# AN INVESTIGATION OF SOME FACTORS INFLUENCING THE AUTOKINETIC EFFECT

James W. Westcott

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Psychology Department
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# I. INTRODUCTION

## Aims of the study

This study has two aims; first, to draw some conclusions concerning the stimulus factors, or evidences, which influence the direction of autokinetic movement; second, to utilize these conclusions in elucidating the nature of the autokinetic effect.

## Beginning of the "autokinetic effect"

The autokinetic effect was first reported observed in 1799 by Von Humboldt (34), an astronomer, who observed that a star would often move slightly if it were steadily fixated. Schweizer (27) in 1851 proved that this movement was illusory by the simple expedient of having several people verbally report the movements of a fixated star. Under these conditions disagreement between observers is marked. To this phenomenon Schweizer gave the name Sternschwanken. At the same time he reported that a black dot on an homogenous light background also seemed to move; this he called punktschwanken.

The first laboratory studies of the phenomenon were made in 1886 by Charpentier (4). He reports that a faint light in a dark room made uniform, steady, long movements. He thought these were basically different from those reported by Von Humboldt, which were oscillatory and of short duration, in spite of the similarities between them which were pointed out by De Parville (5). In 1887, independently of Charpentier, the phenomenon was studied by Aubert (2), who named it the Autokinetische Empfindung.

## Theories of autokinetic movement

The eye movement theory of the autokinetic effect was first advanced in 1879 by Hoppe (15), who maintained that the extrinsic eye muscles, either through their innervation, or through actual contraction resulting in a shift of the image of the dot on the retina, were responsible for the phenomenon. Charpentier supported this theory in 1886, in spite of the fact that his experiments showed large scale eye movements were not responsible. Borudon (3) in 1902 also ruled out gross eye movements but, like Charpentier, thought the movement was due to the summation of slight eye movements. Guilford and Dallenback (13), using a photographic technique, in 1928 found no relation between eye movements and the autokinetic effect. In 1940 Skolnick (31) disputed the conclusions of Guilford and Dallenback, claiming their experimental procedure has serious limitations.

Central theories of the autokinetic effect originate with Exner (9) who reported that a bright spot on a dark disc when fixated, moved independently of the disc. Subsequent experimenters are in disagreement regarding this phenomenon, but the most recent evidence tends to support it. Carr, in his 1910 paper, distinguished three types of movement. In the first type there are no eye movements; in the second, there are eye movements in the direction opposite to that of the phenomenal movement; the third type is a combination of the first two. He concluded that the phenomenon is mainly determined by the changing neuro-muscular conditions involved

in continuous fixation, and that there are four important factors; (a) position of the eye in the socket, (b) after-effects of eye position, (c) motor strains, and (d) after-effects of motor strains.

In 1912 Adams (1) completed an extensive study of the phenomenon. He agreed with Carr that the illusion was due to "strain sensations" coming from the eye muscles while the eyes are relatively still.

A third type of explanation is that advanced in 1928 by Guilford (12) and Guilford and Dallenback (13) who advanced the "streaming phenomenon" theory. The streaming phenomenon was first reported in 1908 by Ferree (10); the phenomenon can be seen by closing the eyelids tightly while facing a diffuse light and looking deep into the field of vision thus presented. Ferree reports the predominant direction of the streams as toward the fovea, thus accounting for the tendency of the autokinetic phenomena to move to the periphery, but not for its tendency to move back. Eldridge-Green (8) in 1910 did not agree with Ferree about the direction of movement; his studies indicated the streams were different for each eye, circling clockwise in the right eye, and anti-clockwise in the left eye. The dominant eye would determine the direction of autokinetic movement. After a series of crucial experiments, Guilford concludes that the streams which produce autokinetic movement are not those of Ferree or Eldrige-Green, but are streams which involve the whole retina at once. Guilford reconciles this with the conclusions of Carr because he reports "changes in

eye pressures produce corresponding changes in the direction of the spot by breaking up the retinal streaming and giving it a new general direction" (12, 404).

The Gestalt theory of autokinetic movement was stated in 1922 by Koffka (19, 571)

".....a definite single phenomenal position exists only within a fixed spatial level. If the conditions for the formation and conservation of such a level are absent, localization is no longer possible; for just as the level grows unstable, so does the single point within it."

There has been a revival of interest in the autokinetic effect since 1938 when Kleint (18) reported autokinesis in the auditory and tactual fields as well as in the visual.

Voth (35) in 1941 made an extensive study of individual differences. Haggard and Rose (14) in 1944, studied the possibility of conditioning the autokinetic effect to move in one direction more than another; this suggests that autokinensis has a cortical locus, and that the streaming effect may be cortical instead of retinal. Graybiel and Clark (11), 1944, report laboratory and night-flight experiments which investigated many aspects of autokinetic movement.

Recent developments

The most significant development in recent years is the use of the autokinetic effect as an instrument in social psychology (Sherif; 29, and 30) and as a type of projective test in clinical psychology (Kleint, 18; Sexton, 28; Voth, 36). It has long been acknowledged that subjective factors are very important in determining visual perception (Murray, 25),

and De Silva (6) in 1926 stressed the importance of these factors in apparent movement. It is to measure these "subjective factors" that the autokinetic effect is used in social and clinical psychology.

Although all the writers on the autokinetic effect are in general agreement as to the description of the phenomenon, there is still disagreement over some of the details. This suggests that some relevant factor or factors are escaping control in the experimental situations thus far used. The present study will vary the stimulus situation along dimensions other than those of size, colour, and intensity in an effort to determine what this factor or these factors may be.

The majority of studies have used a pin point of light as the stimulus. There are three noteworthy exceptions to this. Adams (1) in 1912 discusses suggestions due to the form of the light. A round light, giving the impression of a balloon, was "unrestricted" in movement; a square light, giving the impression of a sailboat, made angular turns; a long narrow light, giving the impression of a board, moved fastest when going in the direction of the long axis. He also presented arrow-head-shape figures in four positions separated by 90 degrees, but found no significant difference between the movement patterns of the positions. Graybiel and Clark (11), in 1945, varied the size, number, and shape of the stimulus objects. Their aim was to find ways of reducing autokinesis; they found reference objects

held by the observers most efficient in this regard. Karwaski et al (17), 1948, found autokinetic movement of a cross shaped figure having an over-all length of thirty-six inches. They also report autokinetic movement of phi lights, resulting in zig-zag or loop paths.

## II. PRELIMINARY EXPERIMENTS

### A. The influence of complex drawings and patterns on autokinetic movement.

Experimental Method:

Apparatus:

A light tight box, approximately thirty-six inches by eighteen inches, and divided into two sections by a ground glass plate, was used. (See Figure 1)

Behind the ground glass plate was a black cardboard mask into which could be fitted stencils bearing the various patterns, either singly or in pairs. At the back of the box there was a small light source which provided even illumination for the stencils. In the front of the box, below the eight and a half inch by five and a half inch aperture through which the subject viewed the stimulus, was a 60 watt bulb controlled by a rheostat.

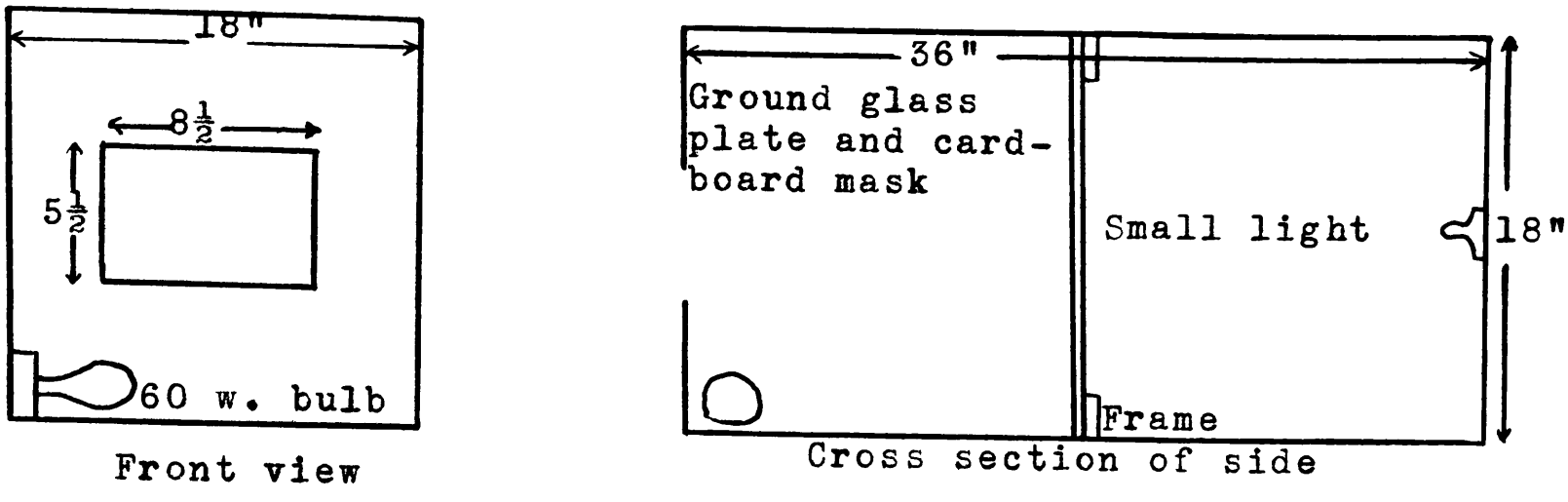
There were twelve stencils used in the experiment: six complex drawings and six patterns. The complex drawings were of two types; things that usually move in life (bird, parachute, plane) and things that usually do not move (stool, vase, tree) (Figure 2). The patterns were of three types: those intended to give a clear suggestion (Figure 3, Nos. 1 and 4), those intended to produce conflict (Figure 3, Nos. 2 and 5), and those made up of three distinct figures (Figure 3, Nos. 3 and 6).

Subjects:

Forty volunteer subjects were used in this experiment. All were university students. There was no attempt to get

FIGURE I

THE AUTOKINETIC BOX




THE EXPERIMENTAL ROOM

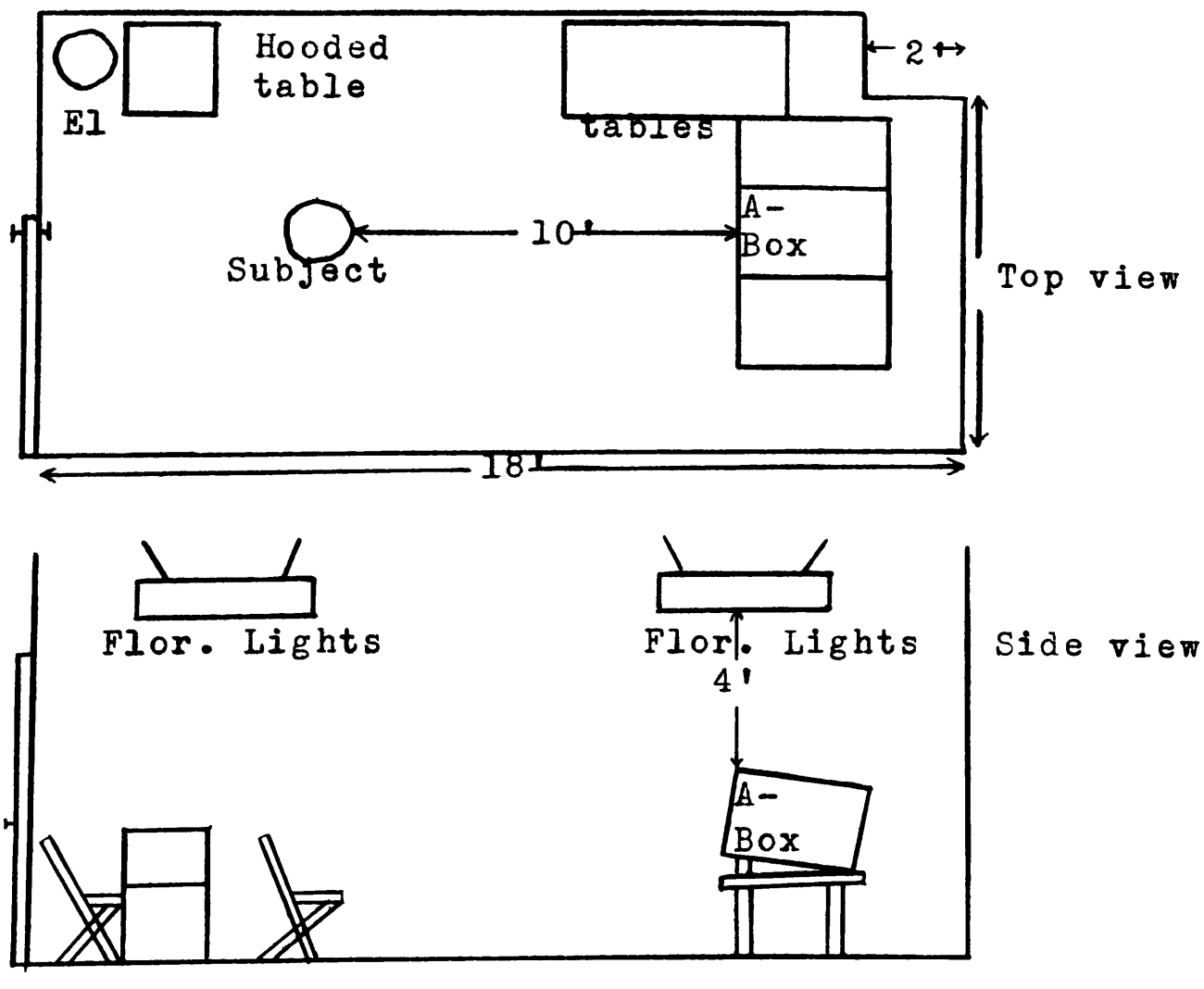
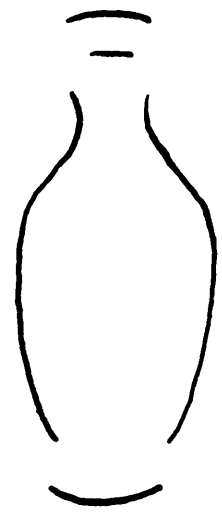
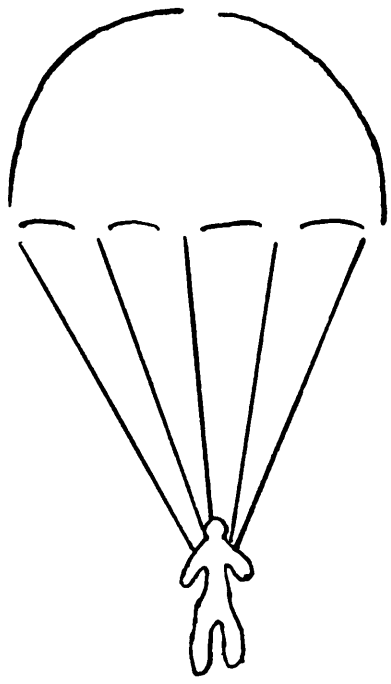
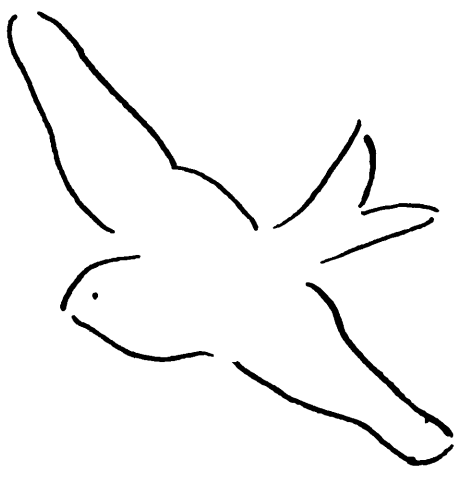


FIGURE 2

COMPLEX DRAWINGS







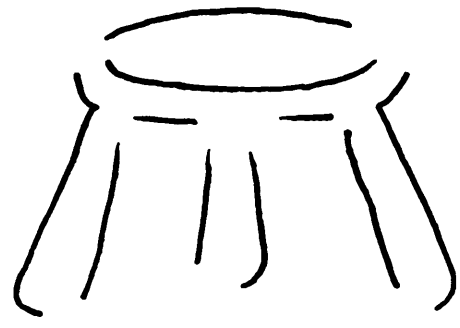
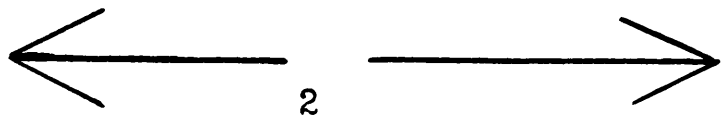


FIGURE 3

PATTERNS

1



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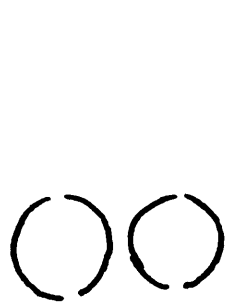

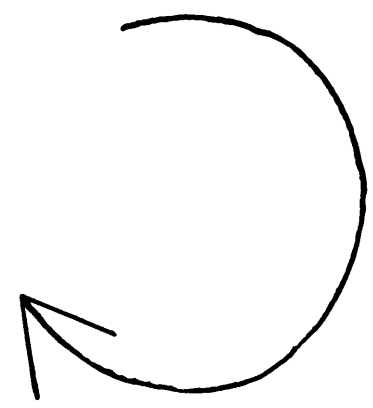

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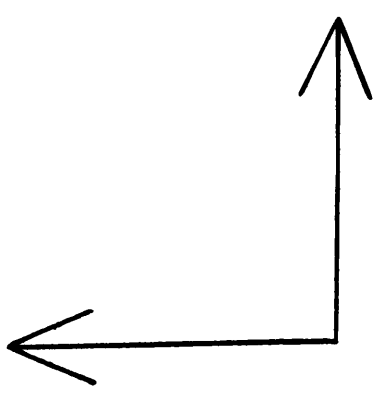

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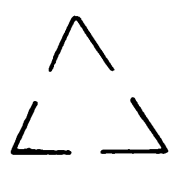

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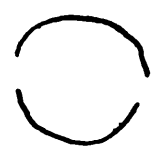


equal numbers of each sex, or to equate the two groups used in any way. Assignment to the groups was random.

Instructions to the subjects:

The subjects were told nothing about the experiment except that it was on vision. When they were seated in the dark room they were told that they were to describe whatever they saw. The experimenter avoided as much as possible any leading or suggestive questions. If the subject merely described the pattern or complex drawing, he was asked if the stimulus was "doing anything". Once he reported movement the experimenter would ask the subject about the direction, speed, and distance of the movement, and, in the case of the patterns, if the parts moved together or independently. Subjects were encouraged to report continuously, and as few questions as possible were asked.

Experimental groups:

The subjects were divided into two groups of twenty subjects each. Subjects assigned to group A were shown complex drawings singly first, followed by patterns, followed by complex drawings in pairs (The pairs were, 1. stool and parachute, 2. vase and bird, 3. plane and tree). Subjects in group B saw first the patterns, then the complex drawings singly, followed by the complex drawings in pairs.

Procedure:

Subjects were tested one at a time, and instructed as noted in a previous section. It was necessary to have two experimenters, one to record the subject's remarks, and operate the rheostat, the other to change the stencils. The

subjects were brought into the dark room and instructed to look at the floor until the door was closed. The room was completely dark except for a faint glow from the flouresscent lights which are visible for at least an hour after the light has been turned off. A small amount of light, not usually visible to the subject until near the end of the session, escaped from the hooded table where one of the experimenters sat.

The first card was presented twice. On the first presentation, latency (the time between presentation of stimulus and report of movement) was recorded with a stop watch and the subject urged to give a phenomenological report. On the second presentation latency was again recorded, and the 60 watt bulb was gradually illuminated, giving a frame of reference, until the subject reported all movement stopped. This procedure was carried out for the following eleven stencils. The three double complex drawings, which came at the end of both A and B series, were presented only once; latency, rheostat reading, and type of movement were recorded.

This experimental method provides us with three criteria for the examination of the influence of patterns and complex drawings on the autokinetic movement:

1. Phenomenological report including direction, speed, and amount of movement.
2. Latency in seconds.
3. Rheostat reading, which gives an objective measure of the "tenacity" of the movement.

Results:

Preliminary statistics showed no consistent or significant differences between the A and B groups; the data were,

therefore, pooled and divided again on the basis of amount of movement reported. Subjects who reported movement of two inches or more in six or more figures were assigned to the "high movement group", there were thirteen such subjects. The remainder constitute the "low movement group".

Table 1

Analysis of movement of complex drawings[x]

| FIGURE | EXPECTED MOVEMENT | % OF REPORTS IN ACCORD WITH EXPECTION | TOTAL NO. OF REPORTS[xx] |
|---|---|---|---|
| Stool | None | 32 | 34 |
| Vase | None | 16 | 37 |
| Tree | None | 14 | 36 |
| Chute | Down | 0 | 37 |
| Bird | Left | 19.5 | 36 |
| Plane | Right | 27 | 33 |

[x] See appendix A for complete summary of movement data.

[xx] The totals vary from 40 because of some minor variations in the experimental technique with a few of the subjects.

Table 1 shows an analysis of the movement of the complex drawings in terms of frequency of movement in the direction suggested by the drawing. The results cannot be termed suggestive. It should be noted that the stool was the first complex drawing shown to all subjects; the subsequent main experiment indicates an increase with practice in the total amount of movement seen; therefore it is not possible to estimate the significance of the 32% movement in accordance with expectation formed for the stool. The other percentages occurring are approximately what one would expect to obtain had a simple point of light been used. (Compare table 8, control test 1, and appendix A)

Tables 2 and 3 show the latency and rheostat readings

Table 2

Latency for single stencils (in seconds)

| | Total Group | | High Movement Group | | Low Movement Group | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| ↳ | 23.81 | 15.44 | 15.00 | 11.25 | 29.23 | 15.18 |
| ↻ | 23.83 | 18.00 | 20.60 | 19.10 | 26.31 | 16.72 |
| ←→ | 19.88 | 14.90 | 17.80 | 12.30 | 21.36 | 16.32 |
| ↑ | 18.25 | 18.55 | 15.00 | 16.80 | 20.61 | 19.31 |
| ∘ ∘∘ | 17.82 | 14.38 | 19.10 | 15.23 | 20.41 | 13.56 |
| △∘∘ | 19.35 | 13.47 | 21.88 | 16.02 | 17.27 | 10.55 |
| Stool | 35.25 | 18.75 | 25.57 | 11.00 | 42.78 | 20.00 |
| Chute | 23.60 | 15.60 | 18.33 | 9.52 | 27.91 | 34.47 |
| Vase | 23.60 | 14.90 | 23.71 | 14.20 | 23.54 | 15.21 |
| Bird | 19.63 | 12.65 | 18.55 | 9.04 | 20.60 | 15.10 |
| Tree | 19.24 | 9.70 | 14.74 | 7.36 | 31.00 | 15.75 |
| Plane | 20.59 | 14.57 | 16.00 | 10.20 | 23.77 | 16.18 |

Table 3

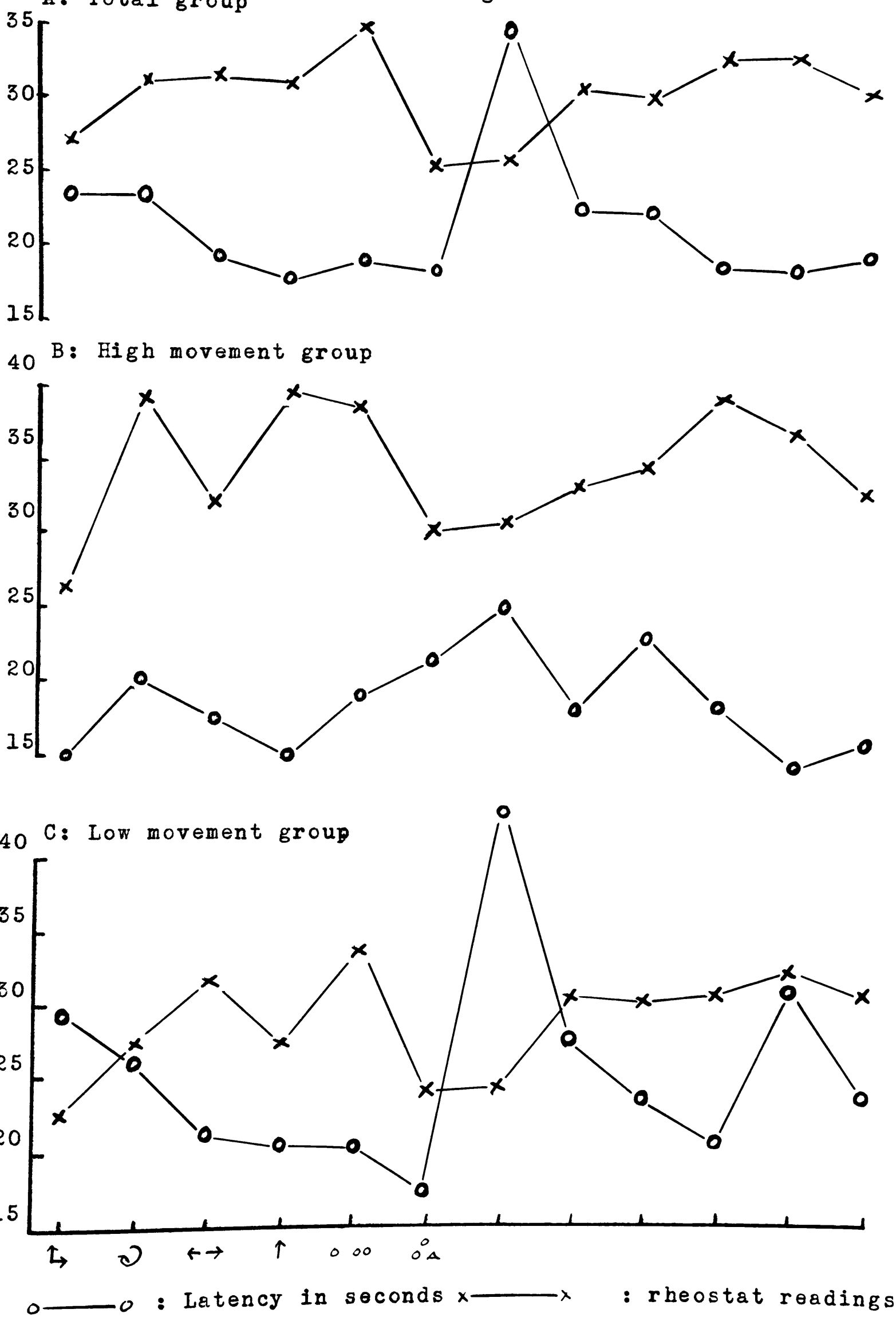
Rheostat Readings for single stencils [x]

| | Total Group | | High Movement Group | | Low Movement Group | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| ↳ | 27.40 | 22.87 | 26.76 | 24.50 | 22.70 | 22.03 |
| ↻ | 31.20 | 18.37 | 39.58 | 12.50 | 27.28 | 19.20 |
| ←→ | 32.00 | 18.02 | 32.30 | 15.64 | 31.85 | 18.95 |
| ↑ | 31.50 | 18.49 | 40.00 | 10.19 | 27.44 | 20.07 |
| ∘ ∘∘ | 35.10 | 24.18 | 39.00 | 16.97 | 33.33 | 28.45 |
| △∘∘ | 26.20 | 24.75 | 30.76 | 19.22 | 24.07 | 26.67 |
| Stool | 26.60 | 19.69 | 31.15 | 18.62 | 24.51 | 7.25 |
| Chute | 31.60 | 17.26 | 33.85 | 18.40 | 30.48 | 16.65 |
| Vase | 31.10 | 20.11 | 35.08 | 17.04 | 30.18 | 21.54 |
| Bird | 33.80 | 22.44 | 39.76 | 20.54 | 30.92 | 22.74 |
| Tree | 33.90 | 17.94 | 37.30 | 18.37 | 32.33 | 17.37 |
| Plane | 31.60 | 20.12 | 33.25 | 23.56 | 30.85 | 19.60 |

[x]The units are those on the rheostat dial. The relationship between intensity of light and rheostat reading is not linear.

FIGURE 4

Graphic representation of averages for latency and rheostat readings



for the total group, the high movement group, and the low movement group. These results are shown graphically in figure 4. The low movement group shows a tendency toward more movement with repeated experience; the high movement group does not show this. Both groups show decreased latency and increased rheostat readings with those drawings which move in everyday life. Thus in these two measures we do discover a trend, not revealed by the direct phenomenological data. No attempt was made to discover the statistical significance of the differences of these data because it was thought that the underlying reports were not sufficiently exact so that it would be impossible to give meaning to the statistics.

The phenomenological reports on the movement of the patterns are also far from conclusive. The arrow pointing up is the only pattern showing a significant trend; 32% of the reports were of upward movement. The circular arrow moved approximately as would a single point (compare table 8 and appendix A). The remaining patterns will be considered only from the point of view of resolution of conflict. Fifteen of the forty subjects reported parts of these figures moving independently. Abstracts of their reports follow:

A1: ↑→ horizontal arrow getting longer, vertical getting shorter

←→ right arrow getting longer, and arrows moving closer together, then further apart

o oo the single circle recedes

A5: ↑→ horizontal arrow thicker, vertical getting smaller and longer

o oo single circle recedes

△ o o top circle moves back as frame develops

A6: ←→right arrow gets longer

A14: ↑→ heads move

←→right arrow moves up and down, left one remains still

o ooo single circle moves back

A15: ←→left moves back and forth, right half still

o ooo single circle moves in front of others

A19: ↑→ bottom arrow moves in and out and up and down

←→the left arrow moves, the right one still

B1: o ooo single circle moves slightly up and down

B2: o ooo all move up and down, but the single one moves more than others

△ooo circles tend to pivot around triangle

B8: o ooo the pair of circles get closer together

B9: ←→ the right arrow recedes

B13: ←→the right arrow moves to the right

o ooo the pair of circles move farther from the single circle

B14: ←→the left arrow tries to join the right

B15: ↑→ horizontal arrow gets longer

o ooo all the circles move farther apart, then closer together

△ooo the triangle moves up a bit

B18: o ooo single circles move toward subject

B20: ←→the right arrow oscillates back and forth

o ooo the single circle oscillated from side to side, then all dropped $1\frac{1}{2}$ inches

△ooo the top circle came closer and vacillated

It will be noted that only two of these fifteen subjects fall into the high movement group (B14, B18) and that in both these cases there was separate movement of the constituent parts of only one of the figures.

Before considering the significance of these data we will examine the results obtained from the presentation of two complex drawings together. In each of the pairs was an object that usually moves, and one that is usually still. The pairs were: stool and chute, vase and bird, tree and plane. Table 4 gives the latency and table 5 the rheostat readings for the double figures.

Table 4

Latency of double figures (in seconds)

| Figure | Total Group | | High Movement Group | | Low Movement Group | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| Stool-Chute | 22.86 | 14.15 | 25.50 | 16.20 | 20.66 | 11.70 |
| Vase -Bird | 24.65 | 14.60 | 26.90 | 14.31 | 22.92 | 14.60 |
| Tree -Plane | 21.74 | 14.25 | 23.30 | 16.85 | 20.54 | 11.66 |

Table 5

Rheostat Reading for double figures[x]

| Figure | Total Group | | High Movement Group | | Low Movement Group | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| Stool-Chute | 33.38 | 20.91 | 38.85 | 23.21 | 30.74 | 19.14 |
| Vase -Bird | 35.38 | 24.72 | 39.62 | 17.13 | 33.27 | 27.49 |
| Tree -Plane | 32.90 | 23.51 | 32.75 | 18.53 | 33.00 | 25.29 |

[x] In the units appearing on the rheostat.

Comparison of table 4 with table 2 shows that the double figures have longer latency than the separate figures, on the average, in the high movement group, and that the

opposite obtains in the low movement group. Comparison of table 5 with table 3 shows a general tendency to increased rheostat readings with the double figures indicating increased "tenacity" of movement. The increase is not great, and is probably due to the tendency to see more movement with practice; these double figures were shown at the end of the experimental session in each case.

A study of the phenomenological reports shows that nineteen of the thirty-five subjects who were shown these pairs of complex drawings did not see both the drawings moving at the same time. These cases are as follows:

| | | |
|---|---|---|
| A1: | stool and chute: | chute moves down toward stool which tilts but does not move |
| | vase and bird: | bird moves down and right; vase still |
| | tree and plane: | plane climbs away from tree |
| A3: | tree and plane: | plane moves right, tree catches up to it |
| A5: | vase and bird: | bird moves away from vase |
| | tree and plane: | tree moves to plane, then the plane moves away from the tree |
| A8: | stool and chute: | man in the chute moving |
| A14: | stool and chute: | both move up and down, but stool moves most |
| | vase and bird: | bird moves back and forth; vase still |
| | tree and plane: | plane moves, tree follows |
| A15: | stool and chute: | chute moves; stool still |
| | vase and bird: | bird moves toward vase, but distance between doesn't change |
| | tree and plane: | plane moves toward and then away from the tree |

| | | |
|---|---|---|
| A16: | stool and chute: | chute moves left, then both move together |
| A17: | stool and chute: | chute moves slowly right, stool still |
| | tree and plane: | plane moves right, tree still |
| A20: | tree and plane: | both move left, but plane more than tree |
| B2: | stool and chute: | chute moves left; stool still |
| | vase and bird: | bird moves; vase still |
| B4: | tree and plane: | plane moves up and backwards; tree still |
| B5: | tree and plane: | tree moves left, plane moves right |
| B6: | stool and chute: | chute moves more than stool |
| | vase and bird: | bird moves up and down more than vase |
| B8: | tree and plane: | plane moves away from tree |
| B9: | tree and plane: | plane alternately moves closer to and farther from the tree |
| B10: | stool and chute: | chute moves down; stool still |
| | tree and plane: | plane down and left; tree to right |
| B15: | stool and chute: | stool still while chute moves away, in and out, and gets smaller |
| B17: | vase and bird: | both recede, but the bird more than the vase |
| | tree and plane: | plane away from tree in direction of flight |
| B20: | stool and chute: | both move separately one at a time |
| | vase and bird: | bird moves away from vase; vase still |
| | tree and plane: | plane moves away from tree |

All of these 19 subjects are from the low movement group. It is interesting to note that only 8 of these 19 subjects had reported that the component parts of any of the figures moved separately.

Conclusions:

(i) Although there is no clear cut significant evidence anywhere in the data, and in spite of some reverse trends, the data do indicate that the meaning implied by or associated with the stimulus configuration may influence the direction of autokinetic movement. The strongest evidence comes from those subjects who saw the patterns of the double complex drawings move separately. These subjects tended to see the "movement" drawings move sooner or farther than the "non-movement" drawings.

In connection with this conclusion it is interesting to note that very few of the subjects mentioned spontaneously that they were conscious of being influenced by the shape (meaning) of the stimulus. Some of the subjects were questioned, but the results were not satisfactory.

(ii) A trend is noted for the simpler and more direct suggestions (from the stimuli) to be more effective. For example, the single upright arrow is more effective than the circular arrow, and the "non-movement" complex drawings which carry the simple suggestion "stay still" more effective than the "movement" drawings which carry the suggestion of movement in a particular direction.

(iii) Subjects in the high movement group see movement sooner and more persistently as the frame of reference builds up than those who see little movement.

(iv) A learning or practice effect is indicated by the tendency of the latency to decrease and the rheostat readings to

increase on successive trials.

(v) There is either no relation or a negative relation between seeing much movement and seeing the component parts of figures in separate movement. This is indicated by the fact that all those subjects who reported separate movement of the complex drawings were from the low movement group.

(vi) The separate movement of component parts, in this context, also leads to these conclusions of a theoretical nature. First, it supplies another nail for the lid of the coffin of the eye-movement theory. Second, taken in conjunction with the effect of social situations, reported first by Sherif (28) and most recently by Paul (26), it makes untenable the "streaming" theory advanced by Guilford (12). Guilford describes the streams as involving "the whole retina at once", and states that a group of small lights "move in the same general direction". If the first statement is correct how would Guilford account for the report of subject A15: "the bird moves toward the vase, but the distance between them doesn't change". In this case movement occurs in only one object, and yet they are not displaced with respect to each other. This experiment does not confirm his second statement. Third, the results of the patterns, (particularly pattern 3 of Figure 3) tend to support the Gestalt theory of autokinetic movement. It will be noted that in pattern 3 more subjects report movement for the single circle than for the pair of circles. This result would have been predicted on the basis of the Gestalt theory. (19, 573).

B. The effect of the path of phi movement on the path of autokinetic movement:

Experimental Method:

Apparatus:

A small box of three light-tight compartments was set up behind a large screen containing a section of milk glass. Each of the light-tight compartments had a small circular aperture approximately 2 mm. in diameter, in the front. The middle light was supplied with current directly from a transformer connected to the main power supply. The two outside, or lateral, lights were connected, via transformers, to an electronic timer which lighted them alternately. The time interval between successive lightings was variable within a fairly large range. The light tight box was mounted so that the lights could be placed at any angle in relation to the floor. The experimenter and the entire apparatus, except the front, were covered by a black cloth, which prevented the subject seeing any light from the small bulb used to illuminate the experimenter's notes. The room in which the experiment was conducted was not completely absent of light but it was usually twenty to twenty-five minutes before the subject noticed it. Figure 5 shows the experimental room and elevations of the screen. It will be noted that the lights appeared on the screen at approximately eye level. During the experiment the electronic timer produced a loud clicking noise.

Subjects:

Seventeen volunteer subjects were used in the phenom-

enological part of this experiment, and fifteen were used in the "training" series. The first set of subjects were naive, but most of the second set were honours or graduate students in psychology.

Instructions to the subject:

The subjects were asked to describe what they saw. At all times the experimenter was perfectly frank with them.

Procedure:

The procedure was varied slightly with different subjects, but the main outline is as follows:

(i) Establish phi movement for the subject with just the two outside lights. The timer was adjusted until the subject reported phi movement.

(2) The middle, or autokinetic light, was presented alone until autokinetic movement was seen.

(3) With the autokinetic light still on, the phi lights were turned on.

(4) With the phi lights still on, the autokinetic light was turned off.

(5) The autokinetic and phi lights were shown together.

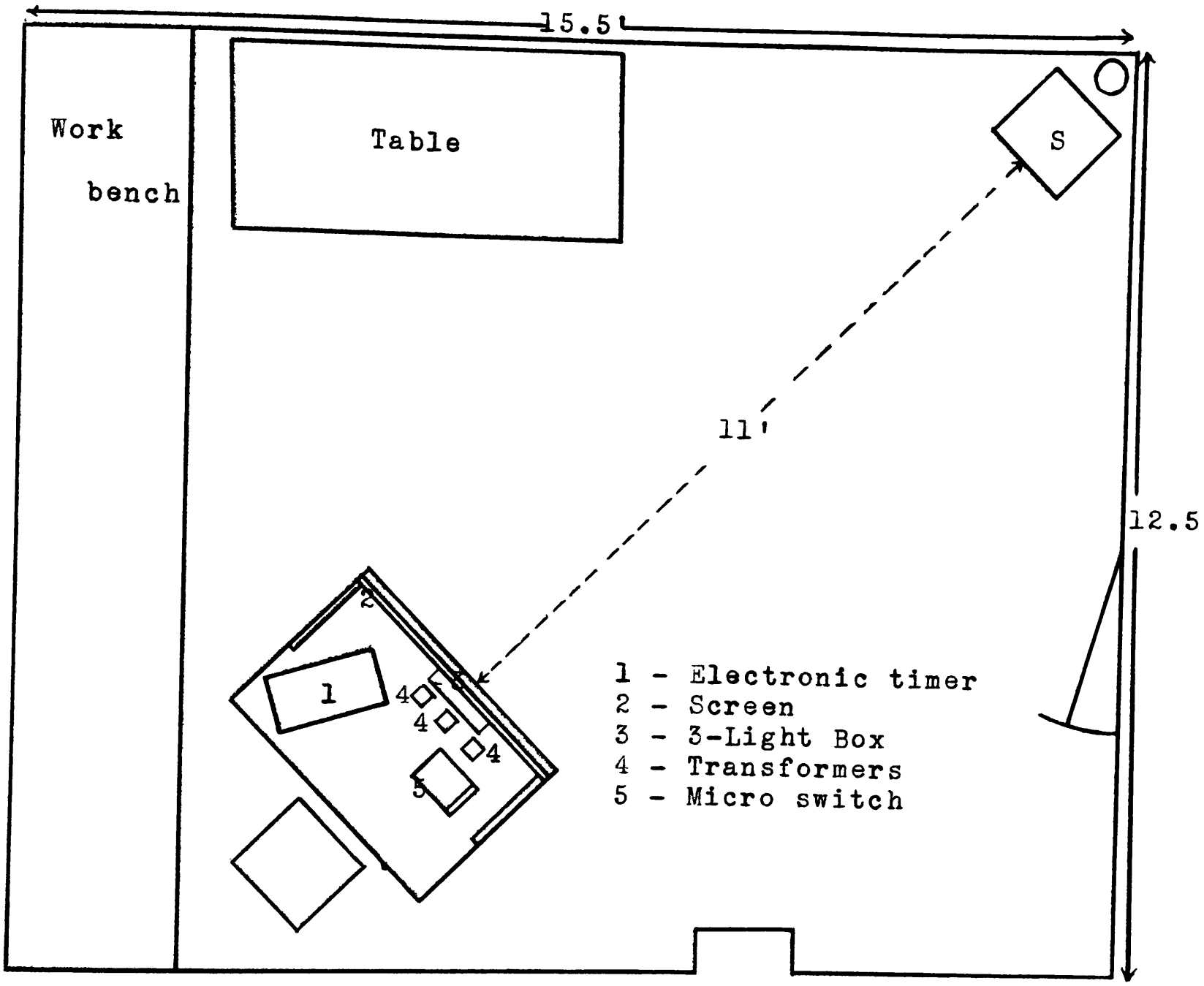
(6) The lights previously parallel with the floor, were turned perpendicular to it.

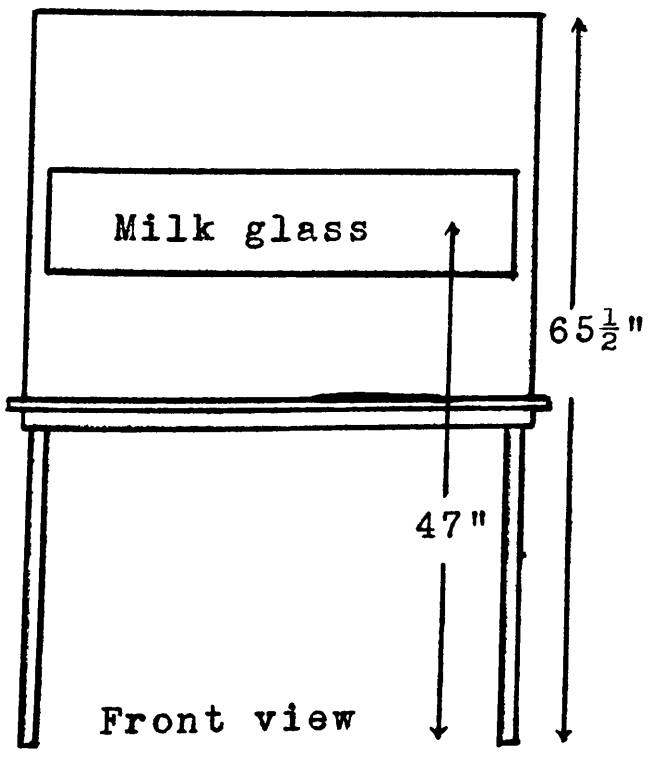
Results:

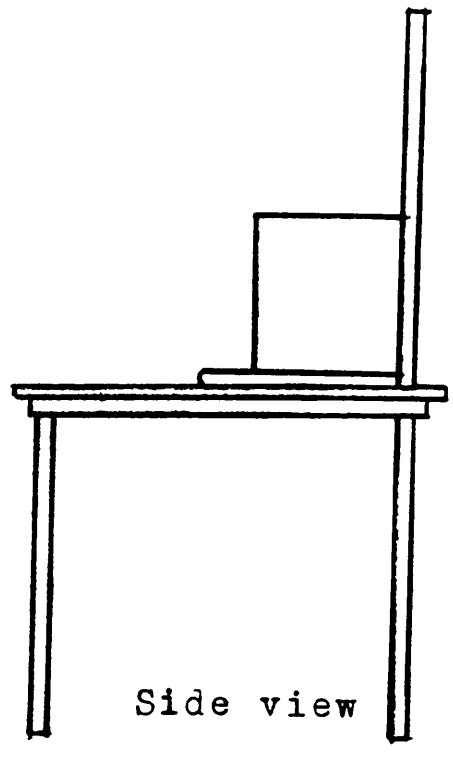
Fourteen of the seventeen subjects report that phi, when first seen moved straight across, two report a curving path, and one a straight path, but the system (that is, the three lights) in autokinetic movement. All the subjects

FIGURE 5

THE EXPERIMENTAL ROOM



reported autokinesis of the single light. The number and types of phenomenological reports for combined phi and autokinesis is given in table 5.

Table 6

Phenomenological reports on combined phi and autokinesis

| No. of subjects [x] | Report |
|---|---|
| 4 | Phi moves straight across A-light |
| 10 | Phi moves behind A-light |
| 1 | Phi moves in front of A-light |
| 1 | Phi moves over A-light |
| 3 | Phi moves under A-light |
| 3 | System still except for Phi movement |
| 7 | System moves as a unit |
| 2 | A-light moves independently of phi lights |
| 1 | A-light "drags" phi lights |
| 2 | Phi moving in orbit around A-light |

[x] The total is more than 17, because some subjects reported more than one illusion.

Following the showing of phi and autokinetic lights together, the autokinetic light was turned off. This was done to see if the path of phi movement would still be deflected. It was thought that this would offer some evidence either for or against the "figural after-effect" theory of Kohler and Wallach (21) as an explanation for autokinetic movement. This was proposed by Graybiel and Clark (11). However, it was not possible for the subjects to report on this with much certainty. It should be noted, however, that one subject at this point reported the light as still, and the darkness moving.

The results of the second presentation of phi and autokinetic lights were similar to the first. When the system was turned ninety degrees, some slightly different effects were reported, these are shown in table 6.

Table 7

Phenomenological reports on combined phi and autokinesis which occured only after the system was rotated ninety degrees to a new position

| No. of subjects | Report |
|---|---|
| 1 | Phi movement only as far as A-light |
| 1 | A-light jumps between the two |
| 2 | A-light is off-centre, the phi movement |
| 1 | A-light "struggles"down, (straight others go up |

The fifteen subjects of the "training" group were treated in a different manner. For the most part they were psychology students who had expressed an interest in the author's experiments. By suggestions and descriptions the author found it possible to "train" the subjects to "see" the lights singly, in pairs, or all three performing in any of the ways reported above. Usually there was an "apprenticeship" period of striving before any particular type of movement could be seen. This was practically universal for the first presentation of phi; this failure to see phi immediately on presentation of the stimuli is reported by several investigators.

Conclusions:

(i) This experiment confirms the results of Smith (32) as to tridimensional apparent movement; none of our subjects

reported phenomena similar to the loop or zig-zag caused by autokinesing phi reported by Karwoski (17).

(ii) The presence of the frame of reference provided by the phi movement, reduced, but in most casesdid not stop autokinetic movement.

(iii) The autokinetic light is capable of tri-dimensional movement.

(iv) In twelve of the seventeen cases the direction of phi movement was altered by the presence of the autokinetic light.

(v) When the three lights move as a system, the autokinetic light usually moves more than the phi lights. The question of induced movement (Dunker, 7) introduces itself here: one subject speaks of the autokinetic light as "dragging" the phi lights, another reports the phi movement as still, and the blackness moving.

(vi) Although the proposed test of the figural after-effect theory was not successful, we feel this experiment casts doubt on its usefulness as our explanation of apparent movement. It is particularly difficult for this theory to account for the two cases in which it was reported that the autokinetic light was to the right or left of the phi lights (which it was not) and that the phi movement was straight, going past the apparently off centre autokinetic light.

(vii) The experience with the "training" group indicates that learning, in some form, may play an important role in the perception of these phenomena.

## III. THE MAIN EXPERIMENT

### Introduction:

The two preliminary experiments raised many questions.. This experiment was designed to answer two of them, namely:

(i) The effect of practice on the direction of autokinetic movement.

(ii) A comparison of the norms set up by social and non-social influence. This choice was made because the preliminary experiments tended to show that suggestion from an individual was more effective than suggestion from the stimulus (second part of preliminary experiment B), and also because of the growing use of the autokinetic effect in social psychology.

### Experimental Method:

### Apparatus:

The apparatus was the same as that used for preliminary experiment B with a few changes. Only two of the three lights were used, and they were wired through a micro-switch which turned one off and the other on; the latency between lights was such that most people saw phi. The distance between the centres of the two lights was two inches.

### Subjects:

Fifty-two volunteer subjects were used. There was no matching of groups, the assignment of the subjects being random. None of the subjects had heard of the autokinetic effect before. All were university students.

### Instructions to the subject:

When the subject was seated, the following was read to him or her:

This is a test of keenness of vision. I am going to darken the room and then I am going to expose a small light for fifteen seconds. After I turn the small light off I want you to tell me what you saw. Watch the light very carefully so you can tell me everything. After you have told me what you saw we will repeat the procedure, I will turn the small light on and again you will report. We will do that twenty five times.

Experimental design:

| GROUP | TEST I | TEST II |
|---|---|---|
| A (control) 24 subjects | 25 15-second exposures of a single light | 25 10-second exposures of a single light |
| B (Phi) 14 subjects | 25 15-second exposures. After 7 seconds the original light went off and a secondary light 2 inches 45 degrees up to the right came on (phi movement). | 25 10-second exposures of a single light |
| C (Social influence) 14 subjects | 25 15-second exposures of a single light. A confederate would report movement up and to right to the experimenter every time. | 25 10-second exposures of a single light |

Test II was held one week after Test I, and was the same for each group. Subjects in C group were introduced to the confederate and told, "he is very good at this". The exposure time was reduced for Test II because it was found that the subjects could not remember all that they saw during a fifteen second exposure; while 15 seconds

were necessary on Test I because of the longer latency. A mimeographed record form was used to facilitate recording of subject responses, which were not taken verbatim but in the form of arrows indicating the direction or directions reported.

Scoring of records:

A study of the records showed they could be scored in eight movement categories, separated by 45 degrees, and a ninth category for those trials on which no movement occured. A score of one was given for every trial in which movement in a given direction was reported one or more times. Since more than one direction could be reported in one trial, it is possible for the total to be over twenty-five. Circular movement was not often reported, but it was usually seen first as diagonal movement, and reported that way until a change of direction occured. For this reason, as well as for simplicity of scoring, circular movement was scored as movement on the various diagonals.

Results:

In Table 8 are the means and standard deviations for all groups except Test I for groups B and C. A comparison was made between the retest performance of those subjects in the "social evidence" group who "accepted" the suggestions of the confederate by reporting movement up to the right in nineteen or more trials of Test I (6 subjects), and those who reported less than nineteen such movements (18 subjects);

these results are shown in Table 9.

Table 8

Means and standard deviations of movement scores for movement categories by experimental groups

| Movement | Control Test I | | Control Test II | | Phi Test II | | Social Evidence Test II | |
|---|---|---|---|---|---|---|---|---|
| Direction | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| ↗ | 4.67 | 4.95 | 5.75 | 4.08 | 6.36 | 5.08 | 10.57 | 8.01 |
| ↖ | 4.96 | 4.52 | 5.71 | 4.08 | 4.14 | 3.31 | 1.64 | 2.02 |
| ↙ | 2.04 | 2.04 | 2.38 | 2.54 | 2.14 | 2.90 | 2.36 | 3.64 |
| ↘ | 3.21 | 3.38 | 2.79 | 3.20 | 2.21 | 2.22 | 3.43 | 5.47 |
| ↑ | 4.54 | 2.89 | 7.04 | 4.59 | 5.29 | 4.60 | 3.50 | 2.94 |
| ↓ | 2.63 | 3.34 | 2.83 | 2.75 | 0.79 | 1.82 | 2.14 | 2.80 |
| → | 2.79 | 3.03 | 3.13 | 3.06 | 2.43 | 2.47 | 0.79 | 1.56 |
| ← | 1.58 | 1.70 | 1.54 | 2.31 | 2.00 | 3.38 | 0.71 | 1.10 |
| Still | 7.75 | 7.40 | 3.92 | 6.77 | 6.86 | 8.70 | 4.21 | 7.25 |
| Total Movement | 26.42 | 14.11 | 31.17 | 13.03 | 25.36 | 12.59 | 25.21 | 10.79 |

Table 9

Means and standard deviations of movement scores of the "acceptors" and "rejectors" of the social suggestion

| | Acceptors | | Rejectors | |
|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. |
| ↗ | 17.67 | 7.41 | 7.50 | 7.00 |
| ↖ | 1.17 | 1.46 | 2.00 | 2.29 |
| ↙ | 0.83 | 1.22 | 3.50 | 4.36 |
| ↘ | 5.00 | 6.95 | 2.25 | 3.90 |
| ↑ | 2.67 | 1.10 | 4.13 | 3.65 |
| ↓ | 2.33 | 2.50 | 2.00 | 4.36 |
| → | 1.17 | 2.19 | 0.50 | 0.71 |
| ← | 0.50 | 1.12 | 0.88 | 1.06 |
| Still | 1.33 | 1.97 | 6.38 | 8.84 |
| Total | 28.33 | 9.47 | 22.75 | 11.36 |

Measures of significance of difference of means were made between Test I and Test II of group A, between Test II of group A and Tests II of groups B and C, between Test II of group A and the two sub-groups of Test II of group C and between the two sub-groups of Test II of group C. The only means that showed a statistically significant difference were some of those arising from comparison of test and retest of the control group. They were: increase of total movement in Test II over Test I (probability of .012), and decrease in number of trials in which no movement was seen (probability of .001), and increase of movement straight up (probability of .002). Most of the other differences between means were smaller than one standard deviation. This result is not surprising when one notes that in Table 8 most of the standard deviations are larger than the means. However, the data do show some trends which are of interest. We shall draw some tentative conclusions under two headings corresponding to the two questions we asked.

Conclusions:

(i) The effect of practice on the direction of autokinetic movement: As was noted above, (comparison of Test I and Test II of group A) there is a significant increase of movement with practice and a significant increase in upward movement. The increase of movement up to the right on Test II of group A is significant to the .097% level. Otherwise practice has no significant effect on direction of movement.

(ii) Comparison of norms: The social influence seemed to produce a greater change than the non-social evidence. As

compared to Test II of group A the greatest changes for group C occur in the upper half of the visual field where movement up to the right is increased, and all other movement decreased. Those subjects who appeared to be influenced by the confederate ("acceptors") give more reports of movement up and to the right, in Test II, than the "rejectors".

The phi group shows less total movement and more trials with no movement than in the first test; the general tendency is for less movement. Their experience seems to have made them more critical in their judgment of autokinetic movement.

## IV. DISCUSSION

Although the types of suggestions which were used in this experiment made little significant difference in the direction of autokinetic movement, the data do show trends which suggest strongly that the suggestions presented did have some effect.

This experiment and other experiments on autokinetic movement have revealed great individual differences in ability to see autokinetic movement. The considerable skew found in the movement data of the main experiment suggests that some who saw little or no movement might have seen movement under optimum conditions; the experimental conditions were not optimum, and this probably resulted in the cutting off and lumping together of a considerable area of the curve. To be sure about the significance of the results it would be necessary to find optimum conditions, and to increase the number of trials.

The trend revealed by the data is quite simple; the simpler and more direct the evidence, the more effective it is. Movement in a given direction implied by the meaning associated with the stimulus is the least effective (first preliminary experiment); actual description of movement and persuasion the most effective (second part of second preliminary experiment).

The only statistically significant changes are the tendency for more total movement, and more upward movement with practice.

We wish to state, paranthetically, that many "other"

illusions were reported during the experiments. Many subjects, particularly those who saw little or no autokinetic movement, reported gamma movement (Lindemann, 21) either as a change in size or as advancing and receding of the stimulus. Induced movement, (Duncker, 7) either of other stimuli, of the observer, or of the darkness were reported. Later we shall propose a common explanation of these effects and autokinetic movement.

The results of the experiment support the Gestalt theory as stated by Koffka and quoted earlier. The more stimulus objects in the field the less the movement; the more isolated an object the more the movement. Certainly the observed phenomena are too complex to be explained by any "streaming phenomena", regardless of its locus.

Koffka (20,79) points out that the distinction between normal and illusory perception disappears as a psychological distinction as soon as we become aware of the fallacy which it implies, much as it may remain as an epistemological distinction. He further says (p.300) that visual motion, being at bottom arbitrary and unpredictable, is an affair of mental sets or attitudes, the stimulus pattern being of secondary importance. Our experiments give further support to this.

Morgan (24) says it is improbable that the cortex is the locus of the interaction effect responsible for apparent movement. He cites the evidence of Smith and Kappauf (33) who, in a study on cats, found complete bilateral removal

of the striate cortex failed to abolish the reaction. They suggest the response of apparent movement is mediated by the superior colliculi or pretectal neuclii of the midbrain. The complexity of the perceptions reported by our subjects casts doubt on the extension of this conclusion to humans.

Lorente de No (23) has illustrated how there may be a point to point projection from retina to visual cortex in spite of the diffuse anatomical projection. Thus, steady fixation of a point of light would involve the repeated firing of the same neurons. Hebb (15) discusses what he calls a neural short-circuit which is due to repeated firing of a sequence of neurones. As an example he gives the gradual disintegration of the familiarity of a word which takes place as we repeat the word many times. We suggest that the movement of a point of light is analogous to this.

The short circuit may result in several phenomena, depending presumably upon the nature of the individual nervous system and upon, what Hebb calls, "the central autonomous factor," which is comparable to the sets and attitudes discussed by Koffka. The effects may be autokinetic movement, changes in the size of the light (gamma movement) or movement of some other aspect of the environment (induced movement). The central autonomous state (expectation, set) may influence the direction of movement by favoring short circuit in one direction over other directions.

This explanation of autokinetic movement raises another question: "Why do not the objects of everyday experience move as does the autokinetic light?" Perhaps the tendency

to short circuit is less when more phase sequences are firing. This hypothesis seems preferable to an "interpretation" hypothesis.

The "apprenticeship" period or latency may be the time before short circuiting takes place, and therefore dependent in part upon the neurophysiology of subject. It would be interesting to seek correlations between latency and intelligence.

Summary:

An attempt was made to discover the role of evidence in determining the direction of autokinetic movement. In various experiments meaningful stimuli, a frame of reference in phenomenal movement, social evidence, and evidence of phenomenal movement were used. The results indicate the more explicit and simple the evidence, the greater the effect, but in no cases were the results striking. It was concluded that the direction of movement may depend upon a "neural short-circuit" mediated by physical laws, but influenced to some degree by an autonomous central factor, which we have here called expectation. It is further suggested that this same explanation may be applied to gamma movement and induced movement.

# APPENDIX A

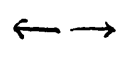
## Movement Data For Complex Drawings and Figures

### (1) Total Group

| PATTERN | ↗ | ↖ | ↙ | ↘ | ↑ | ↓ | → | ← | ↕ | ↔ | No consistency | No consistency | No. of Cases |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 2 | 3 | 5 | 0 | 8 | 0 | 3 | 7 | 1 | 1 | 6 | 0 | 36 |
|  | 2 | 4 | 0 | 0 | 5 | 1 | 5 | 7 | 0 | 3 | 8 | 1 | 36 |
|  | 0 | 3 | 0 | 0 | 5 | 1 | 7 | 3 | 4 | 2 | 4 | 0 | 29 |
|  | 5 | 0 | 2 | 0 | 12 | 1 | 1 | 2 | 4 | 4 | 6 | 1 | 38 |
|  | 2 | 0 | 0 | 0 | 5 | 5 | 3 | 5 | 4 | 2 | 7 | 0 | 33 |
|  | 0 | 3 | 0 | 0 | 3 | 2 | 6 | 8 | 0 | 0 | 7 | 0 | 29 |
| STOOL | 5 | 1 | 1 | 0 | 2 | 2 | 1 | 3 | 2 | 6 | 11 | 0 | 34 |
| CHUTE | 1 | 2 | 2 | 3 | 9 | 0 | 5 | 2 | 3 | 3 | 6 | 1 | 37 |
| VASE | 3 | 1 | 3 | 0 | 5 | 0 | 6 | 3 | 5 | 4 | 6 | 1 | 37 |
| BIRD | 0 | 1 | 3 | 0 | 5 | 3 | 5 | 7 | 3 | 4 | 5 | 0 | 36 |
| TREE | 3 | 0 | 0 | 2 | 3 | 2 | 6 | 6 | 4 | 5 | 5 | 0 | 36 |
| PLANE | 7 | 2 | 2 | 0 | 5 | 0 | 9 | 1 | 0 | 2 | 5 | 0 | 33 |

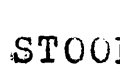
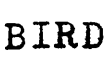
# APPENDIX A

## (2) High Movement Group

| PATTERN | ↗ | ↖ | ↙ | ↘ | ↑ | ↓ | → | ← | ↕ | ↔ | Sti-ll | sist-ency | No con- of cases |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 0 | 1 | 1 | 0 | 2 | 0 | 2 | 3 | 0 | 0 | 3 | 0 | 12 |
|  | 2 | 2 | 0 | 0 | 2 | 0 | 2 | 3 | 0 | 1 | 0 | 0 | 12 |
|  | 0 | 1 | 0 | 0 | 2 | 0 | 5 | 2 | 0 | 1 | 0 | 0 | 11 |
|  | 2 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 12 |
|  | 0 | 0 | 0 | 0 | 2 | 4 | 2 | 3 | 0 | 0 | 0 | 0 | 11 |
|  | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 0 | 0 | 1 | 0 | 11 |
| STOOL | 3 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 10 |
| CHUTE | 0 | 1 | 0 | 1 | 5 | 0 | 2 | 0 | 0 | 0 | 2 | 1 | 12 |
| VASE | 1 | 0 | 3 | 0 | 1 | 0 | 2 | 1 | 1 | 0 | 3 | 0 | 12 |
| BIRD | 0 | 1 | 3 | 0 | 3 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 12 |
| TREE | 1 | 0 | 0 | 0 | 1 | 0 | 3 | 3 | 2 | 1 | 1 | 0 | 12 |
| PLANE | 2 | 1 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 8 |

# APPENDIX A

## (3) Low Movement Group

| FIGURES | ↗ | ↖ | ↙ | ↘ | ↑ | ↓ | → | ← | ↕ | ↔ | Still | No consistency | No. of Cases |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 2 | 2 | 4 | 0 | 6 | 0 | 1 | 4 | 1 | 1 | 3 | 0 | 24 |
|  | 0 | 2 | 0 | 0 | 3 | 1 | 3 | 4 | 0 | 2 | 8 | 1 | 24 |
|  | 0 | 2 | 0 | 0 | 3 | 1 | 2 | 1 | 4 | 1 | 4 | 0 | 18 |
|  | 3 | 0 | 2 | 0 | 4 | 1 | 1 | 2 | 3 | 3 | 6 | 1 | 26 |
|  | 2 | 0 | 0 | 0 | 3 | 1 | 1 | 2 | 4 | 2 | 7 | 0 | 22 |
|  | 0 | 1 | 0 | 0 | 2 | 1 | 3 | 5 | 0 | 0 | 6 | 0 | 18 |
| STOOL | 2 | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 2 | 5 | 10 | 0 | 24 |
| CHUTE | 1 | 1 | 2 | 2 | 4 | 0 | 3 | 2 | 3 | 3 | 4 | 0 | 25 |
| VASE | 2 | 1 | 0 | 0 | 4 | 0 | 4 | 2 | 4 | 4 | 3 | 1 | 25 |
| BIRD | 0 | 0 | 0 | 0 | 2 | 2 | 4 | 5 | 2 | 4 | 5 | 0 | 24 |
| TREE | 2 | 0 | 0 | 2 | 2 | 2 | 3 | 3 | 2 | 4 | 4 | 0 | 24 |
| PLANE | 5 | 1 | 1 | 0 | 4 | 0 | 7 | 1 | 0 | 2 | 4 | 0 | 25 |

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