5-1961

An Investigation of the Horizontal-Vertical Illusion

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AN INVESTIGATION OF THE HORIZONTAL-VERTICAL ILLUSION

A Thesis

Presented to

the Faculty of the School of Graduate Studies

of

Western Michigan University

In Partial Fulfillment

of the Requirements for the degree

of Master of Arts

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by

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Grand Rapids, Michigan

May, 1961

ACKNOWLEDGMENTS

The author wishes to express his sincere gratitude to Professor Frank A. Fatzinger for his assistance and valuable guidance in the directing of this dissertation. The author also wishes to express his appreciation to Dr. E. J. Asher, Jr., for his guidance in the complexities of the statistical analyses. A further word of thanks is due to Professor S. Kuffel for his constructive criticisms of this paper, and H. Farris for his aid in experimentation.

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AN INVESTIGATION OF THE HORIZONTAL-VERTICAL ILLUSION

Survey of the Literature

Experimenters have used the inverted "T" to illustrate the horizontal-vertical illusion for many years. This illusion is characterized by the subject perceiving the horizontal line as shorter than the vertical line.

Credit is usually given to Fick (1851) for being first to call attention to the discrepancy between horizontal and vertical estimates. He demonstrated this by visually noticing that a bright square on a dark background looks like an oblong object. Hicks (1906) stated that Oppel was the first person to actually investigate the horizontal-vertical illusion.

The classical theory generally states that an equal length vertical line in a "T" figure will be regarded as being longer than a horizontal line only because of the horizontal-vertical relationship. This theory stood unchallenged until Pan (1936) suggested a possible interaction between the horizontal-vertical illusion and the illusion produced by a single division of a line (bisected line illusion). Titchener (1901) found that a single division of a line tends to shorten its apparent length.

This interaction explanation was not further developed

until Finger and Spelt (1947) published a study on this interaction effect. This research supported their theory that the "T" illusion was an additive interaction of a horizontal-vertical illusion and a bisected line illusion. They tested this illusory effect by using a sliding black tape as the variable line against a glossy-white background. Four figures were tested; the "L" form, the "L" rotated clockwise 90°, the inverted "T", and the inverted "T" rotated 90°. These figures were shown to seventy-two subjects in a balanced order so that the learning was equated. Every subject was given two sets of ten trials on each of the four figures. The psychophysical method of average error was used in obtaining the data. Slightly over two-thirds of the subjects overestimated the vertical (stem) line in the inverted "T" figure. However, one-quarter of the subjects underestimated the stem line. The prediction that the inverted "T" figure would produce a larger percentage of illusion than the inverted "T" rotated 90° was confirmed at the .01 level of confidence. Finger and Spelt concluded that the total results obtained on the figures supported their hypothesis that the perceptual error in the inverted "T" figure was an interaction between the horizontal-vertical and the bisected line illusion.

Fatzinger (1949) was prompted by the contradiction of the minority results in Finger and Spelt's experiment to

further investigate the interaction between the horizontal-vertical and the bisected-line illusion. He found that the amount of illusion of the "T" figure placed on its side did decrease, but a large base to stem illusion still remained. According to Finger and Spelt, the bisected-line illusion should account for this remaining overestimation of the base line because the horizontal-vertical illusion was reversed. Fatzinger stated that the bisected line is too weak an illusion to account for the large amount of illusion still present when the "T" figure was laying on its side.

Kunnapas (1955) investigated a number of different horizontal-vertical figures including the inverted "T". According to his hypothesis "we overestimate the dividing line as compared with the divided line, irrespective of whether the direction is vertical or horizontal."

Kunnapas tested this hypothesis by drawing the horizontal-vertical figures on white cardboard squares with black India ink. The length of the horizontal divided line was 50 mm., while the length of the vertical dividing line varied from 36 to 64 mm. in 1 mm. intervals. The vertical lines dichosected the horizontal line at nine different positions. The resultant 261 figures were represented on separate cards.

The subjects were exposed to one figure at a time in a prearranged order. Their task was to report whether the

dividing line was longer, equal, or shorter than the divided line. Each figure was presented in four different positions. These positions were obtained by rotating the cards clockwise in 90^0 steps. The point of subjective equality (PSE) was taken as the significant measure of the subject's responses for each of the nine divisions.

Kunnapas concluded that the vertical-horizontal figure is subject to two illusions. The first is the classical overestimation of the vertical line, and the second is the underestimation of the divided line. In this case, the maximum illusion of the divided line was obtained at the midpoint. As the division (dichosection) was moved away from the midpoint, the illusion became weaker.

When the dividing line was vertical, the two illusions operated in the same direction. However, when the dividing line was horizontal, the two illusion acted in opposite directions. As the dichosection approached the "L" figure, the dichosection illusion became smaller until only the classical horizontal-vertical illusion was operating.

The present writer argues that the "L" and "T" figures are balanced "good figures." When the unequal dichosection figure is used the figure balance or symetry was destroyed. The absence of figure balance could produce the lower illusion values. The loss of the bisection could play only a minor part in the drop in illusion size.

The research presented in the first experiment in the

dissertation was designed to test whether the bisected line illusion will be as great as that postulated by Kunnapas. It is hypothesized that the length of the vertical dividing line that bisects the horizontal divided line will be the major factor affecting the amount of illusion.

The apparatus[1] used in the two experiments reported in this thesis was a 21-inch long, light-tight, octagonal box made of 3/8 inch plywood. The box was constructed to house a fluorescent "T" or "L" figure. One side of the box was hinged to permit changes in the lines.

The eyepiece through which the subject looked and the control knob were located on the outside front end of the apparatus. The knob was connected to a gear rack shaft that extended the length of the box. At the exterior back end it was attached to a calibrated millimeter dial. The millimeter calibrations of this dial allowed the experimenter to read the variable lengths of the lines that were set by the subjects.

The gear rack was designed to carry two separate masks so that the variable line would shorten or lengthen as the control knob was moved. A strip of 3/64-inch x 8 inch fluorescent paper[2] was glued on a stationary metal strip

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1. The reader is referred to Fatzinger (1951) for pictures and a more complete description of the apparatus used.

2. Purchased from: The Stroblite Company, 75 West 45th Street, New York, New York.

parallel to the masks. Another metal strip faced with fluorescent paper perpendicularly bisected the base strip. Four inside masks were geared to control levers on the outside of the apparatus. These masks allowed the experimenter to block off various segments of the lines so that different combinations of the "T" and "L" figures could be constructed without opening the box.

Two, two-watt, ultra-violet, argon-glow bulbs[3] were placed in sockets on the inside front of the apparatus to produce the ultra-violet light. A green plastic filter was placed inside the apparatus over the eyepiece to eliminate any possible internal visual cues.

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3. ibid.

EXPERIMENT ONE

Introduction

The hypothesis tested in this study is divided into two parts: (1) the major factor determining the amount of illusion will be the length of the vertical dividing line which bisects the horizontal divided line, and (2) the bisected illusion will not be as great as that postulated by Kunnapas (1955). In other words, varying lengths of the bisecting line should cause the subject to vary his estimates of the horizontal line.

Method

Subjects. - One hundred and twenty college students from General Psychology classes at Western Michigan University served as subjects. These individuals were randomly divided into six equal groups of 20 subjects per group.

Apparatus modifications. - The stem of the inverted "T" figure in this experiment was constructed so that the experimenter could vary the length of this line manually from zero to 70 millimeters. The vertical line was a 3/64 inch wide "washy" yellow fluorescent line. A "poor" vertical line was selected since the subject was instructed to ignore this line in making his judgments. This vertical line bisected the clear sharp green fluorescent horizontal line.

The figures used in this experiment are illustrated in Figure 1. The construction of the apparatus made it possible to determine the amount of illusion associated with different lengths of the bisecting line.

Procedure. - The reading of the instructions and the testing period consumed approximately five minutes per subject. The instructions read to the subjects in this experiment are presented in Appendix A. Each subject was told to produce a two inch horizontal line by turning the knob on the apparatus while visually inspecting the figure and ignoring the vertical bisecting line. The first setting made by the subject was considered a practice setting and was not recorded. The experimenter set the starting lengths of the dependent variable (horizontal variable line) alternately too long or too short to cancel this contaminating variable. The psychophysical method of average error was used in this experiment. The horizontal line was adjusted each trial to a perceived length of two inches. Each subject was given a set of eleven trials.

Results

The means obtained by average error are given and graphed in Figure 2. The summary table of the analysis of variance is presented in Figure 3. This table shows a significant difference found between figures at the 5% level

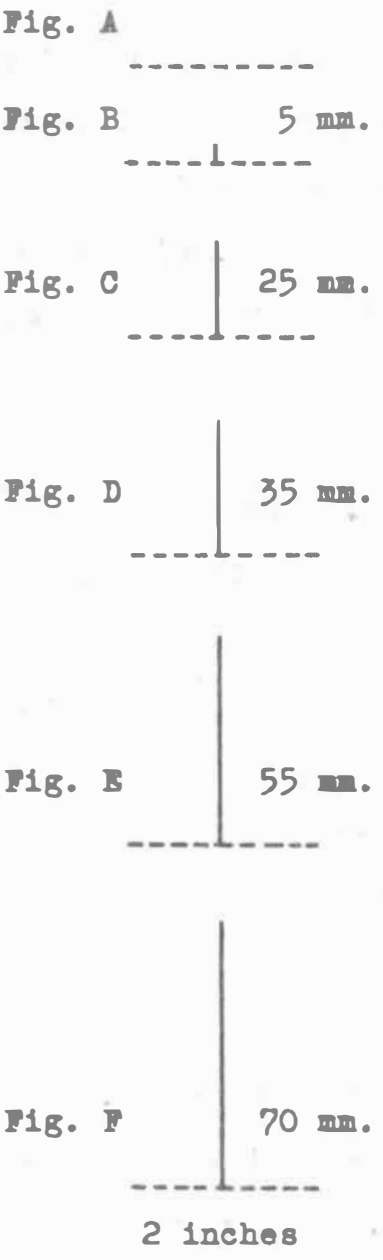


Fig. 1. Figures used in estimating the length of a two inch horizontal line.

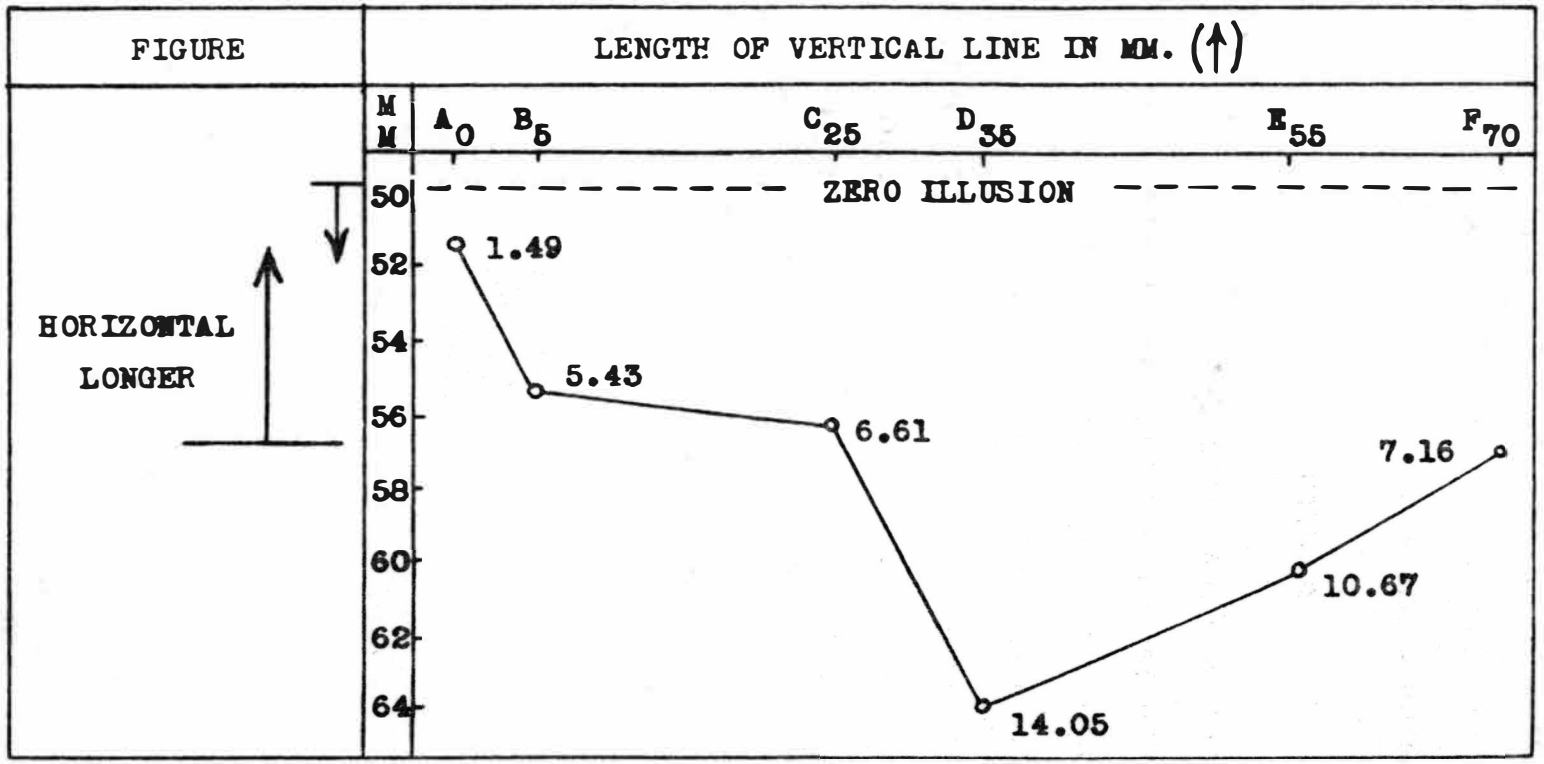


Fig. 2. Mean error in reproducing a 2 inch horizontal line with different lengths of the vertical line.

Source	Sum of Squares	df	Variance Estimate	F
Between Figures	1,885.83	5	377.17	2.39*
Within Cells	17,948.37	114	157.44	
Total	19,834.20	119		

* P=.05, df=5/114

Fig. 3. Analysis of variance summary table.

($F=2.39$, $df=5/114$). These results indicate that the variable lengths of the vertical lines do affect the estimation of a two inch horizontal line.

Duncan's Multiple Range Test (Edwards, 1960) was run to compare the treatment means. Figure 4 shows the results of Duncan's test for the six treatments. The only significant difference found was between D-A at the 5% level. The testing of D-B yielded a difference of 8.62. This is insignificant because it does not exceed $R_5=11.17$, the shortest significant range for five means. It is not necessary to run further tests between subsets B,C,F,E, and D because D-B yielded no significant difference. Any two means underscored by the same line in Figure 4 do not differ significantly; any two means not underscored by the same line do differ significantly.

It should be noted before accepting these results that Duncan's test is based upon the concept of protection levels. In this case the experimenter chose $P=.05$. The protection level based on these six means and degrees of freedom would therefore be 75 per cent. The chances of obtaining a significant difference are then actually 75 times out of 100, rather than 95 times out of a 100 as would be expected. It should also be remembered that Duncan's test is a two-tailed test.

	A	B_5	C_{25}	F_{70}	E_{55}	D_{35}	Shortest Significant
Means	1.49	5.43	6.61	7.61	10.67	14.05	Ranges at P=.05
A 1.49		3.94	5.12	6.12	9.18	<u>12.56</u>	R_6 = 11.35
B 5.43			1.18	2.18	5.24	8.62	R_5 = 11.17
C 6.61				1.00	4.06	7.44	R_4 = 10.92
F 7.61					3.06	6.44	R_3 = 10.56
E 10.67						3.38	R_2 = 10.02
	A	B	C	F	E	D	

Note: Any two treatment means underscored by the same line are not significantly different.

Fig. 4. Duncan's multiple range test as applied between six treatment means.

Discussion

The purpose of this experiment was to test the hypothesis that the major factor determining the amount of illusion in an inverted "T" figure will be the length of the vertical dividing line, rather than the operation of the bisected line illusion.

The results obtained in this study provided limited support for the hypothesis. The illusion became greater as the length of the vertical line approached the point of subjective equality (PSE). This (PSE) is defined as the point at which the average subject perceived the lines as being equal in previous research. This illusion size change can be seen by examining the differences between groups B and D in Figure 2. The horizontal line that was not bisected produced the least amount of illusion. The total results do not support Kunnapas' (1955) conclusion of the bisected line illusion. If the bisected line illusion were actually operating as strongly as he postulated, a significant difference should have been found between every group that was tested against group A. Duncan's test showed a significant difference only between groups D and A.

The graphical results of this study went in the predicted direction; however, significant statistical differences were only found for the extremes. The comparison of

group A with line only and group D with line plus bisection yielded the only significant difference between the groups. If the bisected line illusion was operating, there should have been a significant difference between groups A to B,C,E, and F.

This experimenter argues that a balanced "good figure" is the important factor affecting the horizontal-vertical illusion. Kunnapas (1955) destroyed this balance by using a dichosection rather than a bisection method of dividing the horizontal line. His figures are not appropriate for testing the amount of illusion of different lengths of vertical bisecting lines as used in this present study. This writer argues that as the subject's estimation of the two inch horizontal line approaches the PSE the subject tries to make the "good figure" by underestimating the horizontal line and ends up making it longer than two inches. When the vertical line was not present, the subject's per cent of error was very small. As the length of the vertical line increased to about 35 mm., the percentage of error also increased. Beyond 35 mm., the percentage of error showed a decreasing trend. Whether this trend is significant can only be determined by running additional larger groups with the length of vertical lines used in this experiment and with additional lengths. These "new" groups should give a more accurate picture of the variable line vertical illusion influence. The increase in the number of

subjects in each group would help counteract the great amount of intersubject variability.

Summary

This experiment used 120 college students as subjects to explore the "T" illusion. Six groups were tested with varying vertical line lengths. Each subject was told to estimate the length of a two inch horizontal line by turning the knob on the apparatus while visually inspecting the figure and ignoring the vertical bisecting line.

The results obtained lend some support to the hypothesis that the amount of illusion was influenced by the length of the vertical line, and that the bisection illusion was not a major determiner of the illusion with the inverted "T" figure.

A figure balance "good figure" is proposed as the main factor influencing the illusion. Kunnapas (1955) destroyed this balance as soon as he used the dichosection instead of the bisection. Further research with this basic experimental design is required before any definite conclusions can be drawn regarding the factors influencing the horizontal-vertical illusion.

EXPERIMENT TWO

Introduction

Fatzinger (1951) used the 10:30 o'clock "T" figure and the regular "L" figure to observe changes in illusion of these figures over a long series of trials. The apparatus used by Fatzinger was the same one that was used in the research reported in this paper.

He presented these figures to five subjects over a period of five days. Each subject received ten settings on one figure before switching to the other figure. These sets of 10 trial settings were continued until the subject had judged each figure three times on each day. Immediately after completing the settings on the fifth day new rotations of the "T" figure were introduced at 6:00 and 4:30 o'clock.

Fatzinger found that there was a drop in illusion of the "T" figure from day to day and within trial settings. No change was found in the "L" figure from day to day or within trial settings. In general the amount of illusion of the "L" remained constant and consistently lower. If a "practice effect" were operating in this experiment it should have been present in both figures. To explain this differential response Fatzinger used Köhler's hypothetical construct of "satiation."

Allport (1958) discusses Köhler's "satiation" theory (electrotonus), which is one part of the Gestalt cortical field theory. He stated that "when a current has been passing through a medium for some time its effects alter the medium". In other words, prolonged visual exposure to the "T" or "L" figure should change its appearance. It is hypothesized that chemical deposits accumulate on the interfaces of the cells causing polarization of membranes that alter or oppose the current's passage in the same direction.

Fatzinger (1951) hypothesized that the "T" figure is more highly satiated at the point of bisection than is the "L" figure. The "T" figure satiation is explained as the result of the two right angle vectors in the "T" figure. He believes that these relatively closed areas could produce two vectors of displacement which should push the base line away from the stem. This displacement could cause the vertical line to appear longer. The satiation of the "L" figure is described as a balanced distribution effect across the arc of the 90 degree angle. He hypothesized that this "equalness" of satiation could displace each line of the "L" figure an equal distance even though the open ends of the lines were less affected than the apex section.

Fatzinger found that the "T" figure illusion on the first day was approximately 20 per cent, and the illusion

decreased day to day to about 5 per cent on the final day (day 5) of testing. The illusion of the "L" figure remained constant at approximately 3 per cent over the five day testing period. The results obtained supported the "satiation" theory. The major limitation of this study was the small number of subjects and trials used.

On the final day of testing Fatzinger introduced "new rotations" of the "T" figure. The amount of illusion obtained on the last day was approximately the same as that obtained on the first day. The reversion to the original illusion size with the "T" figure was also interpreted as support for the "satiation" hypothesis. These results did not support a "good figure" hypothesis. The "new" figures should have elicited approximately the same amount of illusion as the last set of the original "T" test figures if a "good figure" hypothesis was to be supported.

The second experiment presented in this dissertation is an attempt to re-evaluate the findings of Fatzinger using a larger number of subjects and continuing the testing period over a longer period of time. This experiment was designed to determine how much of a drop in the "T" and "L" illusion would occur from day to day over an eleven day period, and the amount of illusion that would be obtained on the "new" rotations of the "T" figure on the final day. The experimenter hypothesized that the amount of "L" figure

illusion would remain fairly constant, while the "T" figure would decrease towards zero illusion.

Method

Subjects. - Eighteen inmates of the Southern Michigan State Prison, who were completely naive as to the purpose of the experiment, were used as subjects. Their IQ's ranged from 92 to 112. The age spread was 20 to 39 years. These subjects were divided into two equal groups.

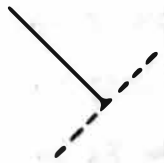
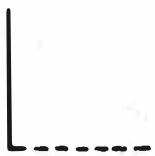
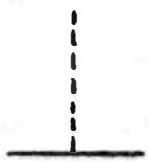
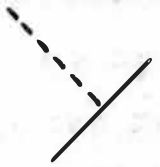
Apparatus modification. - In this experiment the apparatus was modified slightly by gluing green fluorescent paper on both the stem and base lines. Two varieties of the "T" and "L" figures were used. In the first figure the base line was the variable while in the second the stem line was the variable. The standard lines in these figures were always 50 millimeters long. When the base line was the variable in the "T" figure, one complete revolution of the control knob resulted in a 150 millimeter change; however, when the stem was the variable, one complete revolution produced a 75 millimeter change. In the "L" figure, one complete revolution of the control knob resulted in a 75 millimeter change with either line as the variable.

Procedure. - Each subject was seated in a chair in front of the apparatus. There were no lights on in the room during the testing period, but a small amount of external light

did penetrate the room from two, small, shaded windows. The amount of light in the room was kept to a minimum to give the individual's eyes an opportunity to become partially dark-adapted.

The psychophysical method of average error was used in obtaining the data. This method requires the subject to match a constant stimulus by adjustment of the variable stimulus. The length of the line for each setting was read and recorded from the dial as millimeters of error. On alternate trials the experimenter attempted to randomize the order of presentation by making the variable line either too long or too short. The subject's task was to look into the apparatus and adjust the control knob so that the lines appeared to be subjectively equal in total length. The reader is referred to Appendix B for the instructions read to the subjects.

The figures were presented in the order positions shown in Figure 5. It should be noted that both the stem-variable and the base-variable figures were tested. The 10:30 o'clock "T" figure and the horizontal-vertical "L" figure were used for the first eleven days. On the final day (day 12) new rotations of the "T" were introduced at 6:00 and 4:30 o'clock. No knowledge of results was given to any subject. The nine subjects in Group I were tested first with the base-variable "T" figure at 10:30 o'clock, and then with the vertical-variable "L" figure. The second group of subjects was tested

Groups	Rotations Days 1-11		New Rotations Day 12	
I N=9	 10:30	 H-V	 6:00	 4:30
II N=9	 10:30	 H-V	 6:00	 4:30

*(----)=Variable line

Fig. 5. Figures used to test the "T" and "L" illusions.

first with the stem-variable 10:30 o'clock "T" figure, and then with the horizontal-variable "L" figure. After making 10 settings on the first figure, the subject switched to the second figure for an equal number of trials. Each figure was presented three times per day. The results of the 30 settings for each figure were averaged for the subject's score on that day. On the twelfth day, new rotations of the "T" figure were introduced at 6:00 o'clock and 4:30 o'clock.

Before each trial the experimenter randomly set the variable line either too long or too short. The starting lengths of these lines were also varied. This variation was introduced so the various pre-trial settings of the variable line would not "pull" the subject's judgment in either direction. Fatzinger (1951) found this "pulling" effect to influence the subject's judgment.

Results

The mean length of each set of ten trials was used for a stable measurement score. The means were obtained for each subject, illusion, and day, and for combined subjects in the given group on that day. A table of the combined mean illusion is presented in Figure 6. Figures 7 and 8 graphically show the mean error and per cent of difference in the illusions for groups one and two respectively. The per cent of illusion of the combined (stem and base) variables

	Rotations Days 1-11		New Rotations Day 12	
Group I				
Mean Error* in mm.	5.60	-3.34	5.97	4.76
% of Error**	8.85%	6.75%	10.94%	9.54%
Group II				
Mean Error in mm.	-6.76	7.15	-4.03	-4.97
% of Error	12.99%	15.30%	8.26%	7.72%
Combined Figure % Error	10.92%	11.02%	8.26%	7.72%

* Variable line to standard 50 mm. line.
** Percentage overestimation of base to stem.

Fig. 6. Total averaged mean illusions showing amount and direction of error, per cent of error, and per cent of combined error.

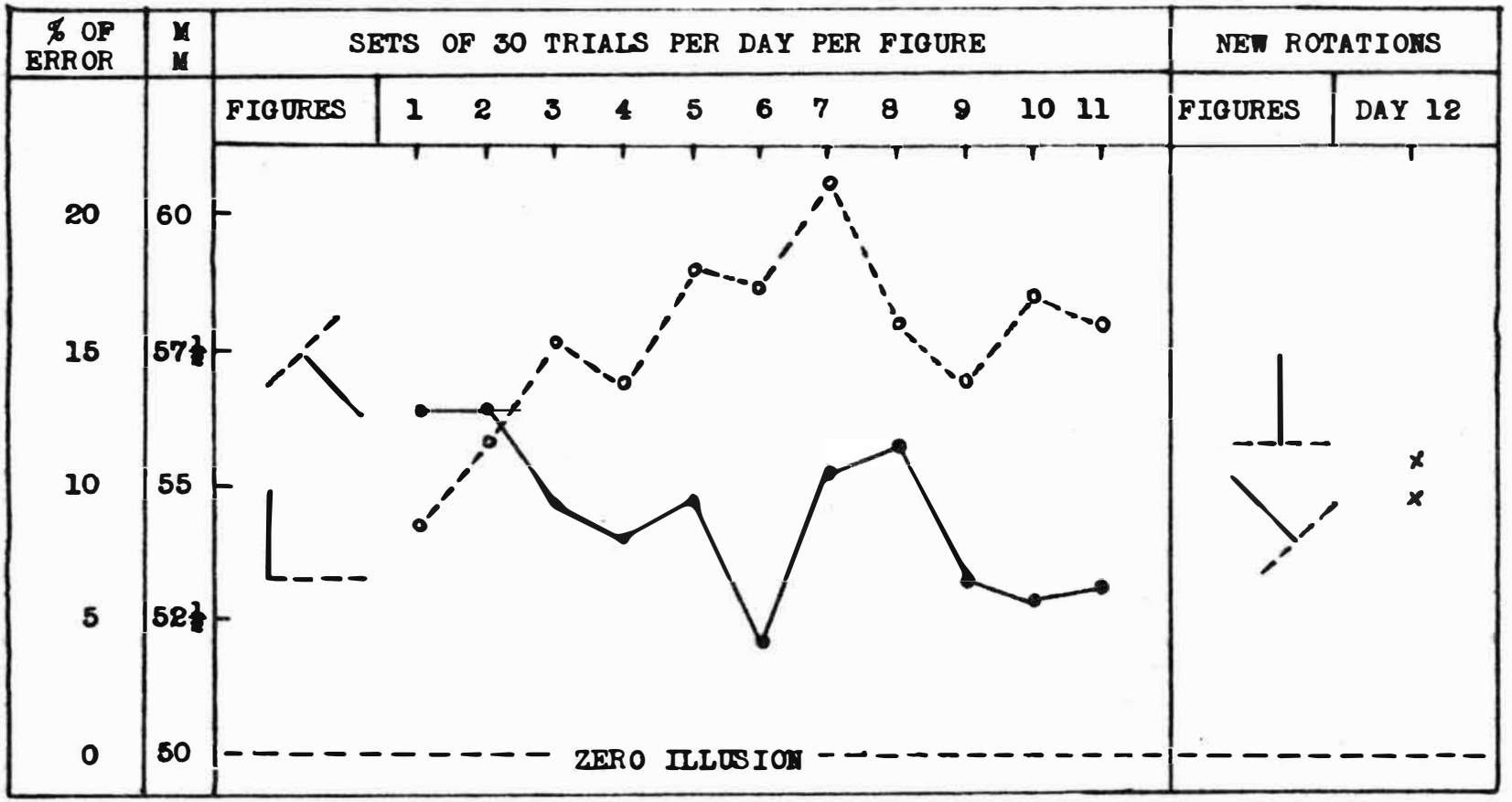


Fig. 7. Mean error and percentage changes in illusion for group one.

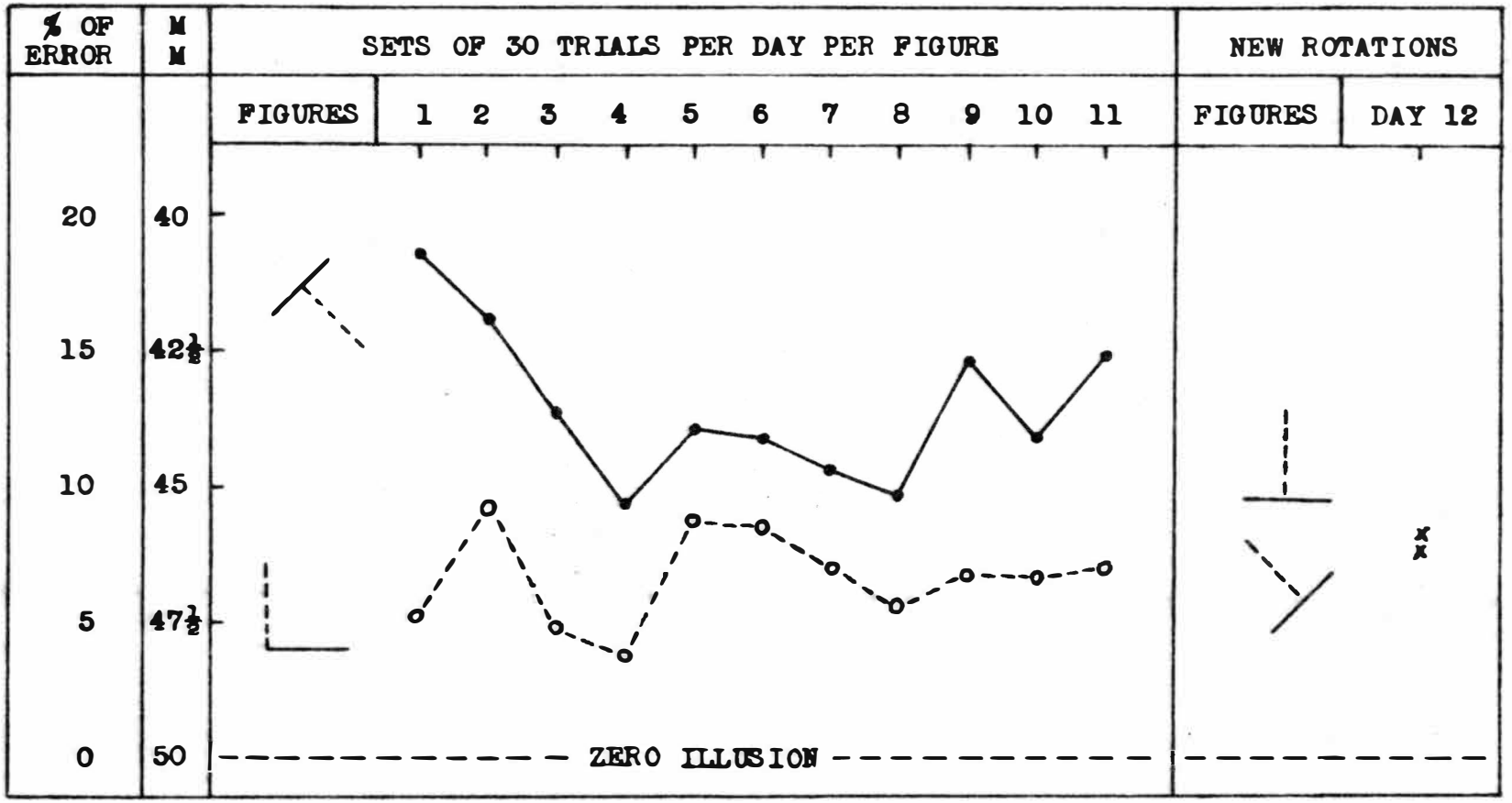


Fig. 8. Mean error and percentage changes in illusion for group two.

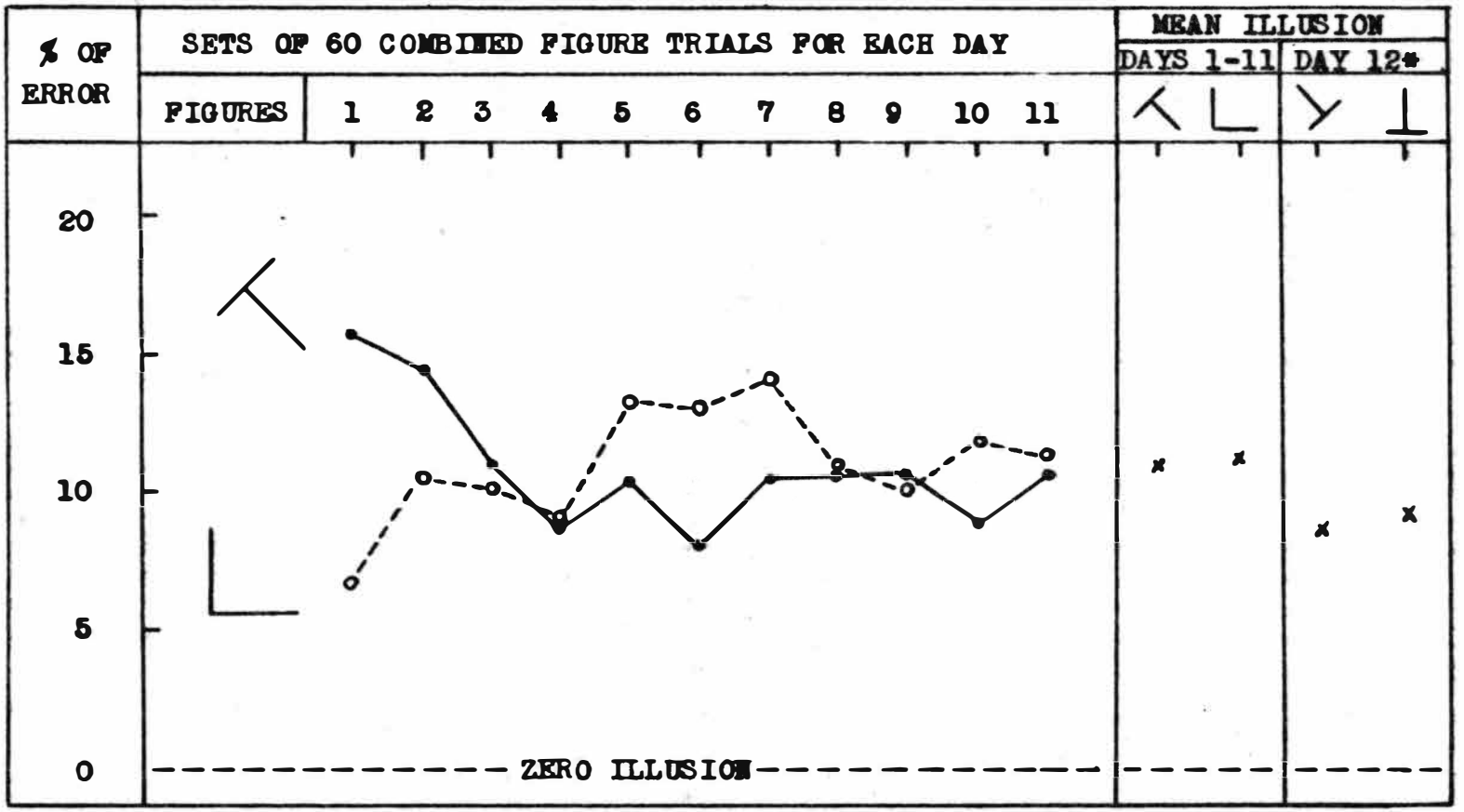
in the "T" and "L" figures is graphed in Figure 9; it also gives the total per cent of combined average illusions for each rotation. The stem and base variables of the figures in each group were combined to cancel out the "variable line effect."

The actual amount of error (positive or negative) of the variable lines was recorded in millimeters of error. A constant of 20.00 was added to the values for the analysis of variance. The summary table of the analysis of variance for the first eleven days is given in Figure 10. There was a significant difference between Figures at the .001% level of confidence ($F=1,253.45$, $df=3/704$), and between Groups X Figures at the same level ($F=174.93$, $df=3/704$). Figure 11 gives the analysis of variance summary table for the combined per cent of error of the "T" and "L" figures. No significant differences were found for the main or interaction effects. The within cells sum of squares indicated a large amount of intersubject variability.

Analyses of Figures

Findings from Figure 9:

1. The "T" figure tended to decrease towards zero illusion for the first four days as predicted in the first part of the experimental hypothesis. The combined per cent of error illusion decreased from approximately 16% to 8.5%



* New rotations

Fig. 9. Percent of illusion for the combined "T" and "L" figures.

Source	Sum of Squares	df	Mean Squares	F
Groups (Variable lines)	25.86	1	25.86	1.17
Days	129.25	10	12.93	
Figures (4)	83,066.19	3	27,688.73	1,253.45*
Groups X Days	123.43	10	12.34	
Groups X Figures	11,593.05	3	3,864.35	174.93*
Days X Figures	182.46	30	6.08	
G X D X F	285.28	30	9.51	
Within Cells	15,551.66	704	22.09	
Total	110,957.18	791		

* P= .001, df= 3/704

Fig. 10. Analysis of variance table for the first eleven days between the four (4) figures.

Source	Sum of Squares	df	Mean Squares	F
Days	1.23	10	.123	—
Figures "T" & "L"	.01	1	.01	
Days X Figures	4.11	10	.411	
Within Cells	2,583.08	374	6.906	
Total	2,588.43	396		

Fig. 11. Analysis of variance summary table for combined percent of error of the "T" and "L" figures.

from day one to day four.

2. After day four, illusion error of the "T" figure varied from approximately 8% to 10.5%.

3. On the first day, the percent of illusion of the "L" figure was 6.5%. The illusion error increased about 4% from day one to day two.

4. The fluctuation in the "L" figure was greater than in the "T" figure after the first four days; however, the average per cent of illusion of the "L" figure remained at about 11%.

5. The total per cent of combined illusion for all the figures, including those introduced on day 12 fluctuated between 8.5% to 11%.

6. There seemed to be an interaction effect present between the "T" and "L" figures after the fourth day. At this point the amount of illusion for the "T" and "L" figures remained about the same for rest of the testing period.

7. The introduction of the "new" rotations of the "T" figure of the twelfth day did not produce any noticable change in illusion.

Findings of the analyses of variance summarized in Figures 10 and 11:

8. The analysis of variance summary tables showed no significant difference between the two groups tested.

This indicated that the experimenter was successful in matching his groups of subjects.

9. No significant difference was found between Days. This lack of significance showed that day to day variability for combined stem and base variables of the "T" and "L" figures was not significant.

10. No significant interaction was found between Groups X Days, between Days X Figures, or with the triple interaction of Groups X Days X Figures.

11. A significant interaction was found between Groups X Figures ($F=174.93$, $df=3/704$, $P=.001$). This significant difference can be seen by exa mining Figures 7 and 8.

12. A significant difference was found between the four different figures ($F=1,253.45$, $df=3/704$, $P=.001$).

13. Figure 11 shows no significant difference between the combined mean "T" and "L" figures; however, the large sum of squares indicates a great amount of intersubject variability.

Discussion

The design of this experiment was planned to control the variable line effect. This line effect may contaminate the measurement unless proper counter-balancing techniques are used. Fatzinger (1951) states: "Any experiment, concerning straight line figures and employing the method of

average error, will be more accurate if the investigator takes this variable into consideration." This experimenter's results were consistent with the findings of Fatzinger. Figures 7 and 8 showed that different variable lines elicited different amounts of illusion. The combined results of Figure 9 must be used if an accurate estimate of illusion size is required.

Figure 9 showed that the "T" illusion decreased for the first four days. After the fourth day, the illusion leveled off so that the over-all, 11-day performance yielded no satistically significant change in illusion size. The "L" illusion increased in size from the first to the fourth day and then leveled off at approximately the same illusion as that demonstrated by the "T" figure. There results, in part, support the findings of Fatzinger (1951). He obtained a drop in "T" and no change in "L" over five days with the same number of trials per day. The Fatzinger study suggested that the "T" decrease might continue over more days. The present study does not support this hypothesis. The "T" and "L" figure illusions which have been presented in an alternating sequence to the subjects have come together after four days and have remained at approximately the same illusion size for the remaining seven days of trials. The concordance of illusion size after repeated trials on two different figures suggests that the figures are

serving as a "frame-of-reference" for each other when presented alternately to the subjects. Future research with these figures should use separate runnings of each figure in order to avoid the "frame-of-reference" effect.

The psychophysical method of average error was used with both the stem and base variables combined. This procedure was followed to cancel out the variable line effect. The results of this experiment for the "T" figure for the first day were consistent with the classical horizontal-vertical illusion measurement. When both the horizontal line and vertical variable line were objectively equal, the vertical (stem) looked longer, and a combined illusion of 15% was obtained. A combined per cent of error for both variables of the objectively equal "L" produced an illusion of about 7%. The combined "T" and "L" illusion size for 11 days was approximately 11%.

The "new" rotations of the "T" figures introduced on the twelfth day produced no noticable difference in the amount of illusion. This finding was inconsistent with the results obtained by Fatzinger. He found the amount of illusion of the "new T" figure to be approximately as great as that elicited on the first day of testing. The present study has used more subjects and has run this testing period out to 11 days.

The Gestalt concept of the "good figure" might be an

explanation of the differential "T" and "L" illusion change; however this explanation could only be used for the first four days. This writer suggests as Fatzinger did (1951), that the "L" is a "good figure" and the "T" is not. If this were the case, the "L" should remain fairly constant and the "T" should be "pulled" in towards zero illusion or the "better figure." This "pulling" should occur in both the original and the new rotations of the "T" figure. The results obtained over the 11 days of testing do not support this explanation.

The phenonmenon of "satiation" may also be used to explain these results. It was hypothesized by Fatzinger that the "T" figure is more highly satiated at the line intersection than is the "L" figure. This satiation of the two "T" figure vectors could push the base line out and make it appear concave, therefore, the stem line should appear longer. The "satiation" of the "L" figure should be balanced so that no noticable displacement of the two lines would occur. If this were the case, the amount of illusion in the "L" figure should remain fairly constant while the "T" figure on long exposure should correct or pull itself in because of the greater amount of "satiation" at the two vectors. The differential results obtained in the first few days of this experiment lends support to this hypothesis. The possible interaction between the "T" and "L" figures after day four prohibits a more complete test of

this hypothesis. A re-running of each figure separately, i.e., running one group on the "T" figure and the other on the "L" figure over a long series of trials is recommended.

Summary

The subjects for this experiment were 18 Southern Michigan State Prison inmates who were divided into two equal groups. The groups were exposed to the 10:30 o'clock "T" figure and the conventional "L" figure for 1,560 trials over 12 days. One group was presented the base variable "T" and the horizontal variable "L". The second group was presented the stem variable "T" and the vertical variable "L". On the final day (day 12) new rotations of the "T" were introduced at 6:00 and 4:30 o'clock positions to determine if the different positions of the figures would elicit different amounts of illusion.

The results obtained for the first four days provided limited support for the hypothesis that the "T" figure will be drawn in towards zero illusion while the "L" figure will remain relatively constant. The combined "T" illusion decreased from approximately 16% on the first day to about 8.5% on the fourth day. After the fourth day the illusion of the "T" figure fluctuated between 8% and 10.5%. The illusion error in the "L" figure was approximately 11%. The

introduction of "new" rotations of the "T" figure on the twelfth day did not produce any noticable change in illusion.

The analysis of variance showed no statistical significant difference between Groups or between the combined per cent of error of the "T" and "L" figures. A significant difference was found between the four variable line figures. This significant difference indicates that the variable line effect is an important factor influencing the subject's judgments.

"Satiation" and a "good figure" are offered as possible explanations of the "T" and "L" figure illusion changes.

The possible interaction between the "T" and "L" figures after day four prohibits a more complete test of this hypothesis. A re-running of these figures separately over a long series of trials is recommended to cancel out this possible interaction effect.

APPENDICES

APPENDIX A

General Instructions to the Subject - Experiment One

The task which is to be presented to you is very simple. It consists only of turning the dial in front of you so that the horizontal line appears to be two inches in total length. You should not pay any attention to the vertical line. Your judgment is to be made while looking into the opening in the box. This is no game, so do not try to beat it by making compensating guesses; if you do you'll be wasting your time and mine. You may wear glasses if you are near sighted and have them with you.

You may now look into the box. Do you see the green line? The line that you now see is two inches in total length. I'll now change the length of this line so that you can make it two inches again by turning the knob in front of you. If you feel that it is necessary you may switch eyes during the experiment.

When you are satisfied with your setting say 'OK' so that I'll know that you are now finished with that particular setting. Then remove your hand from the knob until I record your setting. You'll do this for a series of eleven trials.

Do you have any questions? If not, you may now proceed with the next setting.

APPENDIX B

General Instructions to the Subject - Experiment Two

The task which is to be presented to you is very simple. It consists only of turning the dial in front of you so that the two lines appear to be equal in length; your judgment is to be made while looking into the opening in the apparatus. Each trial will be treated as a separate trial. This is no game, so do not try to beat it be making compensated guesses; if you do you'll be wasting your time and mine. Remember the two lines must appear to be equal in length.

The procedure is very simple, and you may wear your glasses if you are near sighted and have them with you. When you look into the box you will see a fluorescent green "T" or "L" figure in some angular position. One of the lines in each figure will either be too long or too short. Your job is to turn the dial in front of you until the two lines appear to be equal in length. You may switch eyes when ever you feel that it is necessary to do so.

When you are satisfied with your setting say 'OK' so that I'll know that you are finished with that particular setting. Then remove your hand from the dial and look away until I tell you to proceed with the next setting.

Remember now that you are to adjust the line that is either too short of too long until the two lines appear to

be equal in length. Do you have any questions? If not, you may now proceed with the first setting.

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