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The effects of varying fins in Müller-Lyer and Holding illusions*

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Summary. Five experiments were conducted to determine how distortion of spatial position induced by unidirectional Müller-Lyer fins varied as a function of angle and length of fins. Research employing Cornsweet's staircase method yielded ambiguous results, but psychophysical methods of magnitude estimation, paired comparisons, and production showed conclusively that distortions of position are affected by angle and length of fins in a manner similar to that found in distortions of length. It was concluded that similar strategies are employed in processing attributes of length and position and that a theory based on averaging of attributes within an attentional field describes the performance of real observers.

A Müller-Lyer distortion of subjective size can be converted to a distortion of subjective position by orienting fins in a single direction around a standard shaft. Holding (1970) described this phenomenon, shown in Figure 1, and argued that it could be explained best by "a process of visual averaging" in which "the end point [is] taken as a form of weighted mean of the line and arrowhead elements" (p. 281). Holding derived a single prediction from his analysis – the amount of distortion of size should be *twice* the amount of apparent positional shift – but no evidence for this prediction was provided.

Stuart, Day, and Dickinson (1984) proposed to test Holding's idea, but inexplicably argued that Holding would predict that the shift in phenomenal size would be *equal* to the shift in phenomenal position. Since their results indicated that distortion of position was markedly less than the distortion of size, they concluded that Holding's interpretation was incorrect.

A second curious argument made by Stuart et al. (1984) is that an assimilation (integrative field) theory[1] such as the one proposed by Pressey (1967; 1971) cannot explain Holding's distortion. They appear to argue that, since the Müller-Lyer illusion is caused by an averaging of length, and since there is no distortion of length in the Holding pattern, an explanation based on averaging of lengths is false.

There are several difficulties with this argument. First, it has not been proposed that the process of assimilation (averaging, central tendency) is limited to the attribute of length. Indeed, in the very first statement of the theory (Pressey, 1967), the widespread occurrence of the phenomenon was stressed: "Thus, the central tendency effect is a pervasive phenomenon which indicates that it is a fundamental characteristic of behavior" (p. 569). Furthermore, the term "magnitude" instead of "length" is employed to convey the generality of assimilation and since one can conceive of a magnitude of difference in spatial location, as Stuart et al. do, it follows that the theory can, in principle, apply to Holding's figure.

A second problem seems to be that it is not clear how integrative field theory can apply to both distortions of size and position. If perception is conceived to be a passive-reactive process only, then it indeed would be a puzzle. However, one of the distinctive aspects of the theory (which is implicit in the construct of an attentional field) is that perception is the product of a rational-intentional system[2] (Dennett, 1978) that operates according to the *purpose* of the task as specified by instructions. Since the

* Experiments 1 and 2 were reported in a Master's thesis submitted by Nancy Smith to the University of Manitoba in 1987.

[1] The term "assimilation" is inadequate to describe the current theory because it specifies attentional and spatial constraints which can modify distortion to such an extent that, under certain conditions, contrast would be predicted. In the most recent version, assimilation is presumed to be only one of several cognitive processes that is involved in the formation of a percept.

[2] Dennett and other philosophers of mind use the term "intention" to convey Franz Brentano's point that mental events are directed at, or represent, something. In this paper, intentionality refers to the teleological, goal-directed character of behavior and, as such, it conforms to the popular definition of the term.

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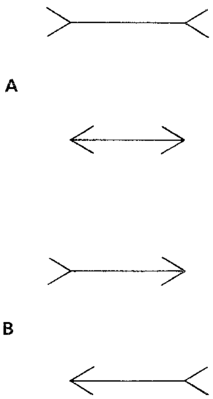

Fig. 1. Müller-Lyer (A) and Holding (B) figures

purpose in the Müller-Lyer task is to judge size, observers will utilize the attribute of size in their judgments. Conversely, since the purpose of the task in the Holding figure is to judge position, positional information will be used in effecting the judgment. Furthermore, it is entirely possible that whatever strategies (averaging, attention deployment) are used in one task also might be used in the other but, since the two tasks are different, there is no a-priori way to make a definitive prediction and the question is necessarily an empirical one. Thus the position we adopt is this: if observers use similar perceptual-cognitive strategies to integrate information in the domain of size as they do in the domain of position, there should be some similarity between the empirical functions in the two domains. For example, variables such as size and length of fins, which are known to affect Müller-Lyer distortions, should affect Holding distortions in a similar manner. But they will not be identical. Specifically, we agree with Holding that distortions of size should be twice the distortions of position (if the two can be measured meaningfully by the same metric). The reason for this is simple. The shaft in Holding's figure does not change in size, but only in position, and so it shifts as a unit. Thus, if the right edge of a standard shaft is subjectively displaced 5 mm, the left edge must also shift 5 mm; that is, a shift of the left edge is redundant. In other words, a shift of 5 mm of the left edge coupled with a shift of 5 mm of the right edge yields a total shift of 5 mm. The same logic does not hold for Müller-Lyer phenomena because distortions at the two ends of the shaft are not redundant. An expansion of 5 mm on one side coupled with an expansion of 5 mm on the other would produce a total expansion of 10 mm.

The purpose of this study was to replicate and extend the experiment conducted by Stuart et al. (1984) by measuring Müller-Lyer and Holding distortions under different conditions of fin angle and fin length. If similar cognitive strategies are employed in the two tasks, similar functional relationships should result, but the levels of the functions should not be the same.

Experiment 1

The purpose of this experiment was to measure the amount of distortion that occurs when fin angle is varied in both the Holding and the Müller-Lyer configurations.

Method

Subjects. Eight males and 16 females, who were introductory psychology students, graduate students, and members of the community, volunteered as subjects. All were required to have good vision either with or without corrective lenses.

Stimulus figures and apparatus. All targets were oriented vertically, as in the study by Stuart et al. (1984). The fin angles used were 15°, 30°, 45°, 60°, and 75°. These were the most common angles used in previous research (e.g., Dewar, 1967; Heymans, 1896; Lewis, 1909; McClellan, Bernstein, & Garbin, 1984). The standard figures (shown in Figure 1) had shafts of equal length, and the endpoints of the opposing shafts were directly aligned. These targets were drawn with fixed shaft lengths of 50 mm and fixed fin lengths of 15 mm, that is, 30% of the shaft length. Previous research has shown that this percentage creates an optimal amount of distortion (Heymans, 1896; Stuart et al., 1984). The distance between the shafts was 50 mm. Control targets were drawn without fins.

Cornsweet's (1962) double-staircase method used by Stuart et al. (1984) resulted in the following arrangement of stimulus figures. For both the Holding and the Müller-Lyer figures, a series of 10 targets was drawn at each level of angle. One of these was the standard Holding or Müller-Lyer figure in which the shafts were, respectively, at the same height in the field or of equal length; 3 of the targets were graduated, in increasing steps, in the direction of the illusion; the 6 remaining targets were graduated, in increasing steps, in the direction opposite the illusion. The unit size for graduating the targets was 1 mm (i.e., 2% of the shaft length in the standard figures). To change the position of the shafts in the Holding figure, this unit was subtracted from one end of the shaft and added to the other end of the same shaft (this was done for both shafts, in opposite directions). To change the length of the shafts in the Müller-Lyer figure, the unit was added to or subtracted from both ends of the shaft (i.e., 0.5 mm at each end). A similar series of 10 targets was drawn for each of the 2 control conditions, using shafts without fins. For each figure and its control, the order of staircase Series A was: the 3 graduated targets arranged in order of largest to smallest discrepancy between the shafts; the standard figure; and the 6 graduated figures arranged in order of smallest to largest discrepancy. Staircase Series B was identical to Series A, but was presented in the reverse order.

All targets were 0.25 mm wide lines drawn in black ink and centered on white bond paper measuring 21.6 × 27.8 cm. These targets were photographed to produce black-and-white slides which were housed in two Kodak Ektagraphic III A slide projectors, each fitted with a Kodak Zoom Ektanar 102–152 mm f/3.5 projection lens. One of the projectors was placed on a table measuring 76 cm high, while the other projector was placed on a slide stand measuring 24.5 cm high, positioned just above the first projector. The projectors were adjusted to produce identical images at the same position on the projection screen. The screen was a rectangular wooden frame measuring 104 × 127 cm, covered by white vellum paper. The bottom of the screen was 57 cm above the floor. A rear-projection method was used for displaying the targets on the screen.

Subjects sat at a 76-cm high table on which a 24.7-cm chin rest was located. The chin rest was positioned so that the distance from the subjects' eyes to the screen was approximately 1.9 m. Thus, figures subtended a visual angle of 4°, as used by Stuart et al. (1984).

Design. A 2×5 within-subjects design, with all subjects participating in each of the 10 experimental conditions and the 2 control conditions, was used. There were two types of figure and five angles. Each subject received a unique, random order of the 10 experimental conditions followed by the 2 control conditions.

Each subject was randomly assigned to one of four groups to determine which of the two staircase series and which of the two figures was to be presented first. Order of presentation for figure and order of presentation for staircase series were considered as counterbalancing variables only and were not included in the statistical analyses.

Procedure. Each target was exposed for approximately 2 s. Individual subjects were asked to make a forced-choice (left or right) judgment and to choose which shaft appeared higher in the Holding figures and which shaft appeared longer in the Müller-Lyer figures. They were instructed to "look at the figure as a whole" and "not to concentrate on the ends only." A double-staircase procedure (Cornsweet, 1962) was used in which staircase Series A targets were presented from one slide projector and Series B targets from the other. Progression through each staircase depended upon subjects' responses to previous targets. Each subject was shown 30 slides (15 from Series A and 15 from Series B) for each level of fin angle for both the Holding and the Müller-Lyer figures and their controls. Finally, each subject was debriefed verbally after testing.

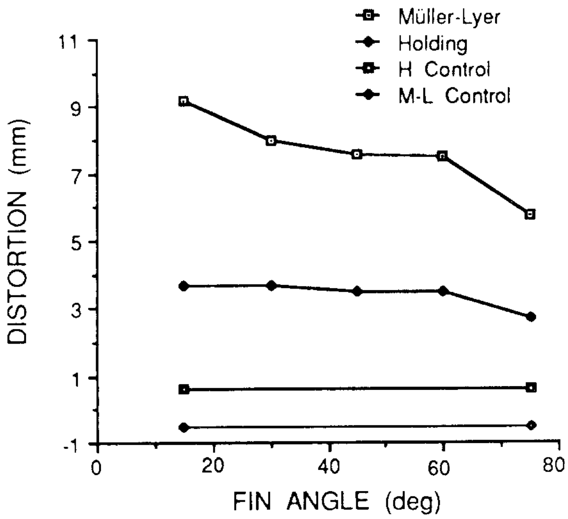

Fig. 2. Changes in Müller-Lyer and Holding distortions as a function of angle of fin

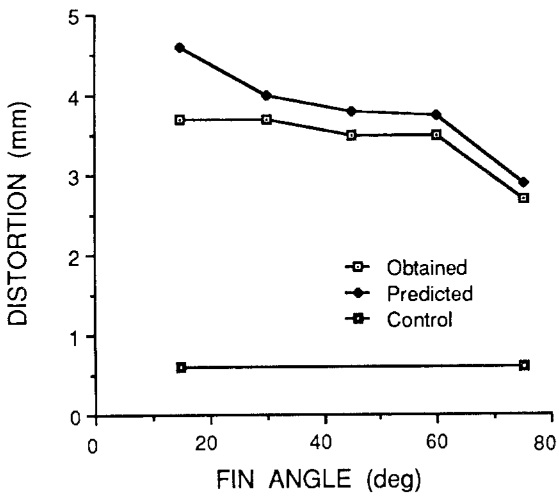

Fig. 3. Obtained and predicted functions for Müller-Lyer and Holding figures. The predicted scores are one-half of the obtained Müller-Lyer distortions

Results and discussion

At each level of fin angle for both figures the point of subjective equality (PSE) was determined by averaging the last 10 responses from each staircase series to give the perceived amount of discrepancy between the two shafts of each figure. The PSE calculated for the control figures was then subtracted from this difference to give the actual amount of illusion.

Distortion at each fin angle was averaged across subjects and is shown in Figure 2. A within-subjects analysis of variance (ANOVA) produced the following values: for type of figure, $F(1,46) = 51.7$, $p < .01$; for fin angle, $F(4,184) = 10.4$, $p < .01$; and for the interaction of figure and fin angle, $F(4,184) = 4.0$, $p < .01$. Distortion was substantially greater in the Müller-Lyer figure than in the Holding figure and, whereas Müller-Lyer distortion declined as the angle between shaft and fin increased, Holding figure distortion did not.

Additional analyses indicated that the strong interaction between type of figure and angle might be more apparent than real. First, Pearson product-moment correlation coefficients were calculated between the two figures at each of the five angles. The value of r at 15° was .36 ($p < .10$) and at 75° it was .38 ($p < .10$). A value of .18 was obtained when scores were summed across all fin angles. These results suggest that some relationship might exist between the two figures.

Second, a trend analysis was conducted to test deviation from a-priori (or predicted) trends (Lindquist, 1956). The predicted function for the Holding figure was calculated by taking one-half of the amount of illusion found for the Müller-Lyer figure at each level of fin angle. This calculation was based on Holding's (1970) derivation that the Müller-Lyer figure should display twice the amount of distortion as the Holding figure. No significant differences were found in either pattern, $F(4,155) = 0.45$, $p > .01$, or vertical placement, $F(4,115) = 1.01$, $p > .01$. This means that the functions obtained and predicted (shown in Figure 3) seem to follow a similar pattern at a similar level.

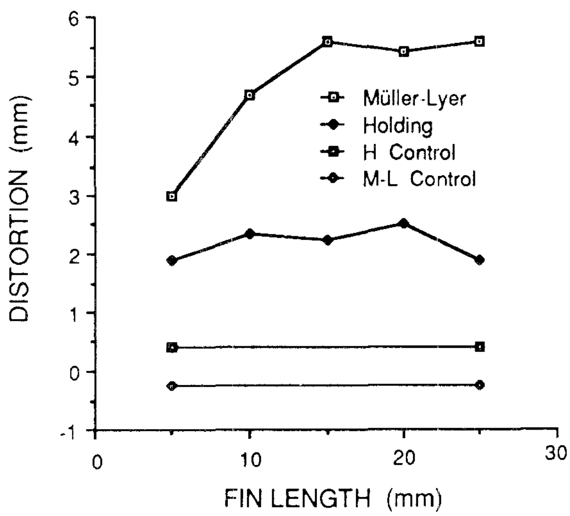

Fig. 4. Müller-Lyer and Holding distortions as a function of fin length

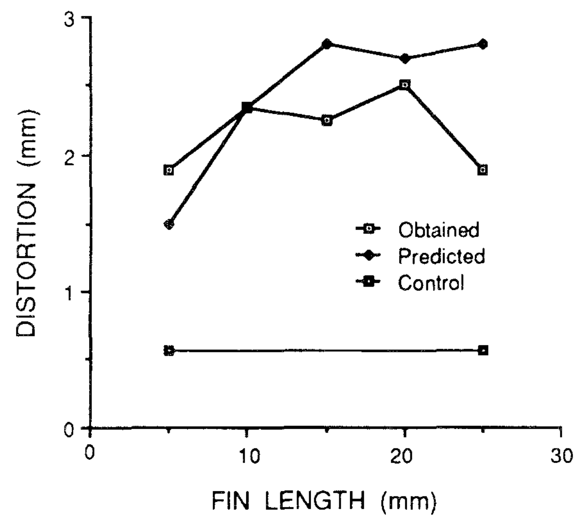

Fig. 5. Obtained and predicted functions for Müller-Lyer and Holding configurations. The obtained scores are one-half of the Müller-Lyer distortions

Experiment 2

The purpose of this experiment was to measure the amount of distortion that occurred when length of fin was varied in both the Holding and the Müller-Lyer configurations.

Method

Subjects. Fifteen males and nine females, who were introductory psychology students, graduate students, and members of the community, volunteered as subjects. All were required to have good vision either with or without corrective lenses.

Stimulus figures and apparatus. All figures were presented in a vertical orientation. The fin lengths were 5, 10, 15, 20, and 25 mm. These were the most common lengths used in previous Müller-Lyer research (McClellan et al., 1984; Restle & Decker, 1977). A maximum fin length of 50% of the standard 50 mm shaft ensured that, with a fixed fin angle of 30°, the opposing fins in the ingoing Müller-Lyer component would not touch or cross each other. Control targets were drawn without fins.

The double-staircase method was used in this experiment also and resulted in the same staircase series as those in Experiment 1 with the exception that fin length replaced fin angle as one of the variables. The targets were drawn, photographed, and presented in exactly the same manner as in Experiment 1.

Design and procedure. The design and procedure of Experiment 2 were identical to those of Experiment 1, except that the five levels of the fin length replaced the five levels of fin angle.

Results and discussion

Measurement of the amount of illusion occurred precisely in the same way in this experiment as it did in Experiment 1. The only difference was that fin length replaced fin angle as one of the variables.

Results of the ANOVA indicated that effects of type of figure, $F(1,46) = 31.7$, of fin length, $F(4,184) = 13.8$, and the interaction between figure and fin length, $F(4,184) = 8.7$, were significant at the .01 level. As is shown in Figure 4, Müller-Lyer distortions increased with an increase in fin length, but Holding distortions did not.

A Pearson r between the Holding and Müller-Lyer scores was calculated at each of the five lengths of fin. The values, ranging from the smallest to the largest fin length, were .44, .47, .53, –.03, and .23 respectively. When scores were averaged across fin length, the r was .45. The coefficients for fin lengths of 5, 10, 15 and for the combined scores all were significant at the .05 level of confidence.

A trend analysis was conducted to test deviation from predicted trends (Lindquist, 1956). The predicted function for the Holding figure was calculated as it was in Experiment 1, and is shown in Figure 5. No significant differences were found for pattern, $F(4,115) = 3.29, p > .01$, but significant differences were found for vertical placement, $F(4,115) = 4.35, p < .01$. These results suggest that the functions predicted and obtained seem to follow the same pattern, but at a different level. Of course, with a less stringent criterion, the conclusion would be that neither pattern nor level of distortion was similar in the two tasks.

The results of Experiments 1 and 2 are consistent in showing that the distortion of size in Müller-Lyer figures is substantially larger than the distortion of position in Holding's figure. These empirical findings thus support those obtained by Stuart et al. (1984). Furthermore, the rule proposed by Holding, viz., that distortions of length should be twice the size of distortions of position, seems to be verified in certain conditions.

The fact that Holding distortions did not vary as a function of angle and length of fin (as did Müller-Lyer distortions) could be construed as evidence against the idea that common perceptual-cognitive strategies are employed in the two tasks. However several facts suggest that this could be a wrong conclusion. First, in Experiment 1, when

Müller-Lyer scores were halved and then compared to Holding scores, the differences between the two types of illusions disappeared. Second, reliable correlations were established in several cases, which would indicate that individuals tended to respond in a similar manner in the two situations. A third consideration concerns the psychophysical method of measuring distortion. Cornsweet's staircase method is tedious and requires a very large number of responses. This can lead to a levelling of scores, perhaps because of the well-known central-tendency effect or because subjects forget what they are to do. This latter point has been elaborated in detail by Pressey (1987) in connection with the problem of measuring perceptual distortions in children. If the magnitude of distortion is small, as it seems to be in Holding's figure, levelling effects and forgetting might mask real differences.

A final problem in comparing Müller-Lyer and Holding distortions is inherent in the figures themselves. In judging Müller-Lyer figures, subjects must include the entire target in their calculations but in the Holding figure it is logically necessary to consider only two endpoints. And, in spite of requests that subjects judge the whole figure, several individuals voluntarily reported that they had used the endpoint strategy. If this is the case, then the use of different strategies in the two tasks would reduce similarity of performance in those tasks.

Because of problems associated with the psychophysical method used in the first two experiments, three additional experiments, employing the methods of magnitude estimation, paired comparisons, and production, were conducted. In all cases, the pen-drawn targets used in the previous experiments were employed as templates, but the shafts were oriented horizontally.

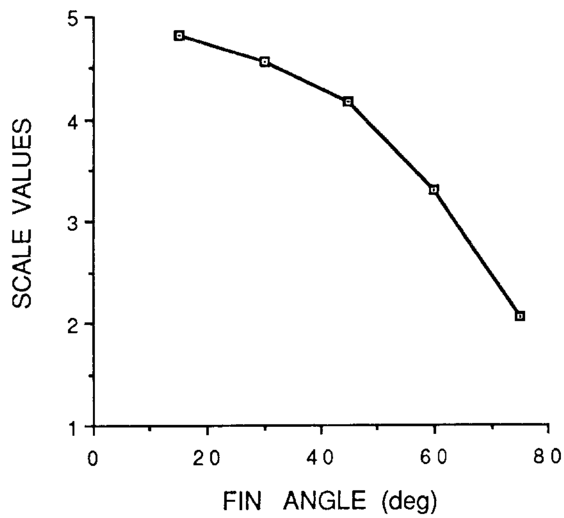

Fig. 6. The effect of fin angle on the magnitude of a Holding distortion as measured by a method of magnitude estimation

Experiment 3

Method

Subjects. Sixteen women and 14 men from an undergraduate course in Perception were asked to participate. All were knowledgeable about both the nature, and explanations of, geometric illusions.

Materials. The five Holding figures with varying angles and the five figures with varying fin length were reproduced by a high quality photostatic copier. The 10 targets were ordered randomly and uniquely into 30 booklets in which heavy blue sheets of paper separated each target. Booklets were stapled at the upper left corner.

Procedure. After booklets had been distributed to subjects, who sat at their desks, two horizontal lines that were directly above each other were drawn on a chalkboard. Subjects were asked to note the apparent position of the two lines in this control position and then to observe what happened when fins were drawn at the ends of the two shafts. The class agreed that the Holding figure on the chalkboard produced a shift in the apparent position of the horizontal shafts. They were then told that they would view several targets similar to the example on the chalkboard and that they were to estimate the degree of apparent shift in the two lines on a scale of 0 to 10. If no shift was apparent, then a score of 0 was to be assigned, and if the shift was very pronounced, then a score of 10 should be given. Scores were to be written beside each target and subjects were to proceed at their own pace. No constraints were placed on potential strategies other than to ask that subjects not spend too much time on each judgment, but to be conscientious. When the experimenter was satisfied that individuals understood the instructions, testing ensued.

Results

Judgments of the five angles were separated from those for fin length and each level of the independent variable was averaged across subjects. The results are shown in Figures 6 and 7. A within-subjects ANOVA verified that distortion in the Holding figure declined as the angle increased from 15° to 75° $F(4,116) = 37.8$; $p < .01$, and that distortion increased as the length of fin increased, $F(4,116) = 63.4$; $p < .01$.

These data indicate that, contrary to the results in Experiments 1 and 2, altering the character of the fins had a powerful effect on subjective positional shifts and that the direction of these effects was similar to what would be expected from research on Müller-Lyer distortions of size.

Because one target (30°, 15 mm) was repeated, it was possible to assess how reliable the ratings were. Pearson's r between the two sets of scores yielded a value of .68 ($p < .01$) which indicates that the method of magnitude estimation yields moderately consistent estimates from trial to trial.

Experiment 4

The purpose of this study was to determine how the Holding pattern shifts in apparent position are affected by fin angle and fin length as measured by the method of paired comparisons.

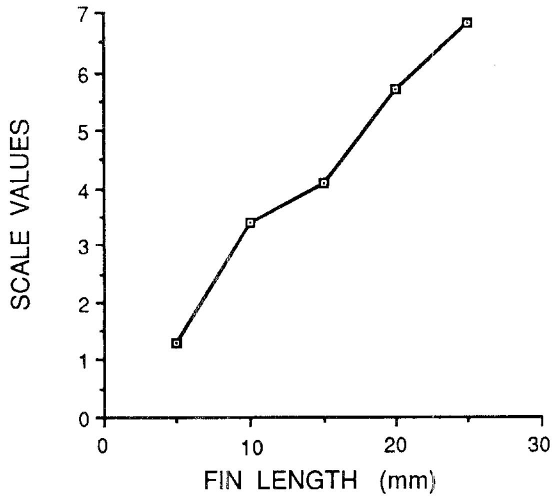

Fig. 7. The effect of fin length on the magnitude of a Holding distortion as measured by a method of magnitude estimation

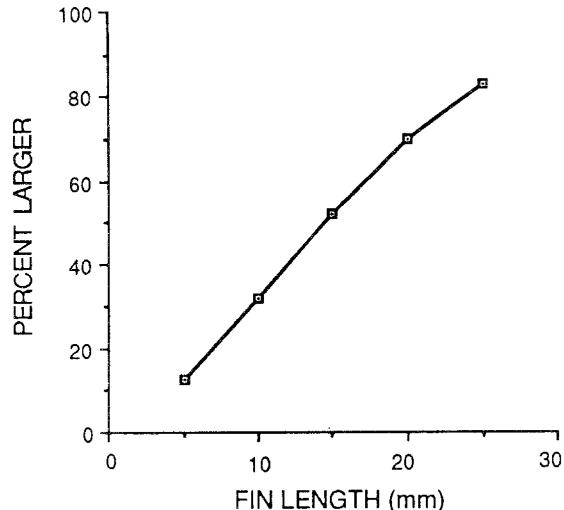

Fig. 9. The effect of fin length on the magnitude of a Holding distortion as measured by a method of paired comparisons

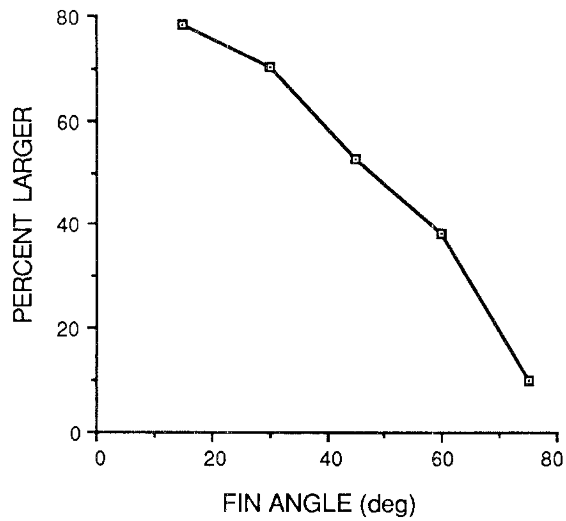

Fig. 8. The effect of fin angle on the magnitude of a Holding distortion as measured by a method of paired comparisons

Method

Subjects. Subjects who served in Experiment 3 were divided into two groups, one consisting of 16 individuals and the other of 14 individuals.

Materials. The five targets varying in angle were paired with each other to form ten targets, each of which was rotated 180° to yield a total of 20 stimulus conditions. The shafts were oriented horizontally; the centers of these were separated laterally by 10.6 cm and the four stimuli were centered on 27.8 × 21.6 cm sheets of white paper and the shafts were parallel to the long size of the sheet. A unique random order of the 20 targets was constructed for each of 14 series which were collated to form a booklet. Heavy blue sheets of paper separated each target sheet and the booklets were stapled at the upper left corner. A response sheet accompanied each booklet.

A similar procedure was employed to develop the paired-comparison series for targets varying in fin length, except that 16 booklets were so constructed.

Procedure. A representation of a sheet containing pairs of stimuli was drawn crudely on a chalkboard. Subjects were reminded of the previous occasion in which they had to judge the apparent shift of pairs of shafts. They were told that a similar task was to be carried out except that this time they were to judge the relative degree of distortion in pairs of stimuli. Specifically, they were told that if the stimulus on the left appeared to exhibit a bigger shift they were to record "left greater" and if the shift was relatively greater in the target on the right they were to record "right greater".

When instructions were understood, subjects proceeded to make the 20 judgments at their own pace.

Results

The number of times that a pair of a particular angle was judged to exhibit greater distortion was calculated and the data were subjected to a within-subjects ANOVA. The effect of angle was significant, $F(4,52) = 67.1$; $p < .01$, as was the effect of fin length, $F(4,60) = 82.5$; $p < .01$. The data are shown in Figures 8 and 9. They verify the trends found in Experiment 3.

Experiment 5

The purpose of this experiment was to measure, by a method of production, apparent shifts in Holding figures that varied in fin angle and fin length.

Method

Subjects. Twenty-five students who had participated in Experiments 3 and 4 volunteered to serve.

Materials. The 10 targets used in the magnitude-estimation task were randomly sorted into 25 booklets. Another 25 booklets containing 10 identical response sheets were also constructed. All the booklets were stapled to ensure that

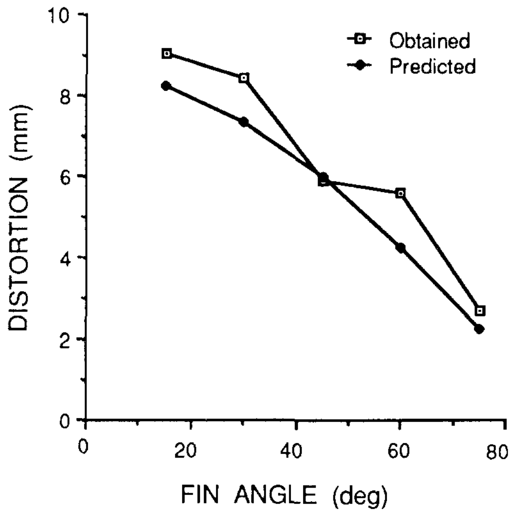

Fig. 10. Obtained and predicted effects of fin angle on a Holding distortion as measured by a method of production. The predicted data were obtained by a computer simulation based on Pressey's integrative field theory

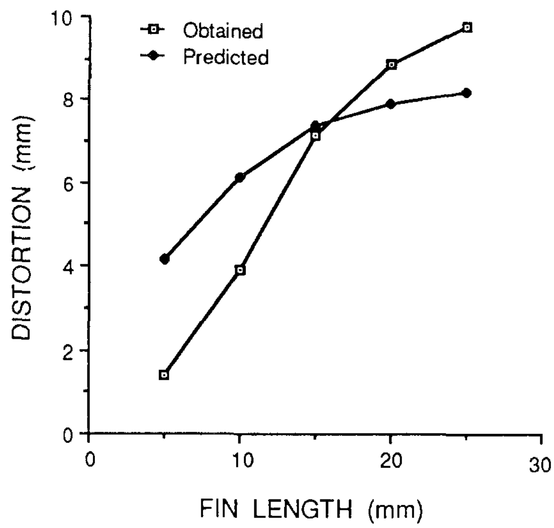

Fig. 11. Obtained and predicted effects of fin length on a Holding distortion as measured by a method of production. The predicted data are derived by computer simulation based on Pressey's integrative field theory

responses could be assigned to the appropriate stimulus conditions.

The response sheet contained one black horizontal line drawn parallel to the long side of a 21.6 × 27.8 cm sheet of white paper. The line was 50 mm long and 0.25 mm wide and its center was 82 mm from the top and 125 mm from the left side of the sheet.

Short arrows that pointed toward the center of the sheet were drawn on each side of that sheet at a distance of 132 mm from the top. They served to define an imaginary line on which subjects were to produce their responses.

All subjects were also provided with a response tab that was a 50 × 135 mm white rectangle. A black line that was 50 mm long and 0.25 mm wide was drawn at the edge of one narrow side of the tab.

Procedure. A sample stimulus sheet, a response sheet, and a response tab were drawn crudely on a chalkboard. Subjects were asked to recall that a subjective shift in the location of lines could be effected by placing appropriate fins at the ends of those lines. They were told to look at each sheet, to note the degree of apparent shift, and then to reproduce that phenomenal shift by appropriately placing the black line of the response tab on the imaginary line defined by the arrows. They were then asked to mark the location of the variable black line by drawing small, but well-defined, dots at the ends of the line. When it was clear that the instructions were understood, subjects proceeded to complete the task at their own pace.

Results and discussion

The location of the variable line was ascertained by measuring the horizontal distance between the tip of the arrow and the left dot. A long mark at the left edge of the scale allowed one to control for slight vertical displacements of the reproduced line. The point of objective alignment was subtracted from this score to obtain a measure of distortion.

The results, shown in Figures 10 and 11, indicate that the angle of fin was significant, $F(4,96) = 12.9$; $p < .01$, as was the effect of fin length, $F(4,96) = 23.9$; $p < .01$. As in Experiment 3, it was possible to establish a reliability coefficient because one condition (30°, 15 mm) was repeated within the test series. Pearson's r was .45 ($p < .05$) which indicates that there is some stability from trial to trial, but that single estimates should probably not be used if individual differences are of concern.

Earlier, the claim was made that an integrative field theory might apply to Holding, as well as Müller-Lyer, figures. Therefore, as a matter of interest, the computational formula that has been used to derive predictions of size distortions (e.g., Pressey & Di Lollo, 1978; Pressey & Kersten, 1989) was applied to the figures used in Experiment 5. Because the perpendicular distance between shafts was 50 mm and not 100, as was the case in most of our previous research, the radii of the hypothetical attentional fields ranged from 36.5 to 58.5 mm in steps of 5.5 mm. The radii for the interactive fields ranged from 10 to 40 mm in steps of 10 mm. The logic for choosing these values has been detailed by Pressey and Di Lollo (1978).

As is often the case, the computational version of integrative field theory underestimated the level of the functions. Consequently all predicted values were multiplied by 4.2 which was the ratio of the difference between the average of the 10 predicted values and the 10 obtained. The predicted data are shown in Figures 10 and 11. The value of r for angle was .97 and for length it was .98. Visual inspection of these figures shows that while both independent variables produced a curvilinear pattern of distortion, the pattern for angle was predicted better than the pattern for length. The difficulty that integrative field theory has in predicting the effect of length of fin was recognized early in the development of that theory (Pressey, 1972) and we have been pursuing the idea that the curvilinear relationship is due to contrast as proposed in 1954 by Obonai (Pressey & Wilson, 1980; Wilson, 1981). However, the fact that the theory overestimates the amount of distortion when the fins are small and underestimates distortion when the fins are large indicates that the radii of the hypothetical attentional fields might be too large for the small fins and too small for the large fins. In other words, the misprediction may be due to the fact that the theory assumes that attentional field size is unaffected by contextual stimuli.

In the initial stages of development it was necessary to link the attentional field only to the standard and comparison stimuli because the theory was cast in hypothetico-deductive form. The attentional field was a rational construct in which the center and the shape were operationally defined in an a-priori manner. With a few simple definitions, qualitative explanations of a broad range of phenomena were generated (e.g., Pressey, 1971, 1974; Pressey, Butchard, & Scrivner, 1971; Pressey & Smith, 1986). However, it was always recognized that in the rational model the attentional field could not vary as a function of contextual features without collapsing the theory into a circular enterprise.

The predicted trend in Figure 11 indicates that the attentional field might well increase as the outward pointing fins increase. In other words, increasing fin length can "draw" attention well beyond the standard line, which would result in a larger field as compared to an equivalent condition in which the fins are oriented toward the shaft. Since, according to theory (Pressey & Murray, 1976), large fields produce large distortions and small fields produce small distortions, the well-known asymmetry between the expansion and shrinkage forms of illusion (Beagley, 1985) would be explained.

Furthermore, it is plausible to argue that as the outward-pointing fins become very large, at some point they would fail to attract attention and field size would collapse back to the "typical size" employed by the observer. If this were the case, then a curvilinear relationship between fin length and distortion would be predicted. Effort should be directed to evaluating such a notion and, on the surface, it seems that the Holding pattern might provide a suitable medium for such a test.

On the basis of the five experiments conducted here the following conclusions are warranted. First, Müller-Lyer distortions of size are larger than Holding distortions of position when an equivalent metric is employed. Second, Holding's proposal that a Müller-Lyer distortion should be twice the magnitude of an analogous Holding distortion seems accurate. Third, Holding distortions decline as a curvilinear function of increasing fin angle and they increase as a curvilinear function of increasing fin length. Fourth, the curvilinear functions (but not the levels) are predicted by a computational version of integrative field theory and this supports Holding's original claim that displacements in phenomenal space can be explained by an averaging process.

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