The corridor illusion*

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Contrary to general belief, the classical corridor illusion is not due solely to the perspective and contextual cues provided by the corridor. Additional factors that are equally important are the inherent spatial anisotropies of the visual system and fixation tendencies.

Figure 1 illustrates one form of the corridor illusion, the subject of this study. The illusion is that the cylinder at the front of the corridor generally looks smaller than a cylinder of the same size placed farther back. (The front cylinder is actually 10% larger.) The basis for this illusion has often been postulated as due primarily to context or to the effects of apparent depth induced by the perspective cues (Gibson, 1966; Gregory, 1966). This explanation cannot be entirely correct, however. For example, if Fig. 1 is turned upside down, then the perspective cues will remain identical, but the magnitude of the illusion will change. Clearly, factors other than perspective or context are contributing to this particular illusion. The following study shows that spatial anisotropies of the visual system and fixation behavior are the important factors that influence the magnitude of the corridor illusion.

METHOD

Twenty-one cylinders were prepared as cutouts which could be placed on top of a perspective line drawing of a corridor, shown in Fig. 1. Each cylinder represented 1 of 20 3% increment steps (or decrements) in size of the standard cylinder. Thus, the range of cylinder sizes varied from 84% to 140% of the standard cylinder, which measured 1.5 deg high x .65 deg wide, seen at an observation distance of 210 cm.

Two sets of slides were then made from the cylinder cutouts: One set consisted of the standard cylinder paired with the test cylinder, with a homogeneous background (i.e., no perspective grid); the second set paired the standard and test cylinders in exactly the same positions but, in addition, included the perspective grid of the corridor (as in Fig. 1). The first set, without the grid, is identified as the "no-pattern" condition. The second set, which included the corridor, is the "pattern" condition. These slides were then rear projected individually in a haphazard order onto a screen of sandblasted Plexiglas for viewing by the S. The resting luminance of the screen before the test flash appeared was 6 fL. The flash had an equivalent luminance of 300 fL.

For most of the tests, the slides were flashed for 50 msec while the S fixated a pinpoint fixation light, seen in the plane of the projection screen. The fixation point was always located in the same position relative to the two cylinders, regardless of whether the perspective grid was present. The two positions were L and B, chosen to lie on contours of the grid, as shown in Fig. 1. When Fixation Position L was used, the picture was rotated 180 deg and reversed, in order that the same retinal positions would be used for all tests. In the upright condition (as shown in Fig. 1), the cylinders were called "baskets"; in the inverted position, the cylinders were identified as "lamps." An illusion was measured for both "lamps" and "baskets" in order to determine whether the orientation of the perspective grid influenced the illusion.

All size measurements were made using a method of constant stimuli. The slides were presented in a haphazard order; then the S judged whether the test cylinder was "taller" or "shorter," or "wider" or "narrower" than the standard cylinder. Thus, the illusion was measured both vertically (cylinder height) and horizontally (cylinder width). The full range of 20 slides was used for all Ss, regardless of the illusion. At least four sets of measurements were made for each S for each condition. From these data, the point where 50% of the judgments were "smaller" (or "narrower") was used as an estimate of the illusion. Such positions of subjective equality were determined for each set of measurements and then averaged.

RESULTS

Steady Fixation

Typical data showing the percent of judgments of "shorter" are plotted in Figs.

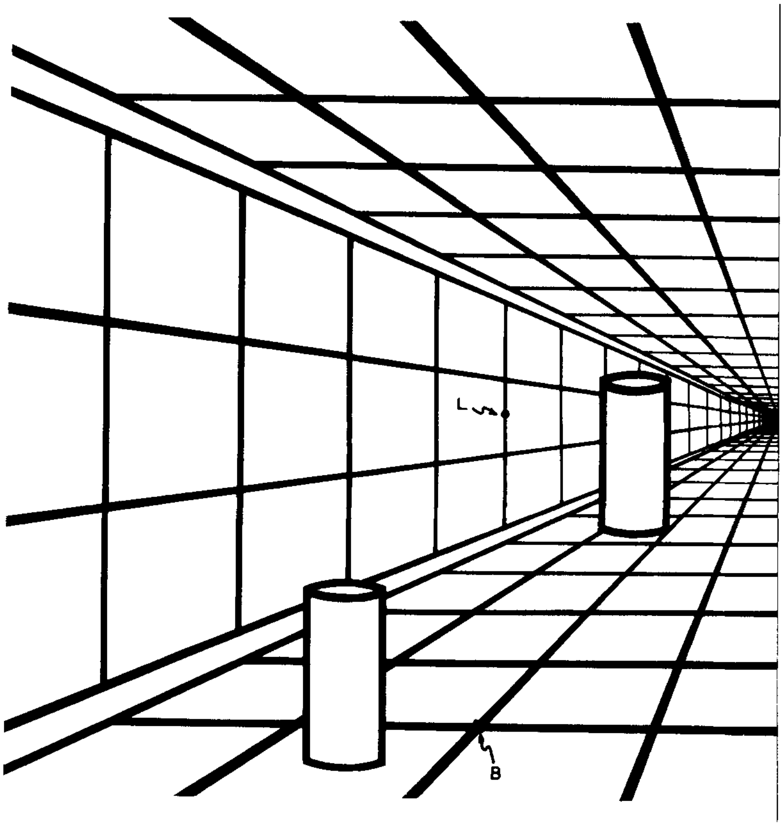

Fig. 1. The corridor illusion used for this study. B and L identify the two different fixation positions.

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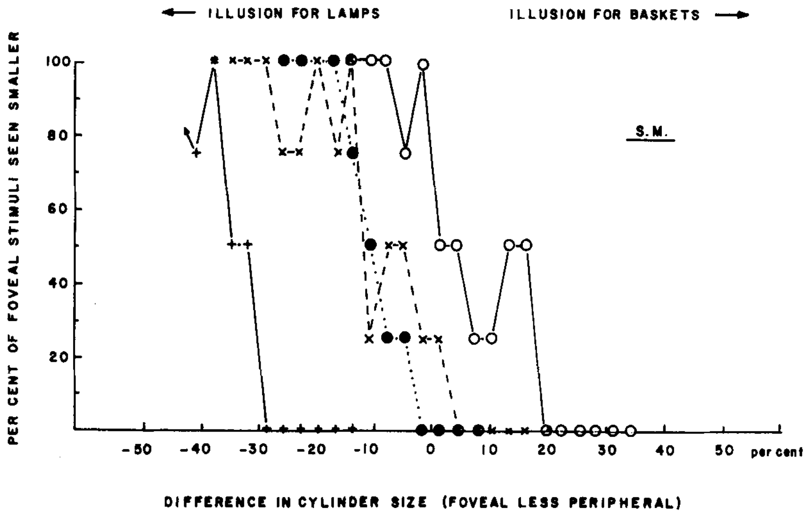

Fig. 2. Judgments of the relative cylinder sizes made by SM. The filled circles and crosses show size judgments made when the corridor was absent and indicate biases attributable to the relative positions of the cylinders alone. The open circles show size judgments made when the cylinders are seen as baskets in a corridor. The pluses show size judgments made when the cylinders are seen as lamps.

2 and 3. These results are obtained using steady fixation upon either Position B or Position L. The abscissa is the percent difference in real size between the standard and test cylinders, with the foveal cylinder taken as unity. Thus, as the standard cylinder appears nearer the fovea in the "basket" condition, the customary corridor illusion for "baskets" should appear to the right of the zero position. On the other hand, because the "lamp" condition required a rotation of the grid, the expected perspective illusion for "lamps" should be to the left of the zero position.

The reason for presenting the data in this way becomes more obvious upon closer inspection of the figures. When no grid (or corridor) is present but only the cylinders are seen alone, then a rotation of the retinal positions of the test and standard cylinders should not affect the point of subjective equality. The near coincidence of the dashed (crosses) and dotted lines (closed circles) shows this to be the case. For S SM (Fig. 2), these two curves cross the 50% horizontal near zero on the abscissa, indicating that the peripheral stimulus (in either the lamp or basket condition) must be only 10% larger than the foveal cylinder for them both to appear equal in height. Considering that there is no perspective grid to cause an illusion, this result is not surprising. When the grid is now added (open circles and pluses), the test cylinders have to be decreased by about 20%, shown by a displacement to the right in the case where the cylinders appear as baskets and to the left where they appear as lamps.

Figure 3 shows similar results for S RH. In this case, when the cylinders are seen alone (closed circles and crosses), the peripheral stimulus must be about 15% smaller in order to appear the same height as the foveal cylinder. Presumably, because there is no perspective grid present, this size illusion is due solely to spatial anisotropies in the visual system. Superimposed upon these inherent size anisotropies is the effect of the grid, which causes a further 12% change in the relative sizes of the cylinders (open circles and pluses).

Table 1 summarizes the results for seven Ss. For each S, apparent size measurements were made with the grid oriented in two ways: for baskets and for lamps. For each of these two conditions, measurements were made with the grid present and without the grid, in order to determine the basic foveal-peripheral anisotropy for each S. These inherent foveal-peripheral anisotropies are shown in the two columns headed "no pattern," with the means given in the next-to-last column on the right. A positive value indicates that a smaller peripheral stimulus matches a larger foveal stimulus.

The two columns headed "pattern" list the percent decrease in size necessary for the peripheral cylinder to match the foveal cylinder when the grid is present. The negative values given in the section under "lamps" is in the expected direction of the perspective illusion, because the grid has been rotated 180 deg. Thus, inspection of Columns 2 and 5 in the upper portion of the table shows that, for the height illusion, RH has the greatest illusion for baskets, whereas JM has the greatest illusion when the cylinders are seen as lamps. The intermediate Ss are rank ordered between these two extremes. These individual differences in the magnitude of the illusion, depending upon the orientation of the corridor, show that, in general, the perspective cues and context provided by the corridor are not the significant factors responsible for the illusion. If they were, the illusion should have remained equally large when the orientation of the corridor was inverted. By inspection of Fig. 1, it can be seen that inversion of the figure changes the grid from an array that expands in the foveal region (fixation at B) to one that contracts in the foveal region and expands in the

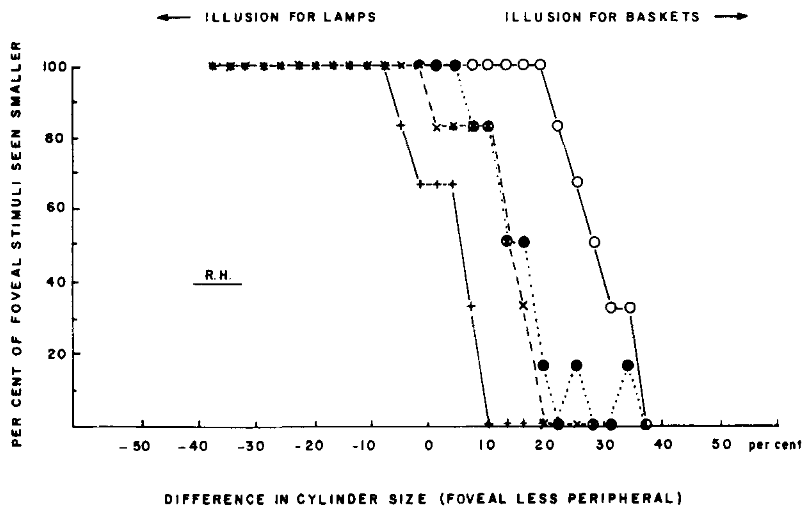

Fig. 3. Judgments of the relative cylinder sizes made by RH. Symbols same as in Fig. 2. Note that, even with no corridor present (closed circles and crosses), the peripheral cylinder appears larger by almost 15%.

Table 1
Mean Values of Illusion (Percent) for Steady Fixation

Subject	Baskets			Lamps			Means	
	Pattern	No Pattern	Grid Effect	Pattern	No Pattern	Grid Effect	Foveal-Peripheral Bias	Grid Effect
				Height				
RH	29.3	15.5	13.8	4.5	14.3	9.9	14.9	11.8
WR	19.5	8.7	10.8	5.1	7.5	12.6	8.1	11.1
WD	13.0	−1.8	14.8	−15.0	4.7	19.7	1.5	17.3
HK	7.5	−5.7	13.2	−17.4	8.7	26.1	1.5	19.6
MK	12.9	−3.9	16.8	−9.6	−3.6	6.0	−3.8	11.4
SM	6.4	−12.8	19.2	−30.8	−9.0	21.8	−10.9	20.4
JM	9.6	−16.2	25.8	−39.0	−11.1	27.8	−13.7	26.9
		Mean:	16.3		Mean:	17.6	Mean:	16.9
				Width				
RH	8.5	8.0	.5	4.0	15.4	11.4	11.7	5.9
WR	7.5	9.0	−1.5	3.0	12.9	9.9	11.0	4.2
WD	8.8	−0.2	9.0	−8.0	6.8	14.8	3.2	11.9
HK	4.8	−5.1	9.9	−3.0	9.0	12.0	2.0	11.0
MK	0.0	−7.5	7.5	−8.1	7.5	15.6	0.0	11.6
SM	−2.3	−6.4	4.1	−15.4	−3.4	12.0	−4.8	8.1
JM	3.6	−5.1	8.7	−23.7	−10.8	12.9	−8.0	10.8
		Mean:	5.5		Mean:	12.6	Mean:	9.1

Table 2
Illusion for Roving vs Steady Fixation (Percent)
(Height)

Subject	Fixation	Pattern			Grid Effect		
		Steady	Roving	Difference	Steady	Roving	Difference
RH	(B)	29.3	−0.5	29.8	13.7	6.8	6.9
HK	(L)	17.4	7.5	9.9	25.9	7.5	18.4
JM	(L)	39.0	21.6	17.4	27.8	28.4	−0.6
WR	(B)	19.5	3.0	16.5	10.8	6.0	4.8
		Mean Difference:		18.3%	Mean Difference:		7.5%

periphery (fixation at L). Apparently the illusion is very sensitive to the interaction between retinal position and the spatial metric imposed by the grid of the corridor.

In order to determine the effect of the grid alone, the size illusions measured with and without the grid present may be compared (pattern vs no pattern). For each orientation and for each individual, these differences appear in Columns 4 and 7 of Table 1. The mean result is given in the rightmost column. The average effect of the grid alone is to induce about a 17% change in the apparent height of the cylinder and only a 9% change in width for the 50-msec displays seen with steady fixation. The grid was more effective in inducing a change in apparent width when the cylinders were seen as lamps; in contrast, the larger illusion for height appeared to be unaffected by the orientation of the grid.

Roving Fixation

If the patterns are not seen flashed under steady fixation but are presented continuously, so that the S may scan the display, then the illusion is drastically reduced. This conclusion follows from Table 2, which shows measurements obtained from the four Ss who were able to complete the series of experiments. For each of these Ss, the corridor was oriented in the position giving the greatest illusion (Column 2). Two eye-movement conditions were then compared: steady fixation (50-msec flashes) and roving fixation, with the display on continuously. When the perspective grid is present and when the S is allowed to scan the display, the illusion is reduced by 18% to a value approximately one-third of the steady-fixation condition (Column 5). If foveal-peripheral anisotropies are factored out so only the effect of the grid alone is measured, then again the illusion is much weaker if the S is allowed to scan the display (last column). Scanning eye movements, therefore, reduce the magnitude of the corridor illusion toward physical equality.

DISCUSSION

Three variables have been shown to be major factors that affect the corridor illusion. The most important is whether the S is allowed to scan the display, as opposed to steady fixation of a flashed display. With steady fixation, the magnitude of the illusion can be over twice as large, providing an appropriate fixation position is chosen. An improper choice of fixation position can markedly reduce the illusion, however, due to inherent foveal-peripheral anisotropies in judged size. These anisotropies represent the second major factor that contributes to the magnitude of the corridor illusion. In this respect, therefore, part of the basis for the corridor illusion is similar to that underlying the horizontal-vertical illusion (Pearce & Matin, 1969). Superimposed upon these inherent spatial anisotropies is the effect of the grid that creates the perspective effect. This factor is approximately independent of the orientation of the grid on the retina, because similar illusions are generated by the basket and lamp conditions where the grid was rotated 180 deg. Note that such a rotation of the grid also changes the relationship between the size of the grid and its position on the retina. For the basket condition, the fovea views the fine part of the grid creating the corridor, whereas for the lamp condition, the coarser gridwork is seen by the fovea. Yet, in spite of these altered relationships between the grain of the grid and retinal position, the size effects induced by the grid remain the same. Such independence between grid size and retinal location would suggest that the size illusion created by the grid occurs later in the visual pathway than do the constraints leading to the spatial anisotropies.

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