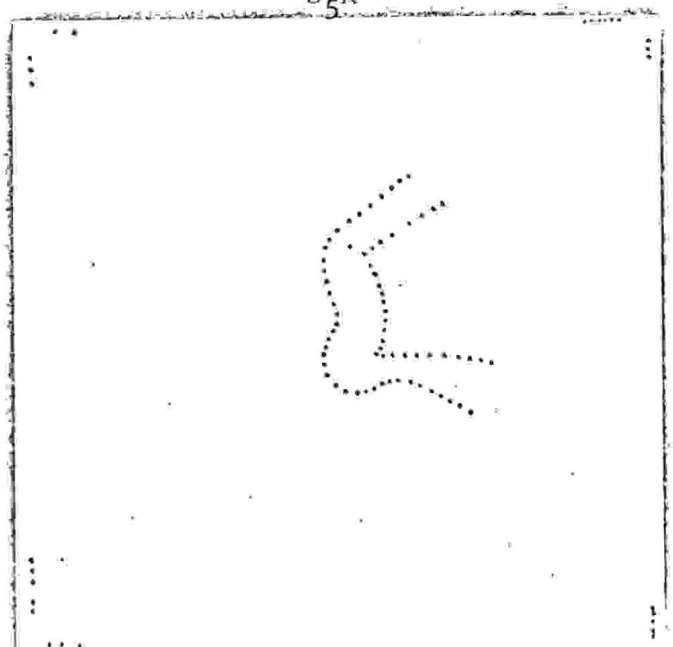
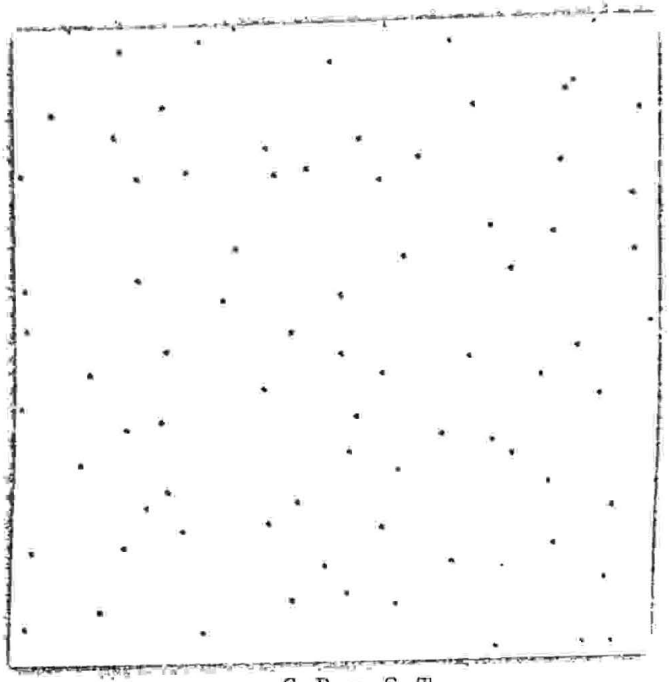


Cascade D

target



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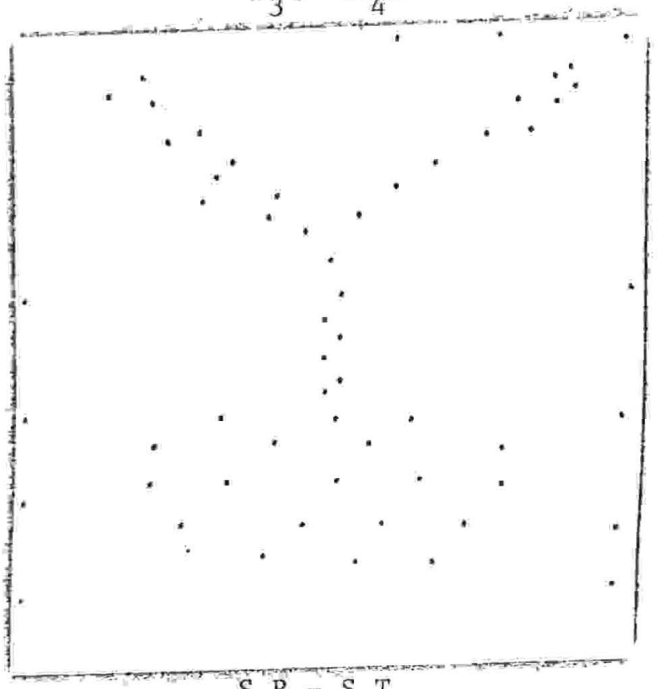

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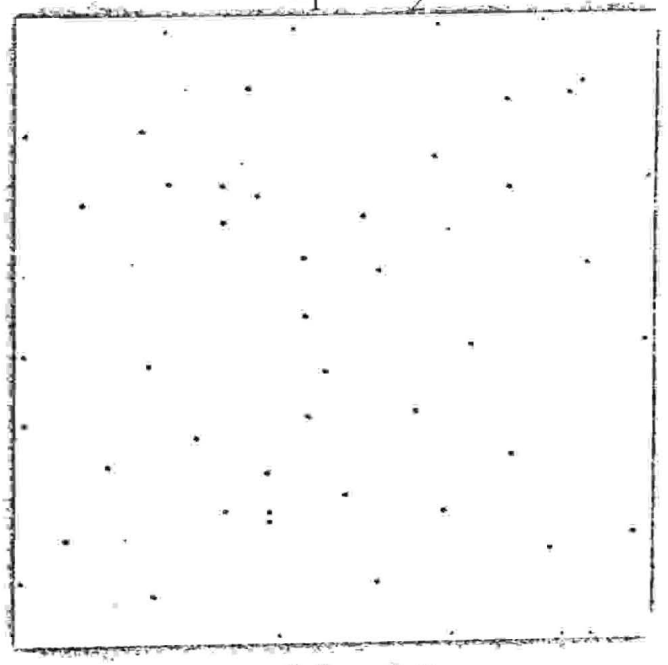

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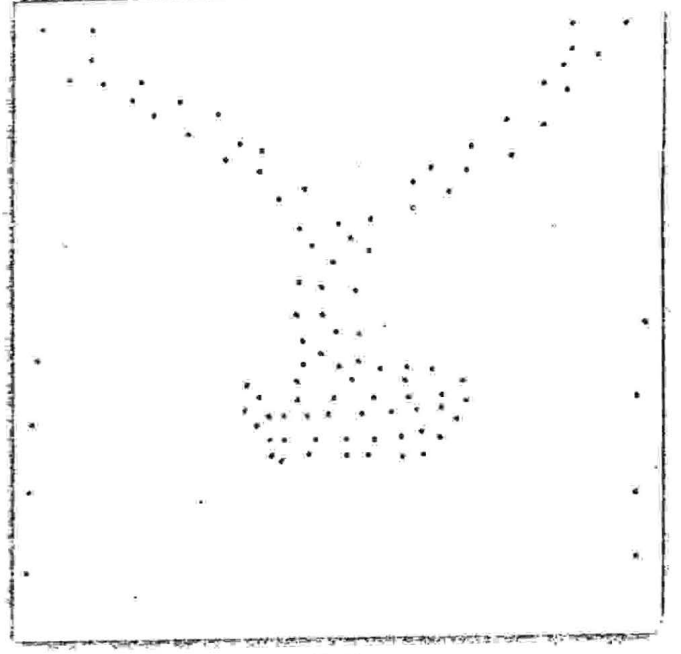

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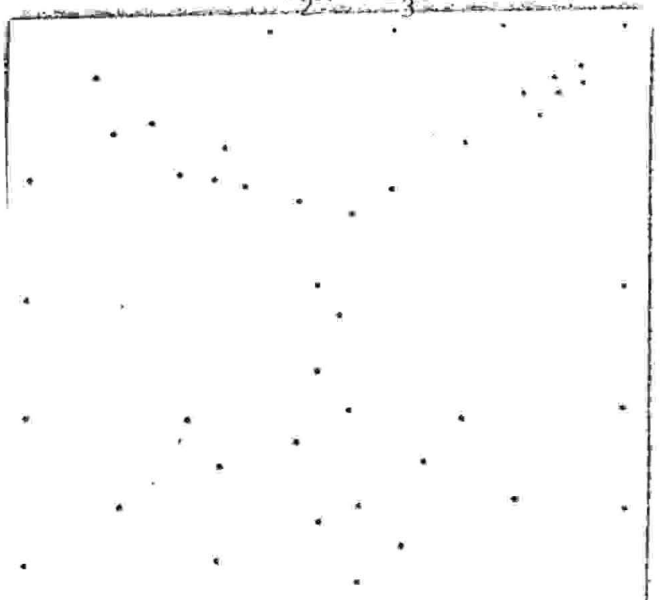

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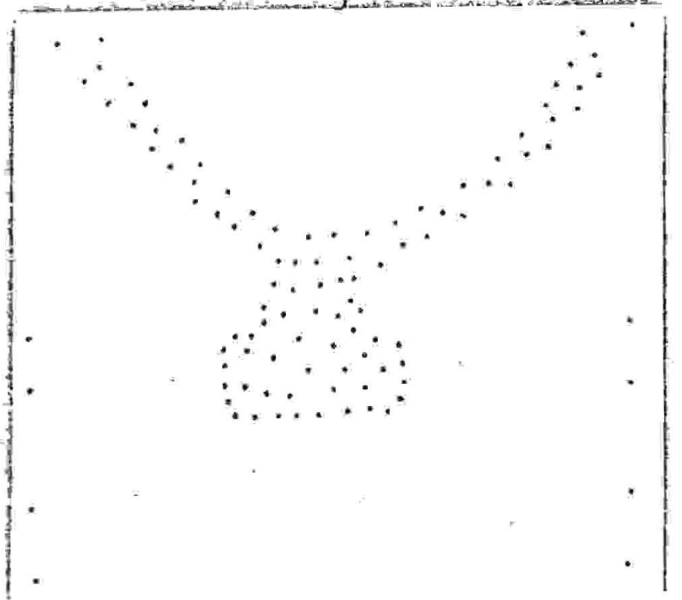

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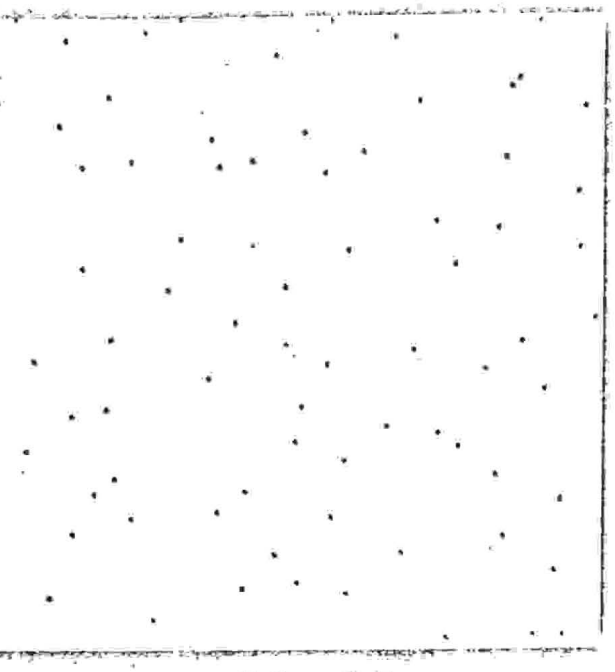

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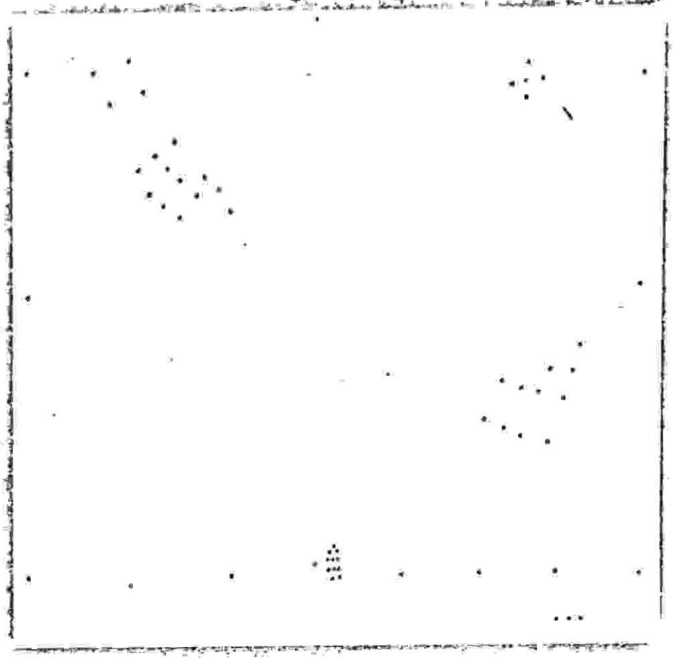

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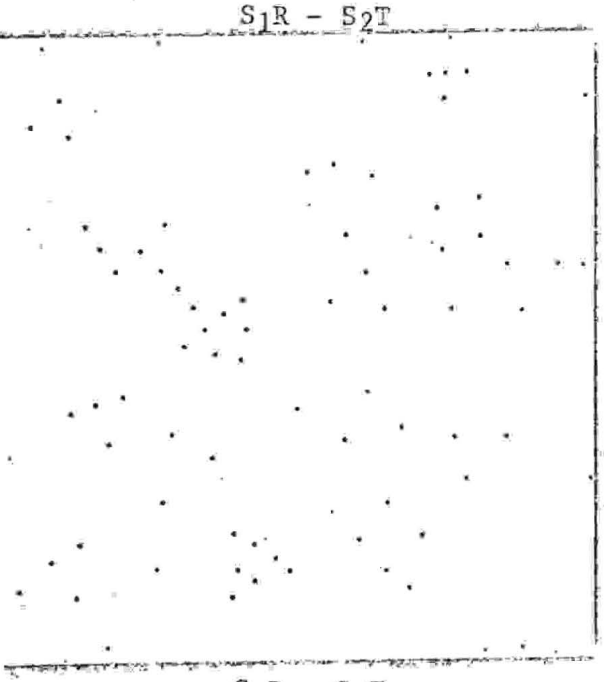

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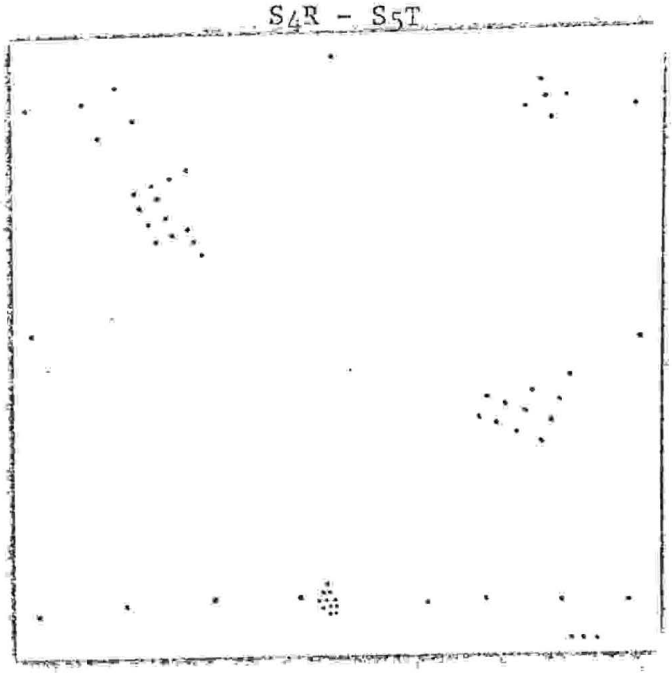

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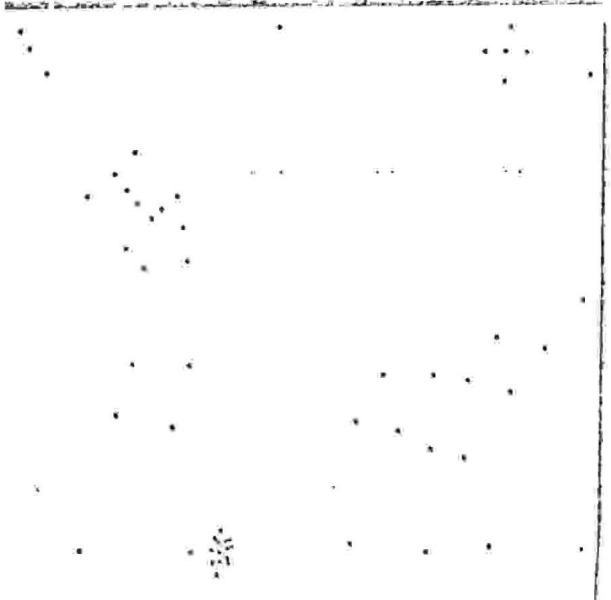
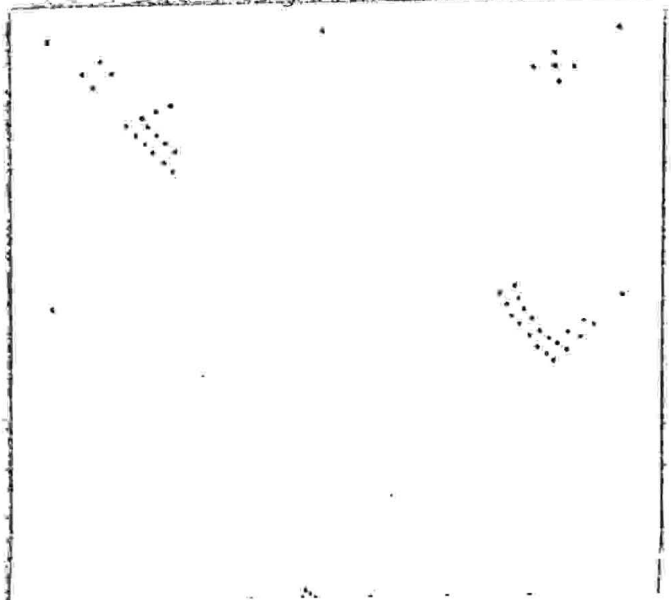


S_5R



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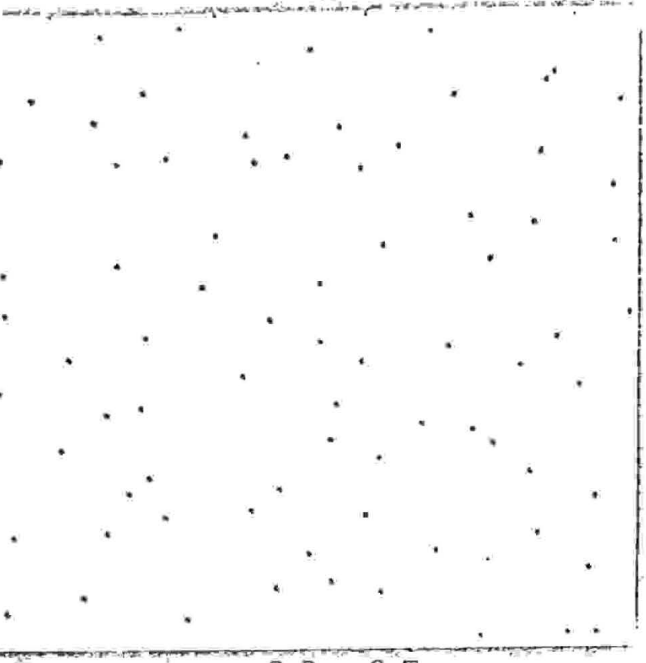

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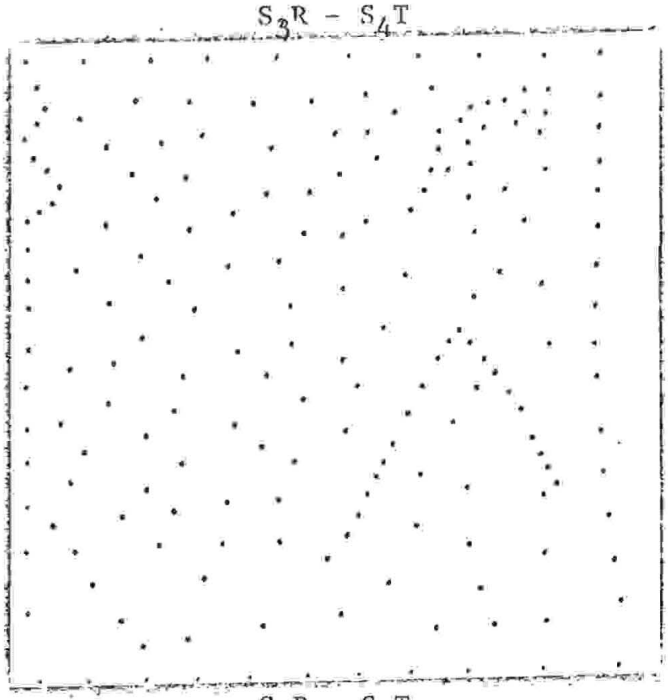

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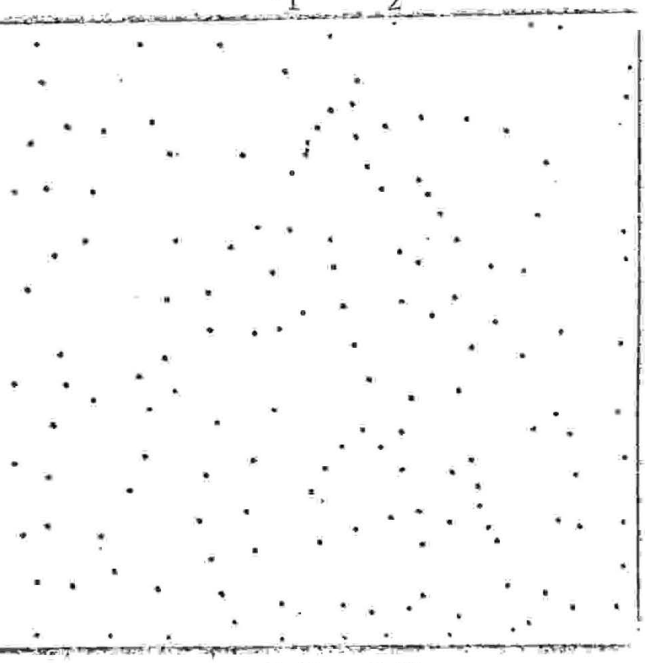
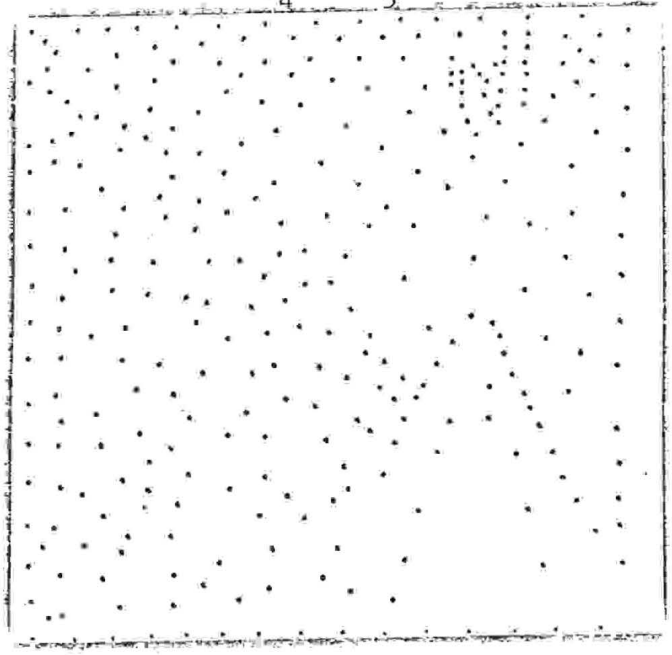
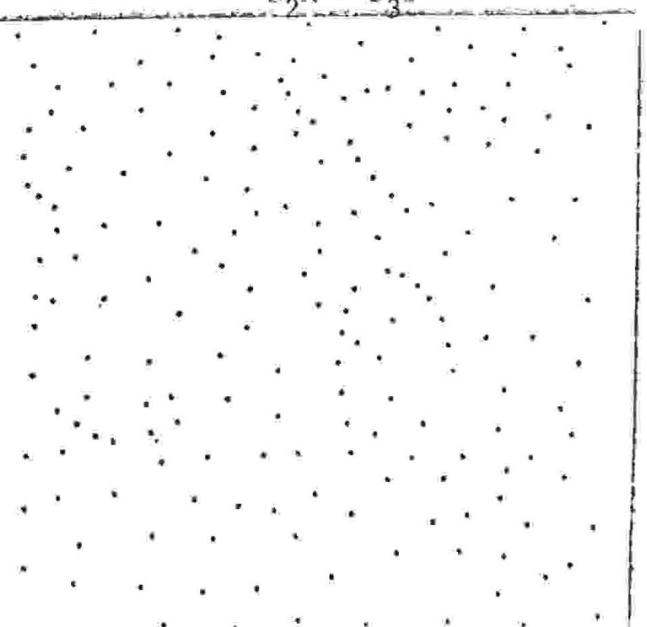


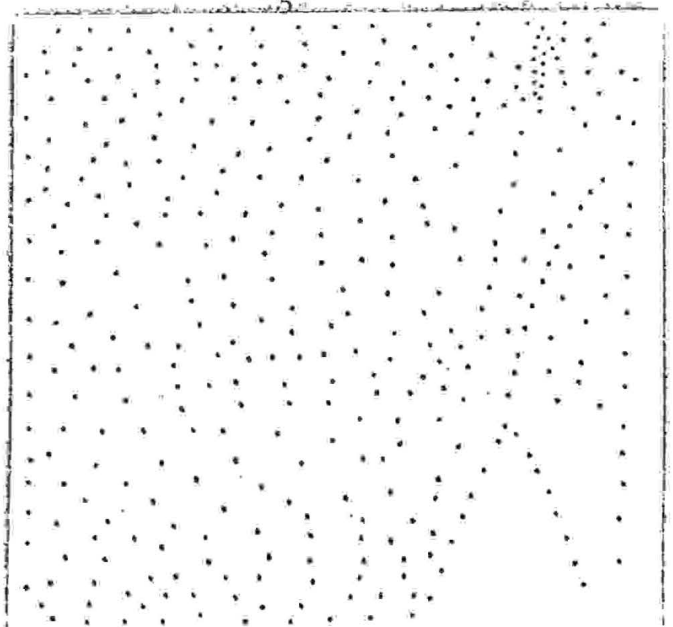
$S_4R - S_5T$



$S_2R - S_3T$

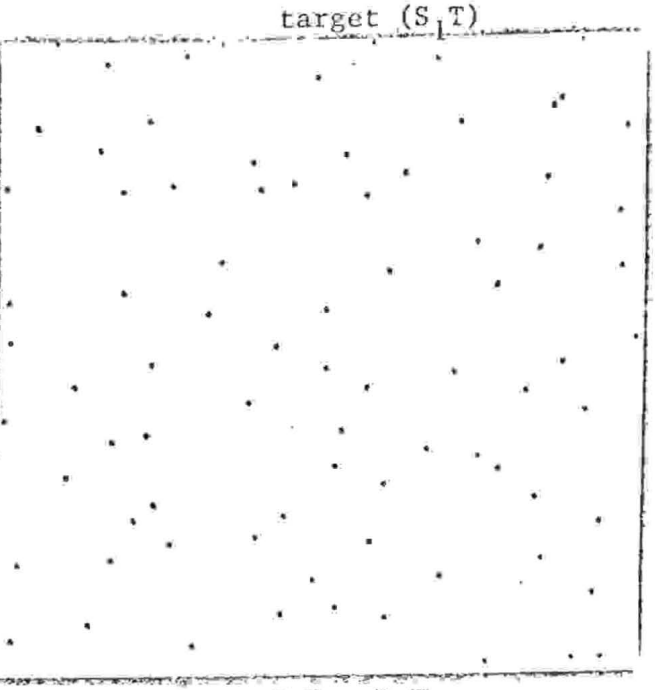


$S_5R -$



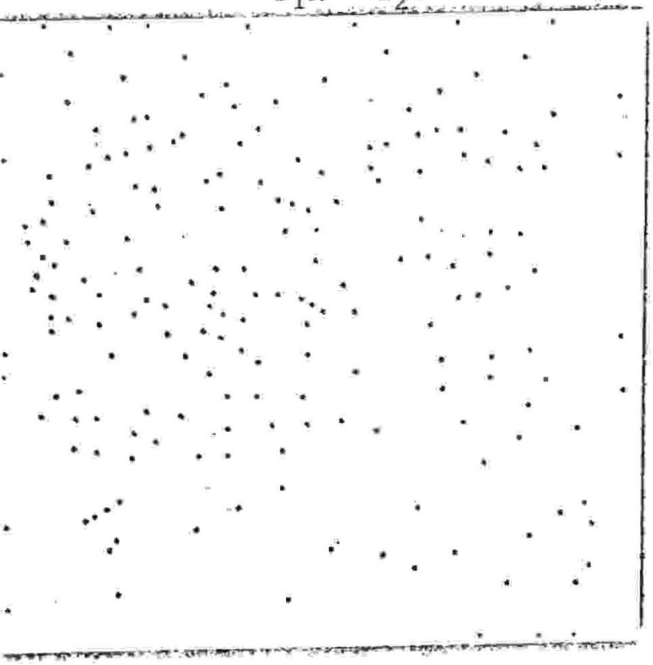
Cascade G

target (S_1T)

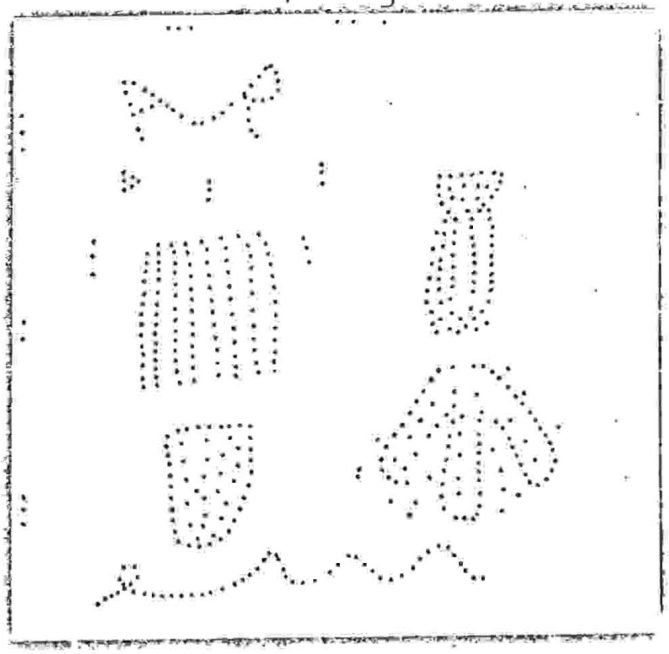


$S_3R = S_4T$

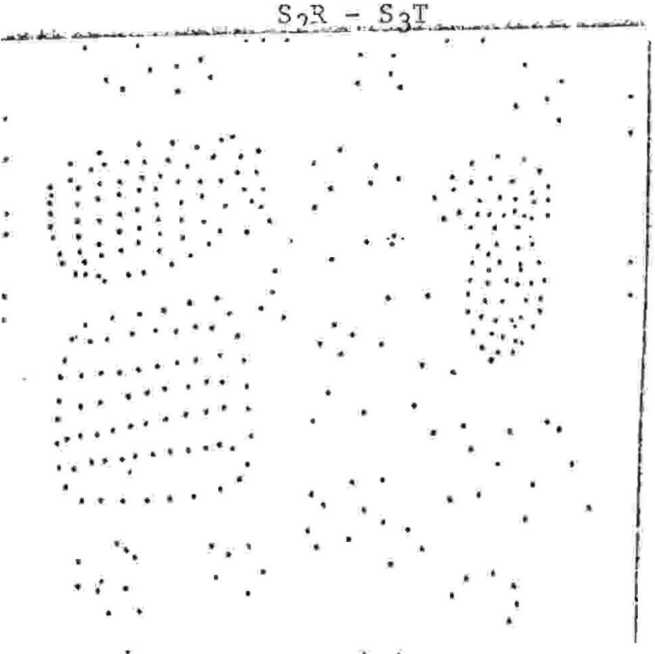
$S_1R - S_2T$



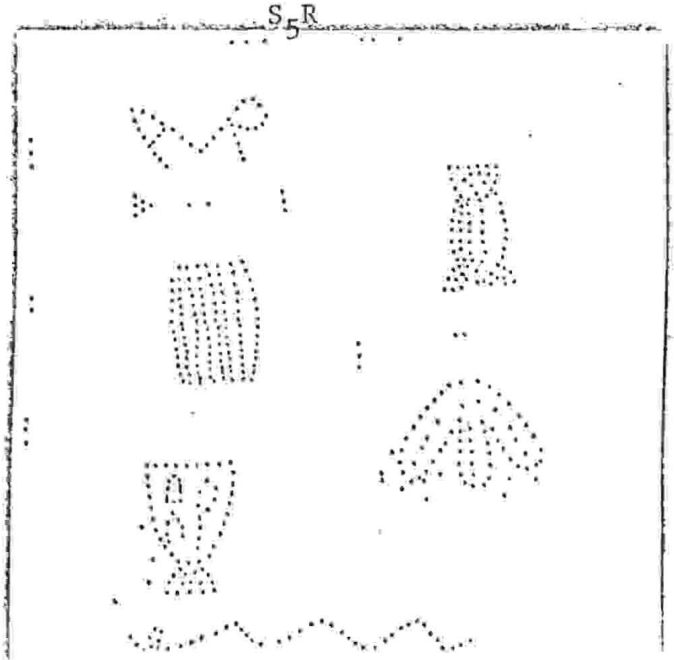
$S_4R - S_5T$



$S_2R - S_3T$

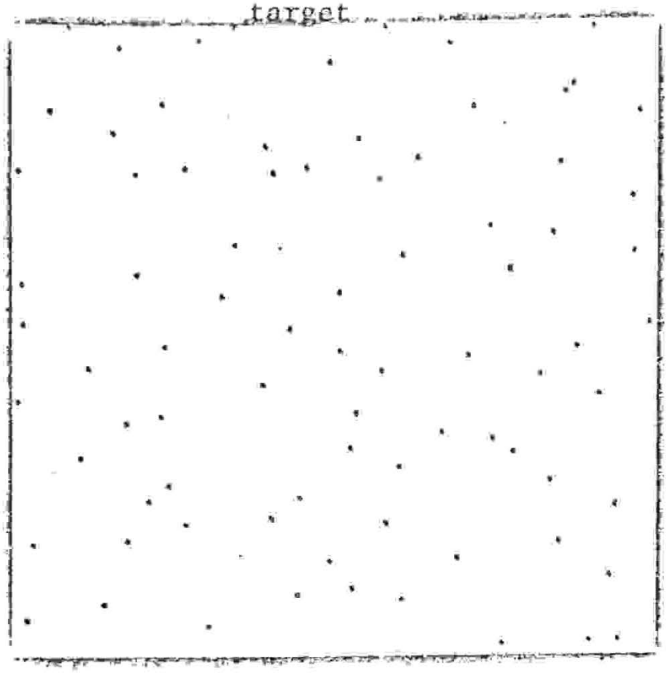


S_5R

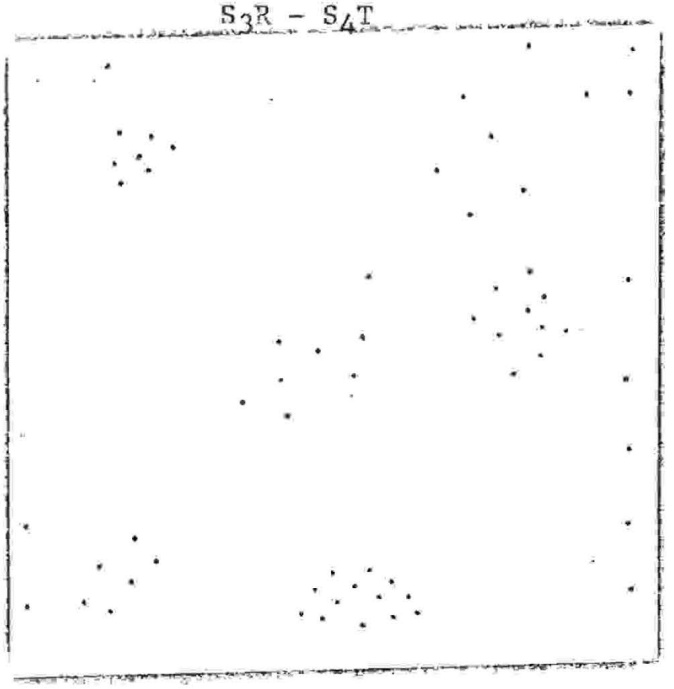


Cascade H

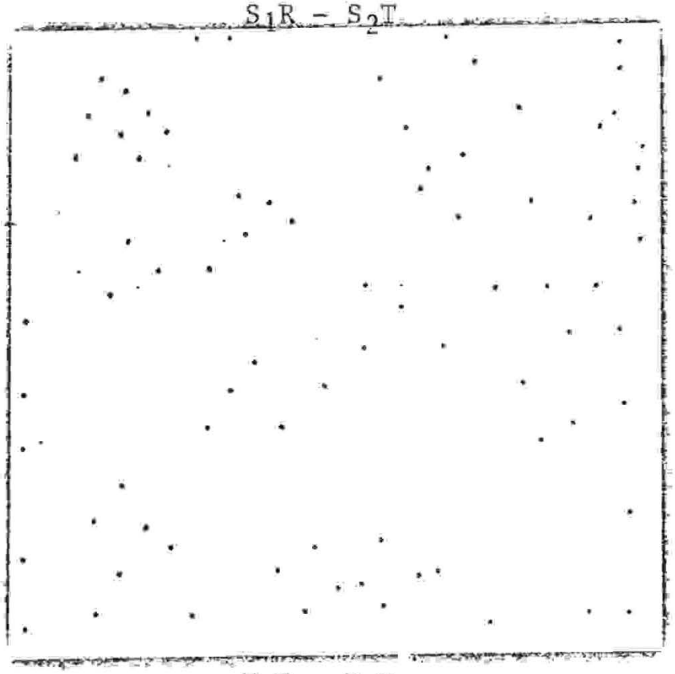
target



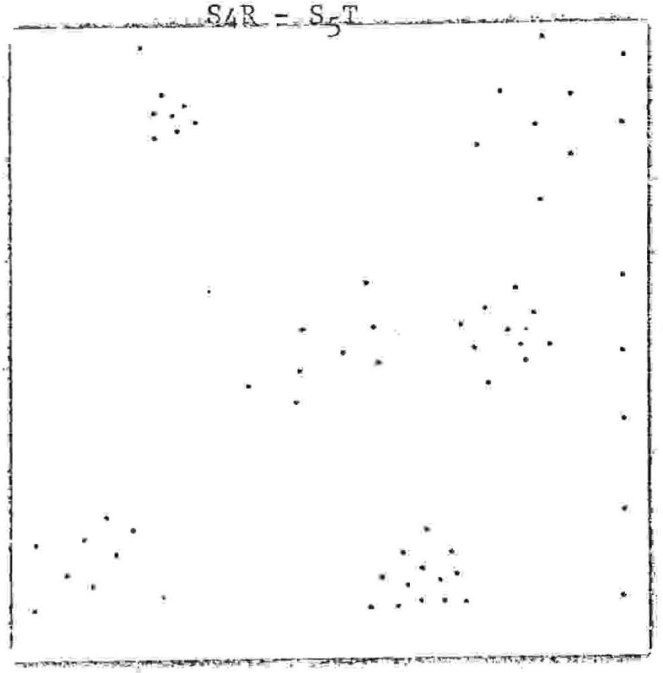
$S_3R - S_4T$



$S_1R - S_2T$



$S_4R - S_5T$



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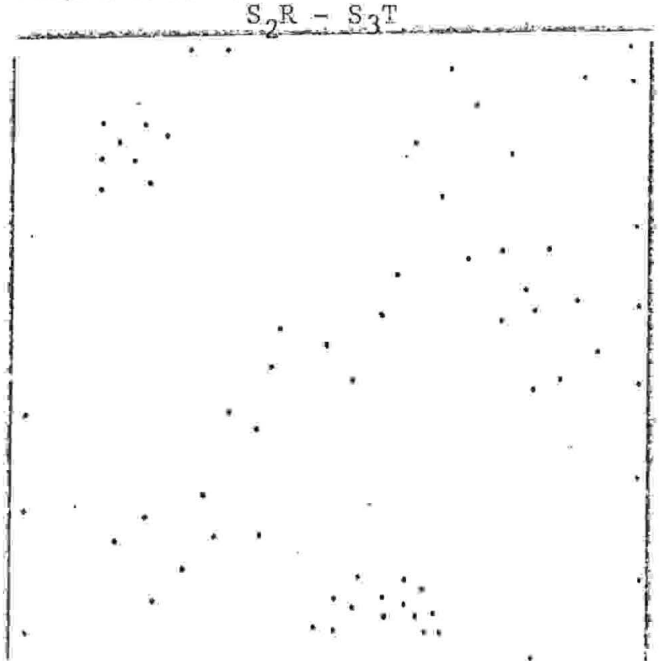
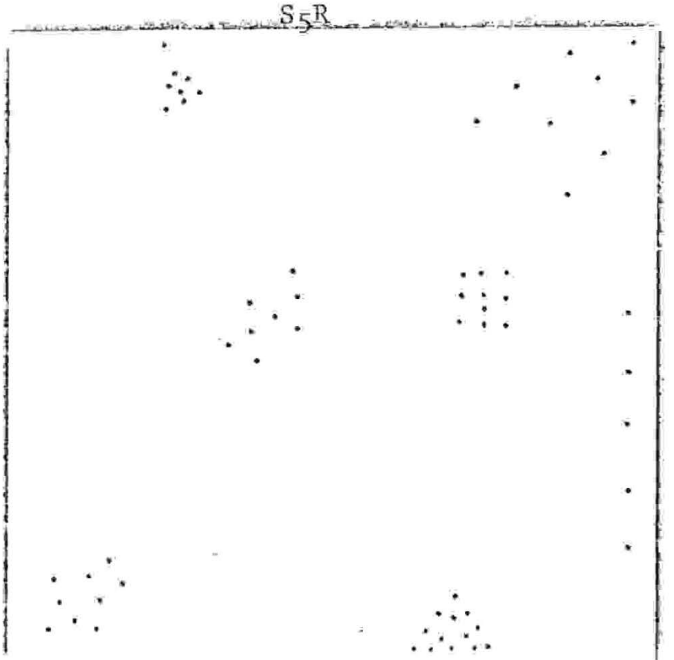
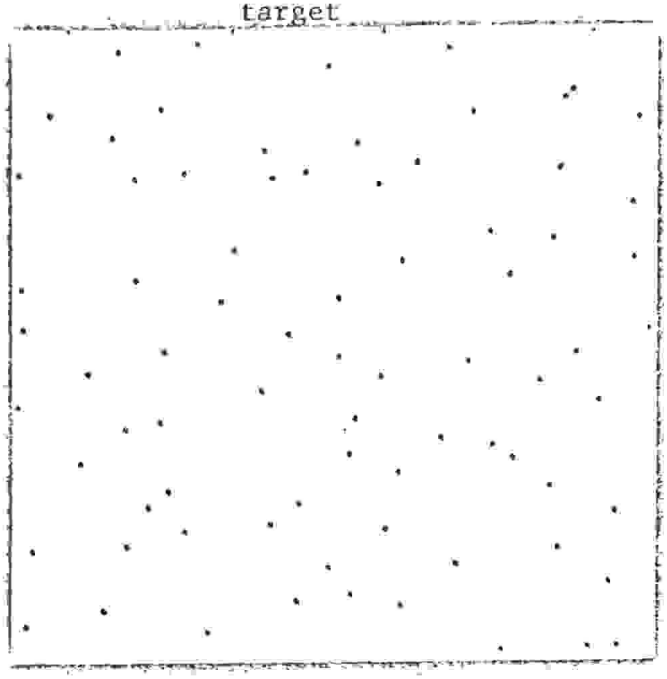


S_5R



target



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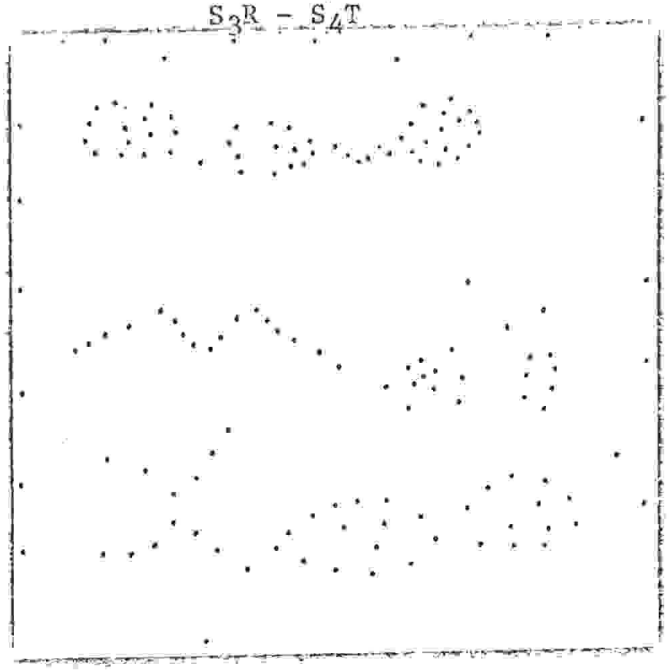
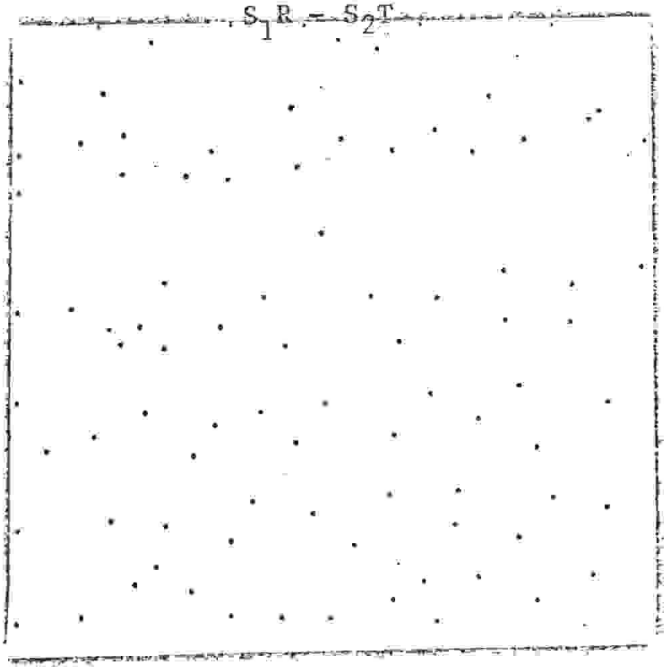
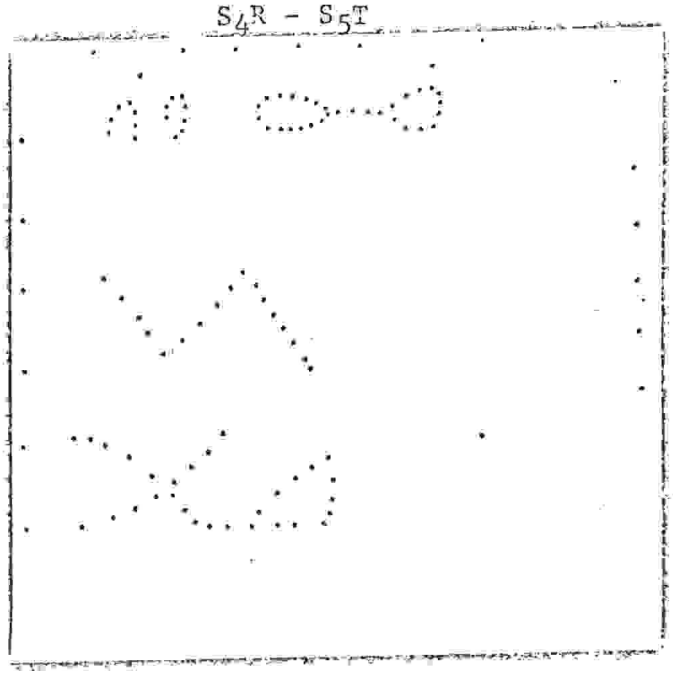


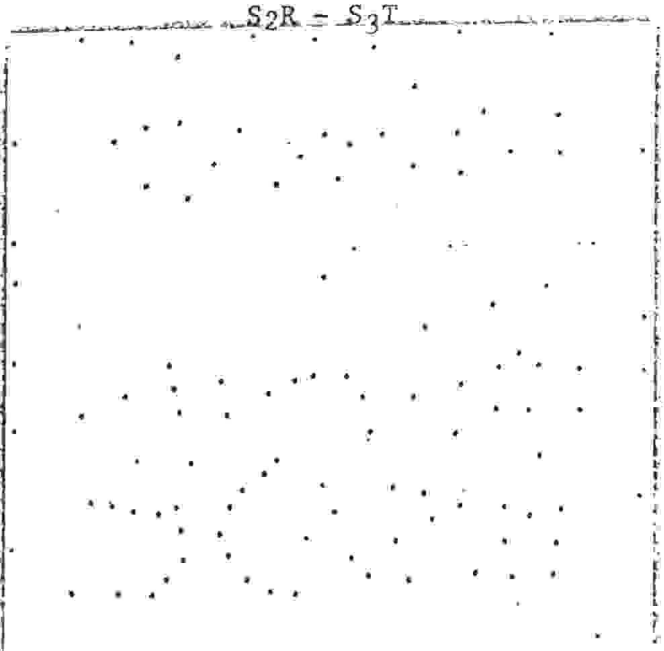
$S_1R = S_2T$



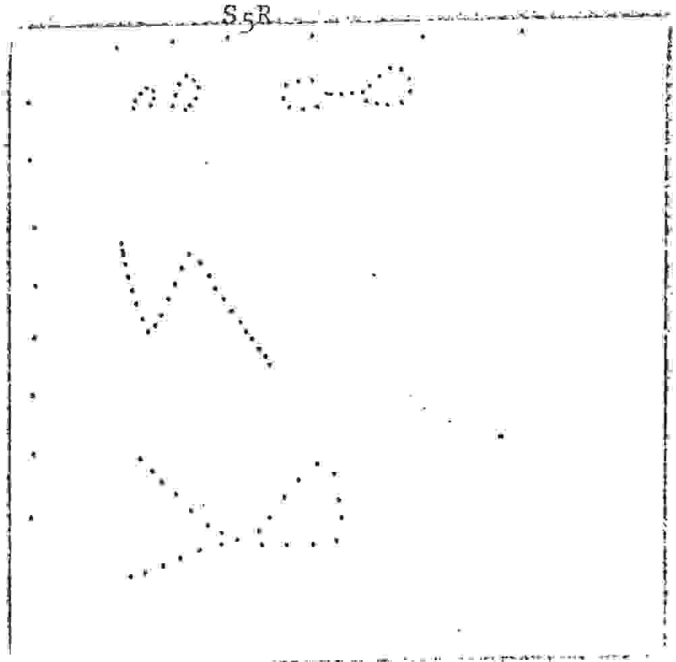
$S_4R = S_5T$



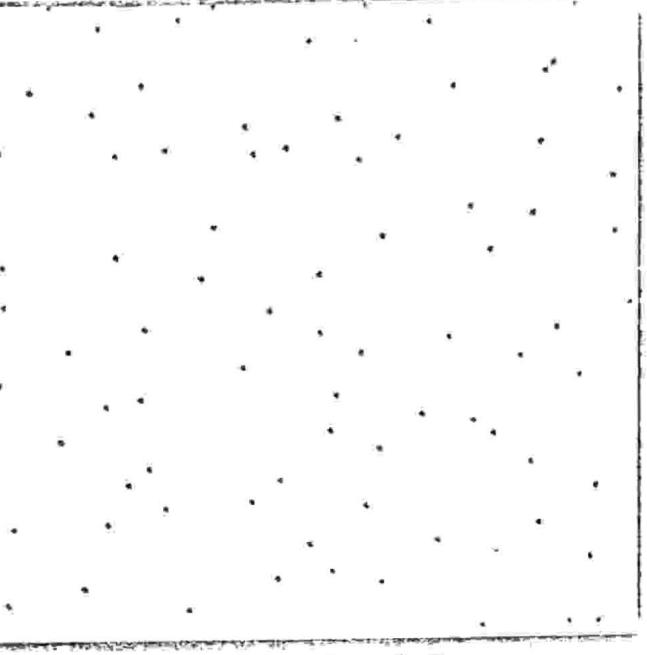
$S_2R = S_3T$



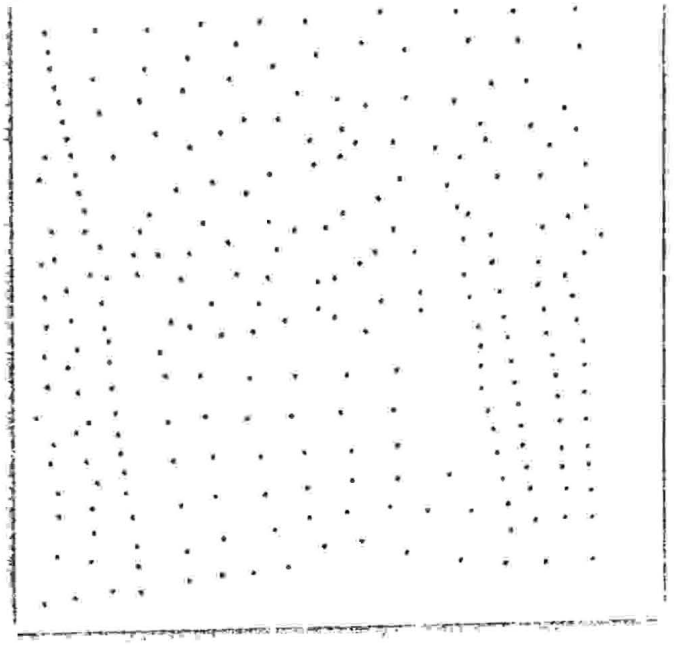
S_5R



target



$S_3R - S_4T$



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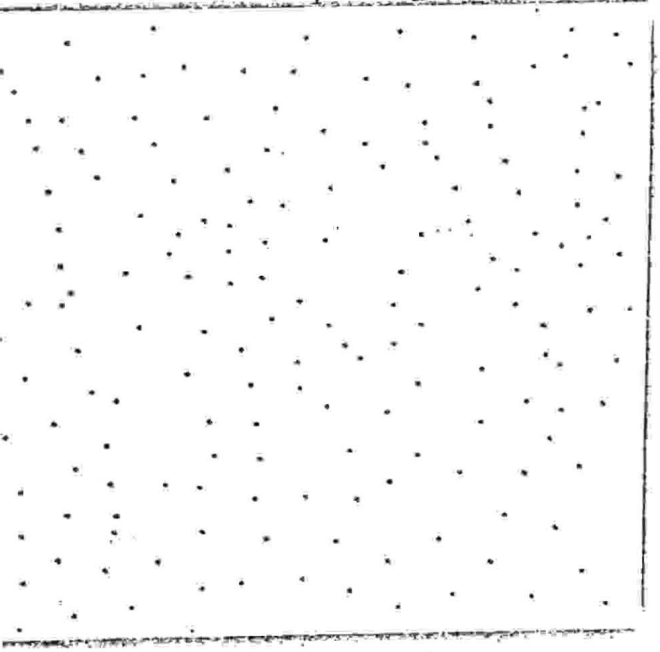

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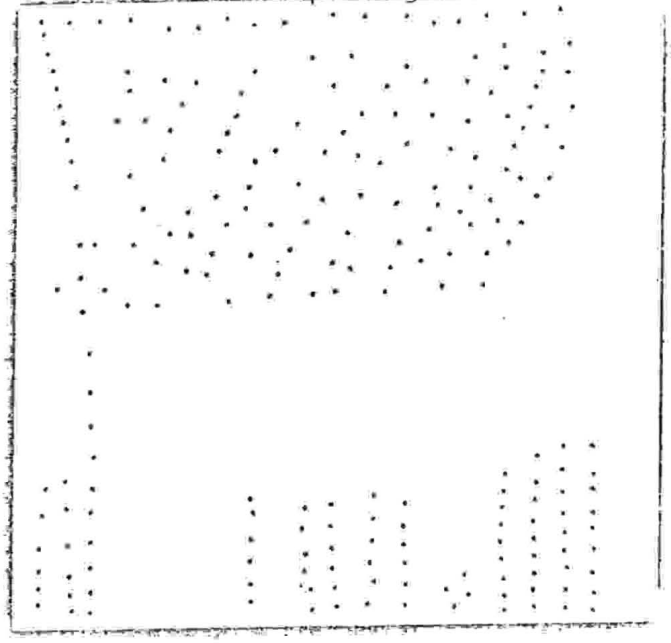

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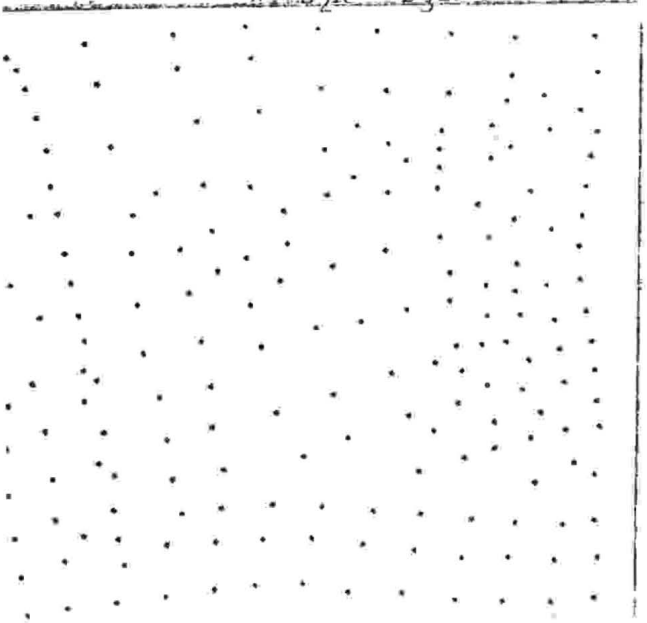
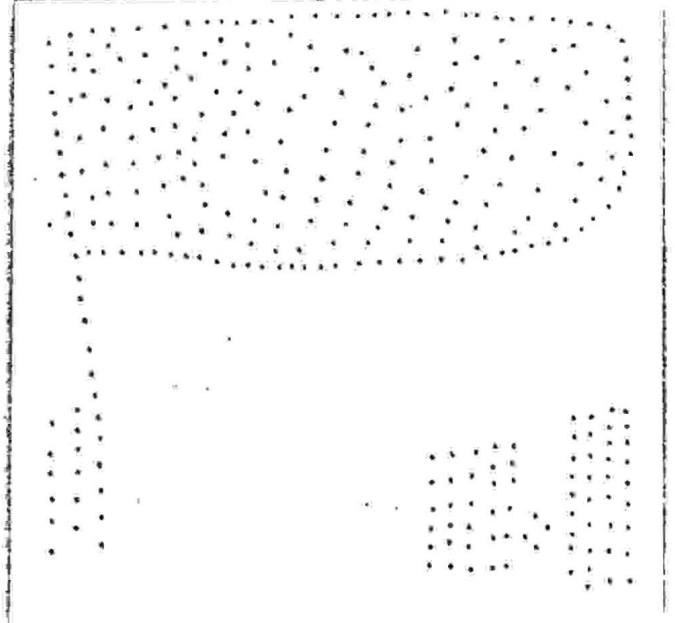
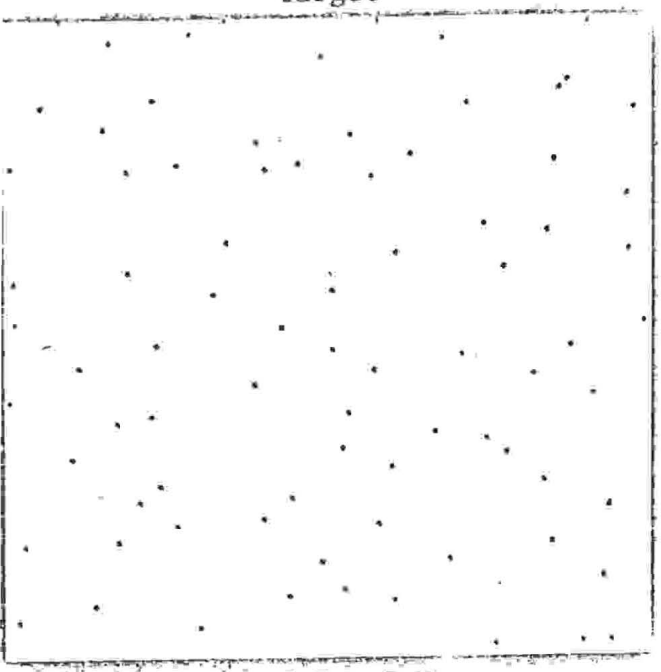


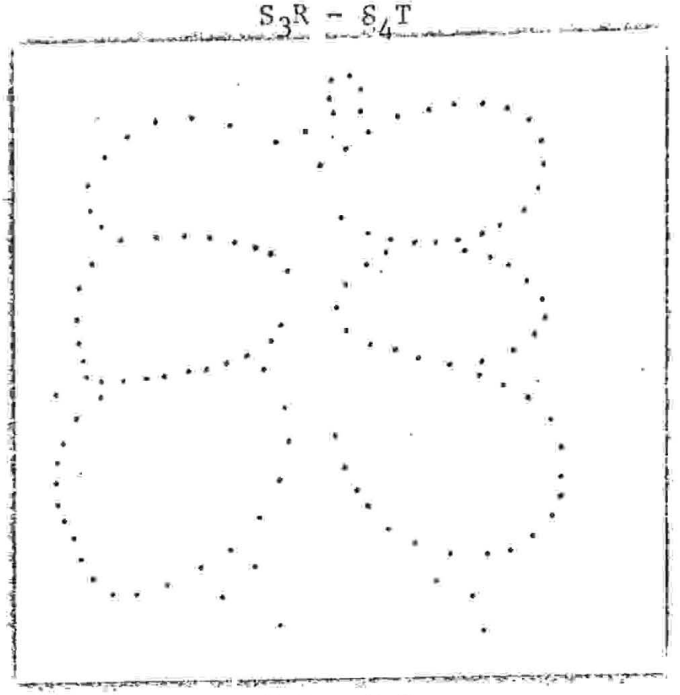
S_5R



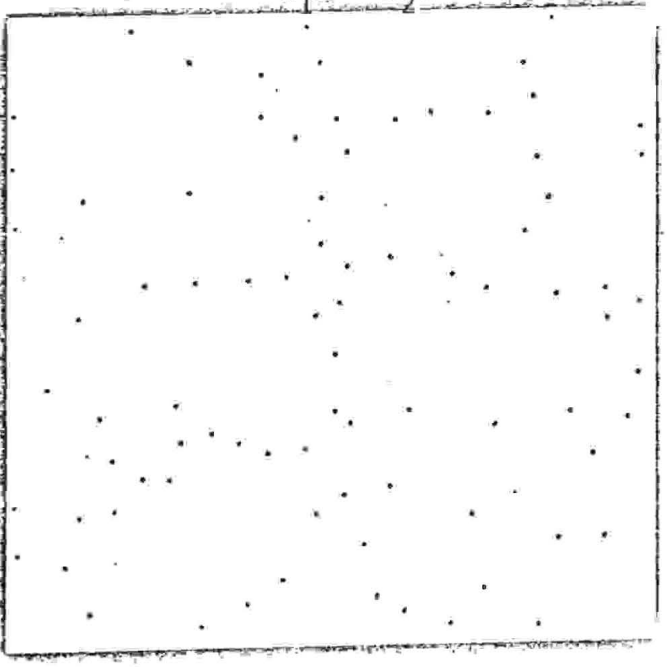
target



$S_3R - S_4T$



$S_1R - S_2T$



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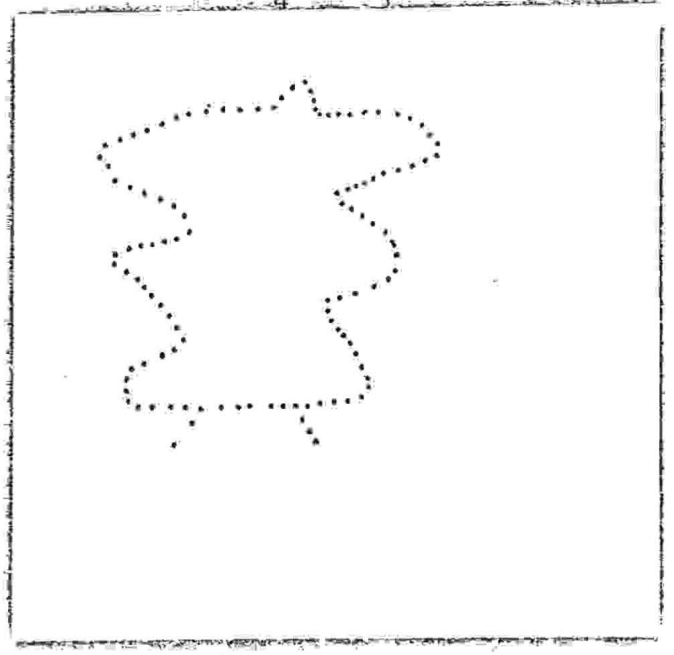

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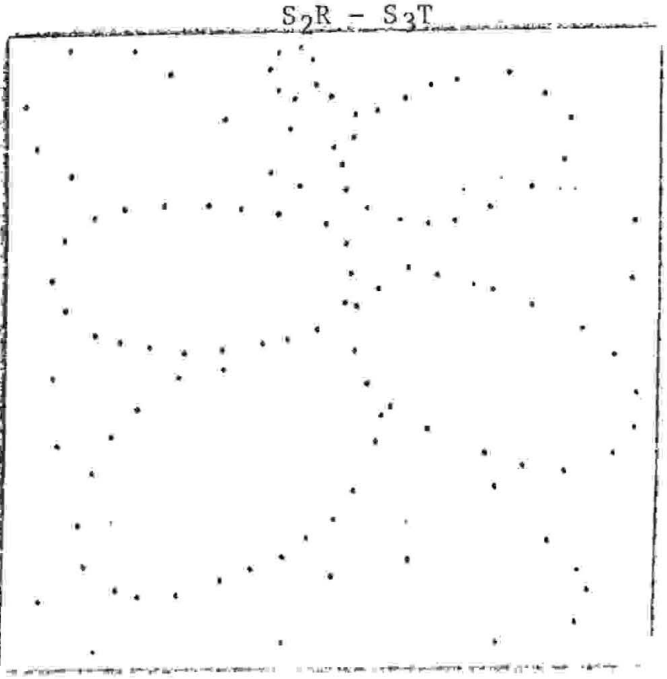
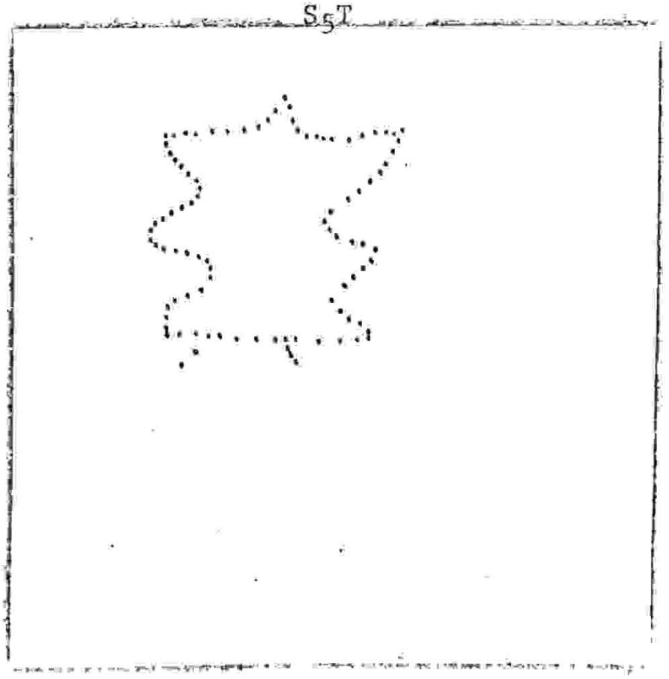
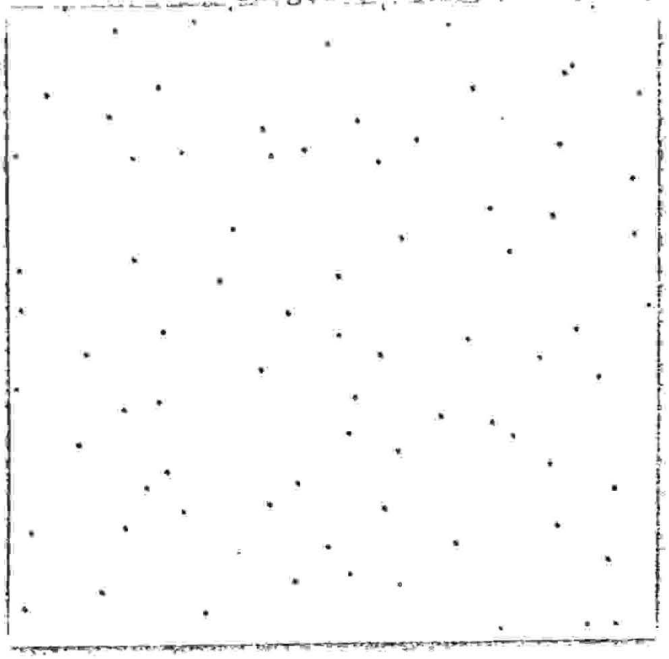


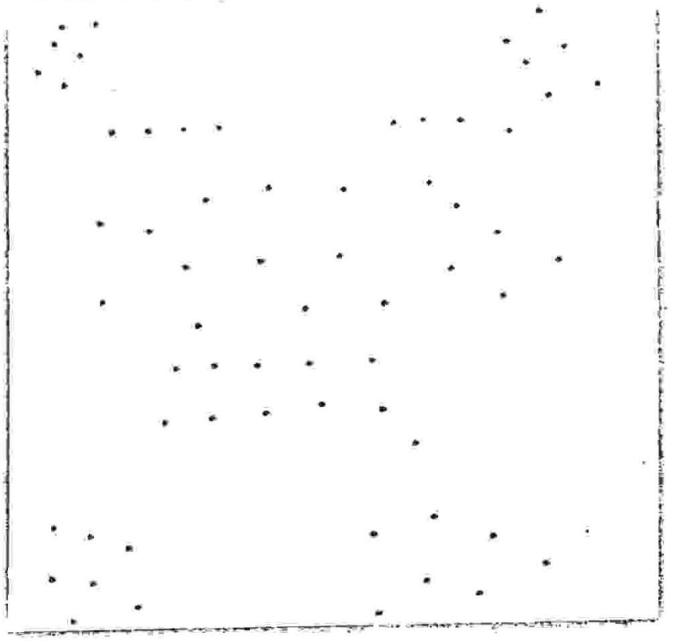
S_5T



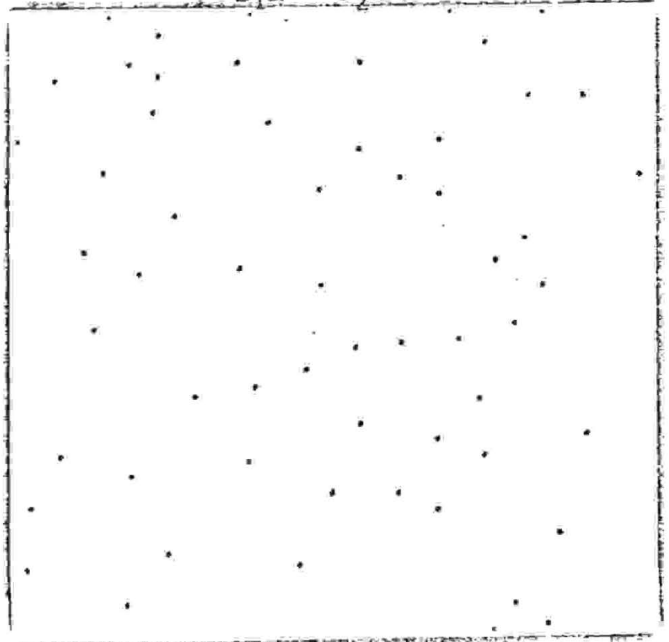
target



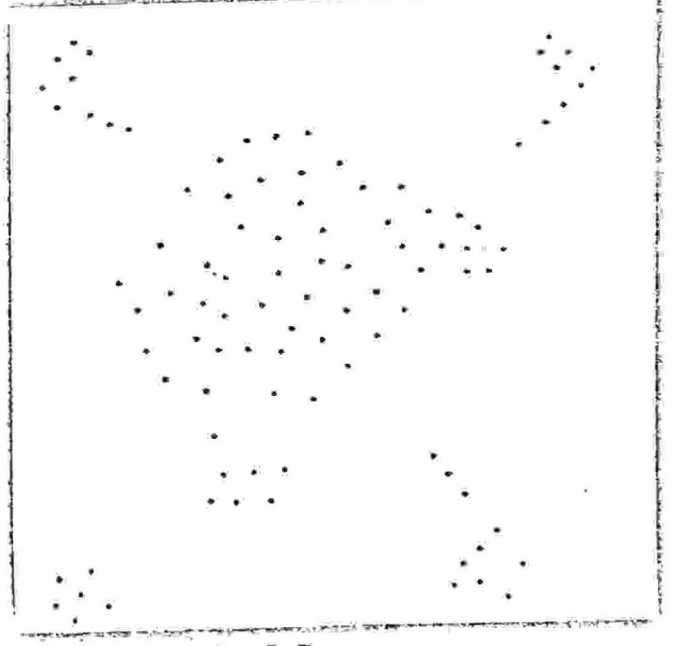
$S_3R - S_4T$



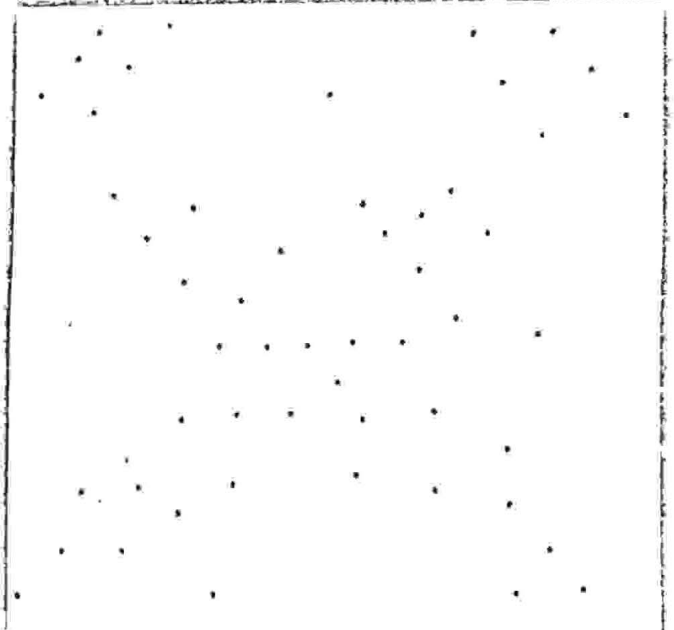
$S_1R - S_2T$



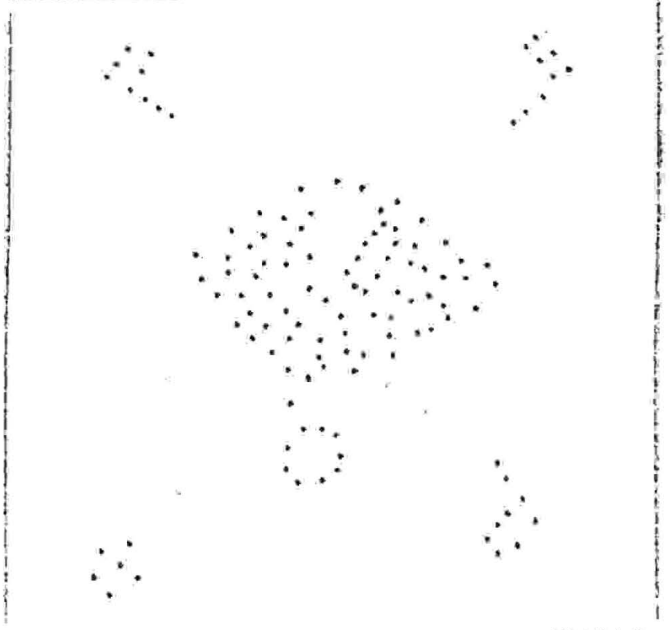
$S_4R - S_5T$



$S_2R - S_3T$



S_5R



APPENDIX B

Cascade A

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge # 7	223	199	170	107	118	150
judge #20	213	225	167	99	137	119
judge # 2	224	203	183	43	102	71
judge # 1	235	215	160	34	90	8
judge #12	232	212	185	114	71	90
judge #18	204	193	133	44	65	58
$\bar{X}$ =	221.8	207.8	166.3	73.5	97.2	82.7

Cascade B

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge # 3	171	112	141	67	34	16
judge #17	232	225	215	108	52	28
judge # 1	228	208	120	97	49	10
judge # 4	200	160	180	141	98	79
judge # 8	219	194	170	109	79	53
judge #19	221	217	207	112	42	25
$\bar{X}$ =	211.8	186.0	172.2	105.7	59	35.2

Cascade C

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge #16	238	212	205	182	168	160
judge # 7	221	169	145	89	59	35
judge # 5	233	212	166	134	98	69
judge # 1	235	97	54	43	20	10
judge # 6	236	167	120	70	37	18
judge #24	231	170	112	66	33	11
$\bar{X}$ =	232.3	171.2	133.7	97.3	69.2	50.5

Cascade D

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge # 7	210	185	159	115	62	38
judge # 5	203	184	134	97	72	46
judge #23	181	114	78	54	32	11
judge # 2	206	231	154	93	58	29
judge # 4	176	155	136	81	62	41
judge # 8	218	188	125	67	40	21
$\bar{X}$ =	199.0	176.2	131.0	84.5	54.3	31.0

Cascade E

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge # 9	233	149	112	78	59	96
judge # 2	232	193	162	93	111	55
judge #13	217	188	139	103	82	57
judge # 3	154	119	81	57	34	12
judge #10	232	207	148	84	67	76
judge # 6	233	203	108	89	32	12
$\bar{X}$ =	216.8	176.5	125.0	84.0	64.2	51.3

Cascade F

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge # 4	235	214	195	175	136	155
judge # 6	230	203	178	150	102	122
judge # 8	231	205	182	111	88	141
judge #11	181	199	160	105	137	122
judge #12	216	164	187	64	93	119
judge #21	220	181	200	85	126	126
$\bar{X}$ =	218.8	194.3	183.7	115.0	113.7	130.8

Cascade G

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge # 5	223	202	139	117	80	59
judge #22	236	197	126	91	39	15
judge #13	192	221	160	134	92	70
judge # 3	176	148	96	68	40	16
judge #12	228	205	165	131	56	82
judge #14	173	202	137	110	48	72
$\bar{X}$ =	204.7	195.8	137.2	108.5	59.2	52.3

Cascade H

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge #16	237	221	206	197	180	170
judge #15	218	174	129	90	67	45
judge #23	184	107	77	54	31	11
judge #11	210	180	125	114	80	72
judge #18	195	158	124	92	83	49
judge #19	216	153	105	82	58	22
$\bar{X}$ =	210.0	165.5	127.7	104.8	83.2	61.5

Cascade I

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge #17	228	207	182	108	51	31
judge #10	233	237	181	117	46	34
judge #11	197	188	133	118	83	70
judge #18	203	203	135	91	57	44
judge #21	218	218	191	94	56	34
judge #24	220	195	114	61	34	10
$\bar{X}$ =	216.5	208.0	156.0	98.2	54.5	37.2

Cascade J

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge #15	202	232	173	154	79	53
judge # 9	234	216	158	115	81	59
judge #20	228	202	172	143	106	75
judge #13	206	183	151	121	66	40
judge #14	158	188	124	100	66	43
judge #19	233	216	131	110	30	11
$\bar{X}$ =	210.2	206.2	151.5	123.8	71.3	46.8

Cascade K

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge #16	236	221	207	193	164	164
judge #15	178	152	91	66	36	30
judge #20	222	194	127	105	84	84
judge #22	234	206	173	133	95	74
judge #17	223	193	116	87	48	21
judge #21	222	104	56	9	9	9
$\overline{X}$ =	219.2	178.3	128.3	98.8	72.7	63.7

Cascade L

	target	S_1R	S_2R	S_3R	S_4R	S_5R
judge # 9	235	216	142	123	81	63
judge #23	236	177	198	209	159	214
judge #22	225	198	160	114	75	53
judge #10	235	209	160	121	85	49
judge #14	192	159	131	106	78	54
judge #24	176	214	103	70	10	37
$\overline{X}$ =	216.5	195.5	136.5	101.7	61.5	44.7

APPENDIX C

The length or perimeter of the figures the subject connected up on their carbon sheet and on their target sheet were compared. The length of the lines in open figures and the perimeter of closed figures were used as measurements of the size of the figure. The Gestalt principle of area states that the smaller the figure, the more prominent it appears against the ground (Hochberg, 1978). In Gestalt demonstrations the inside area of a smaller figure even appears brighter than the area of a larger figure (Koffka 1935). In addition, Allport (1930) reported, "shrinkage of a figure with time is one of the definitely 'dynamic' properties of traces".

This would suggest that if organization was occurring on the basis of Gestalt principles of organization, the principle of area would predict a tendency to shrink the figures. Therefore, for each subject the figures he/she identified on the carbon sheet as the patterns they remembered and reproduced were compared to the figures the same subject identified in their target sheet as the patterns they had perceived and tried to remember. The comparison yielded results in the predicted direction: The lengths and perimeters of the reproduced figures were less than those of the perceived figures in the target. It is therefore concluded that the subjects' reproductions of the figures they saw were smaller than the original figures.

VITA

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Canadian Pacific Command Legion Scholarships, 1973/74, 1974/75, 1976/77

Publications:

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PERCEPTION OF ORGANIZATION IN AN ISOTROPIC STIMULUS

Author [redacted]

Signature

Beverly June Smith

Name

August 10, 1979

Date