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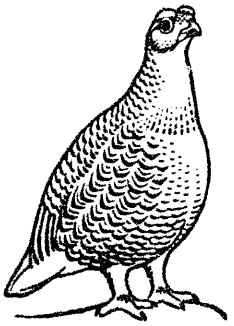

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Size-illusion

P. J. Grant

Accurate judgment of the size of a bird is apparently even more difficult than I suggested in my earlier contribution on the subject (Grant 1980). Then, I believed that the difficulties stemmed only from the inability of the eye to judge accurately relative distances and perspective at long range. Now, I realise that a potentially highly misleading illusion may also be operating whenever binoculars or telescopes are used. Illusory relative sizes and perspective angles are created, giving a false impression that

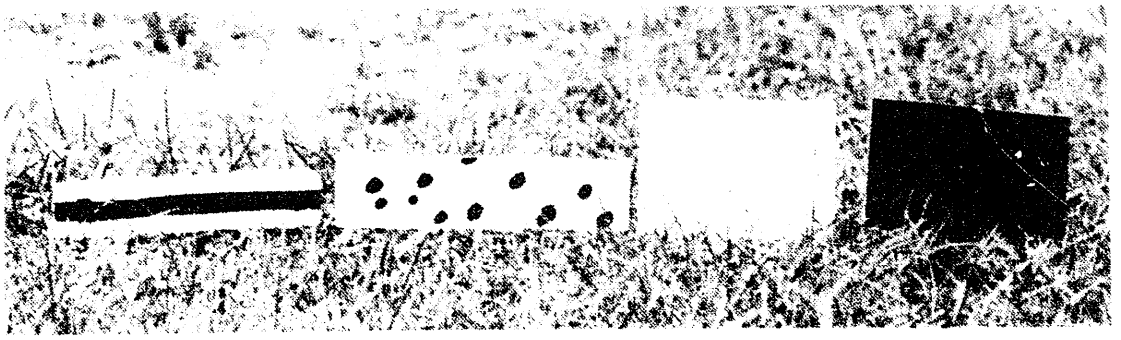
137. Brick wall photographed through telephoto lens which provides equivalent of 20× magnification. Because of size-illusion, far end of wall, or far end of each line of bricks, looks larger than near end (*Richard Chandler*)

objects farther away from the observer are larger than they really are in comparison to nearer objects, the reverse of normal perspective. For simplicity, I have called this phenomenon 'size-illusion'.

Size-illusion can be readily demonstrated, for example, by looking through binoculars obliquely at a brick wall: the far ends of the lines of bricks appear larger than the near ends. The illusion can be reproduced in photographs taken with a telephoto lens (plate 137). Similarly, a short plank of wood, lying on the ground pointing away from the observer, will look wider at the far end when viewed through binoculars. I have noticed that the higher the magnification, and the closer the subject, the more striking is the illusion.

Because it is known that the bricks or plank are actually of even size, the observer instantly recognises these optical illusions for what they are. In natural landscapes, however, where there are no obvious perspective-lines, I believe that an observer may be unaware of the size-illusion which is

138. Size-test cards in line, showing real relative sizes (*Richard Chandler*)



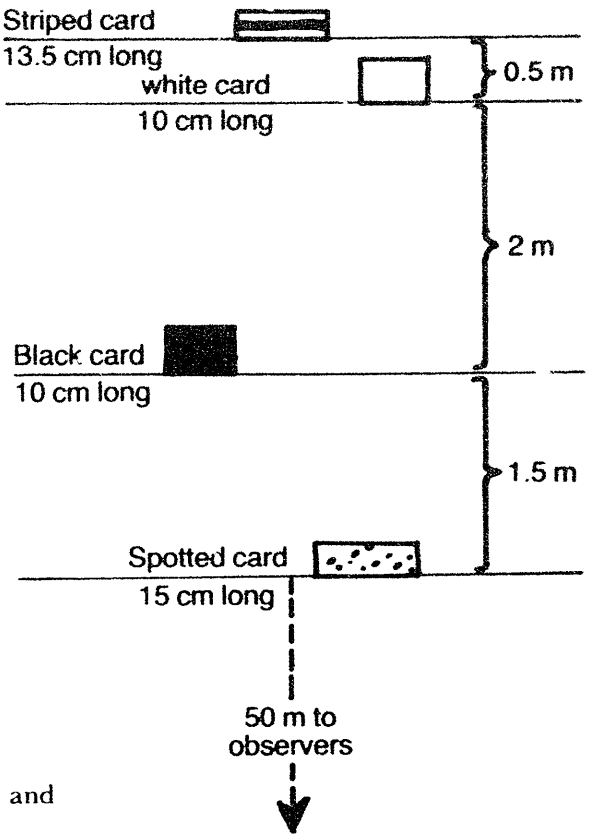
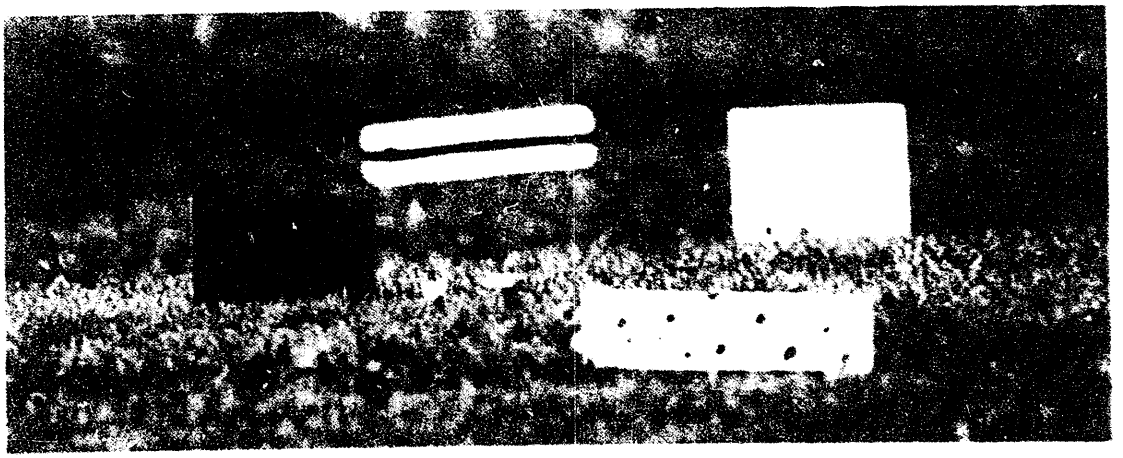


Fig. 1. Diagram showing sizes and arrangements of cards in size-test

operating, and in certain circumstances may make size judgments of birds based on images which are actually illusory.

To test this belief, and also to try to demonstrate the difficulties of estimating distance, relative distances, perspective and size as discussed earlier (Grant 1980), I devised a simple test with four cards of various sizes and patterns (plate 138). They were set up on a distant area of flat ground in the arrangement shown in fig. 1: their appearance in situ, viewed through a telephoto lens, is shown in plate 139. On separate occasions, two groups of highly experienced and competent birdwatchers were asked to make various estimates of distances and sizes. There were nine observers in group A and eight in group B. No restrictions were placed on the time spent on

139. Size-test cards arranged as shown in fig. 1, photographed at 25 m through telephoto lens which provides equivalent of 20× magnification. Relative sizes of the cards are distorted by size-illusion (*Richard Chandler*)



making their estimates, and they were free to use the naked eye and whatever optical aids they wished (a choice which they would have had if judging the size of a bird in normal circumstances). Sharp eyes would be needed to make assessments with the naked eye at the rather long ranges involved in the test (up to 54 m), however, so it is probable that the observers were most influenced by binoculars- or telescope-aided views. Answers could be given in imperial or metric measurements, but all were converted to metric. The questions are given below, with a summary of the responses.

1. How far away is the spotted card? (actual distance approximately 50m) Group A answers ranged from 40m to 80m, with an average of 63m, an average overestimate of 26%. Group B answers ranged from 18m to 91.5m, with an average of 57m, an average overestimate of 14%.
2. How far away is the striped card? (actual distance approximately 54m) Group A answers ranged from 45m to 90m, with an average of 69.5m. The spotted and striped cards were actually approximately 4m apart, but their estimated separation averaged 6.5m. Group B answers ranged from 21m to 100m, with an average of 61.5m, and an average separation of 4.5m.
3. How long is the striped card? (actual length 13.5cm) Group A answers ranged from 14cm to 30cm, with an average of 18.6cm, an average overestimate of 37.7%. Group B answers ranged from 10cm to 30cm, with an average of 18.3cm, an average overestimate of 35.5%.
4. Each observer was then asked to mark the length of the striped card on a blank sheet of paper, so that his actual perception of his size estimate could be assessed. Thus, if in answer to question three he had estimated 20cm, he was asked to mark on the sheet of paper two points 20cm apart. The actual perceptions ranged from 70% to 103% (Group A) and 66% to 100% (Group B) of the size-estimate, with an average of 92.5% (Group A) and 89.1% (Group B). The average actual perception of the length of the striped card in Group A was thus 17.2cm (92.5% of 18.6cm), still an actual overestimate of 27.4%; in Group B the equivalent figure was 16.3cm (89.1% of 18.3cm), still an actual overestimate of 20.7%.
5. If the spotted card is 30 units long, how long in units is the striped card? (actual length of striped card 27 units). In Group A, six observers estimated that they were the same size, and the other three estimated 29, 34 and 35 units, an average estimate that the striped card was 0.9 units longer instead of 3 units shorter than the spotted card, an average overestimate of 14.4%. In Group B, one observer estimated that they were the same size, one estimated 25 units, two estimated 30 units, and four 40 units, an average estimate that the striped card was 4.4 units longer than the spotted card, an average overestimate of 27%.
6. If the white card is 10 units wide, how wide is the black card? (Group A only) Two observers estimated correctly that they were the same size, six estimated 8 units and one 7.5 units, an average of 8.3 units, an average underestimate of 17%.

Discussion

The large difference in the extreme answers to questions 1 and 2 demon-

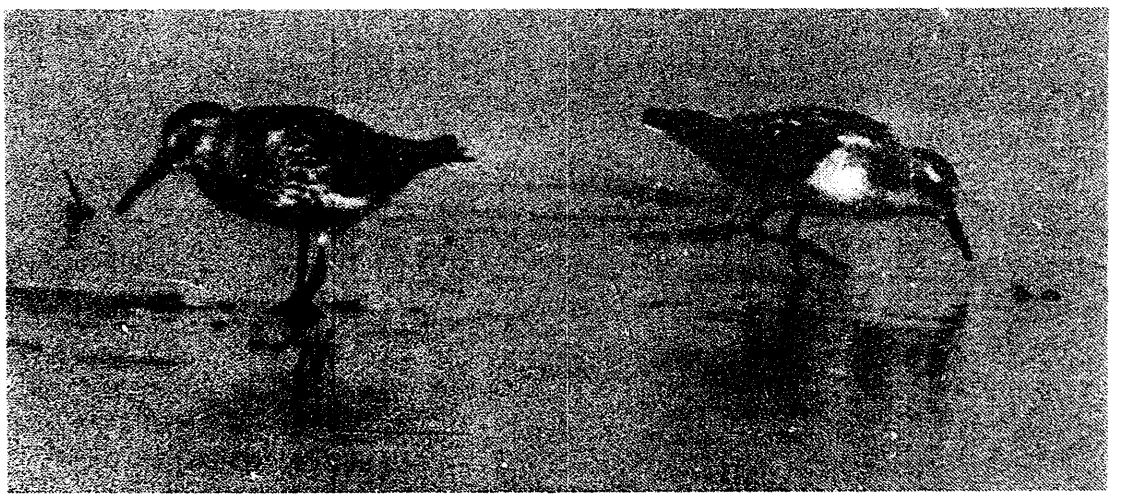
strates the difficulties of judging distance and relative distance. The answers to questions 3 and 4 demonstrate not only the problem of judging the size of lone objects in itself, but also that individuals' perception of measurements may in any case differ widely from the actual.

It is the results from questions 5 and 6, however, which demonstrate the particular pitfalls of size-illusion. I had previously believed that size was difficult to judge only on lone birds, and that if another species of known size was nearby, size assessment was comparatively straightforward. In the test, in the cases of questions 5 and 6, size comparisons were made with one card of known size, and on average in both cases the farther card was perceived as proportionately larger than it really was, producing an average overestimate of 14% (Group A) and 27% (Group B) in the first case, and an average underestimate of 17% (Group A) in the second. Translated into bird size, such discrepancies are very significant. The discrepancies are especially alarming considering that the estimates were made by very experienced birdwatchers, over relatively short distances, in a situation where there was every opportunity—with no time limit—carefully to assess perspective over flat ground, and to make comparisons with nearby grasses, plant leaves and the known-size card. In the real field situation, with quick views, moving birds, soaring raptors, passing seabirds, dashing crakes, and so on, the problems of size assessment—and the potential margin of error—would clearly be much greater.

Size-illusion needs to be borne in mind, too, when interpreting apparent sizes in photographs taken with telephoto lenses. The disproportionately larger size of the farther birds in a flock is obvious in several photographs which I have examined since realising the effects of size-illusion. When unidentified birds or possible rarities are involved, special care may be needed. The possibly misleading effects of size-illusion in photographs are illustrated in plates 140-142. In a recent paper (Wallace, on behalf of the Rarities Committee, 1979), it was suggested that the two stints were possibly Red-necked Stints *Calidris ruficollis*. In each case, the unidentified stint is farther away, and possibly thus looks disproportionately large in comparison with the nearer Dunlin *C. alpina* (plates 140 & 142) or Little Stint *C. minuta* (plate 141). Taking into account the possible effects of size-illusion, it seems likely that the two stints could be Little Stint-sized: certainly, their apparently too-large size, in itself, should be used with caution as an argument against identification as odd-looking juvenile Little Stints (which would be my personal diagnosis).

Conclusions

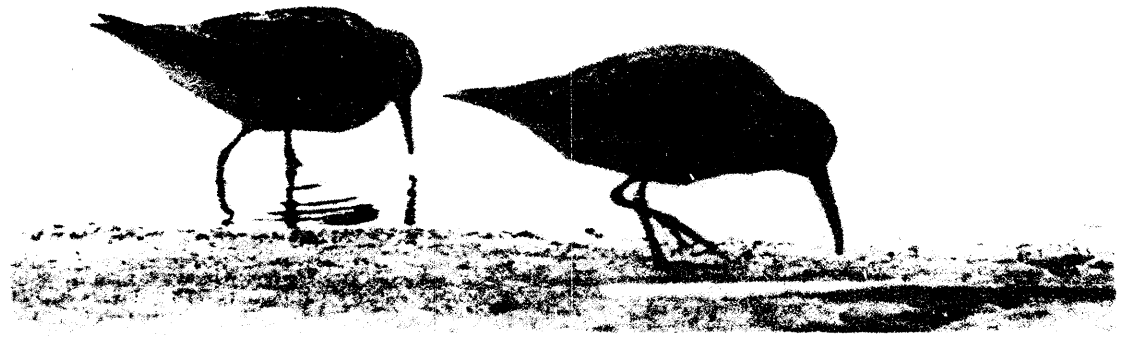
Some observers are undoubtedly better than others at judging size. Practice at judging distances helps, and it was probably not a coincidence that the most correct answers in the size-tests came from the observer who was used to judging driving and putting distances on the golf-course. As a general rule, however, judging the size of birds is much more difficult than would be expected if the facile advice given in field guides (where size-assessment is often suggested as the starting-point in the identification process) was taken at face value. It seems more likely that real size assessments are rarely



140. Juvenile stint *Calidris* (right) with Dunlin *C. alpina*, Dungeness, Kent, September 1965. Size-illusion clearly operating, making stint appear as large as Dunlin. In author's opinion, stint is juvenile Little Stint *C. minuta*, and apparently large size should not be held against this diagnosis (*Pamela Harrison*)

made; instead, it seems likely that size is not really judged at all, but it is known instantly an identification is made in a subconscious process drawing from prior knowledge of the species' size. In fact, real size-assessments would seem to be possible in only relatively few, rather special,

141 & 142. Juvenile stint *Calidris* with (in plate 141) juvenile Little Stint *C. minuta* (left), and (in plate 142) Dunlin *C. alpina*, Lincolnshire, September 1974. In both cases, apparently large size of stint compared with accompanying bird may be result of size-illusion and thus may not be valid argument of identification as Red-necked Stint *C. ruficollis*, or against view, shared by the author, that it is odd-looking juvenile Little Stint (*Keith Atkin*)



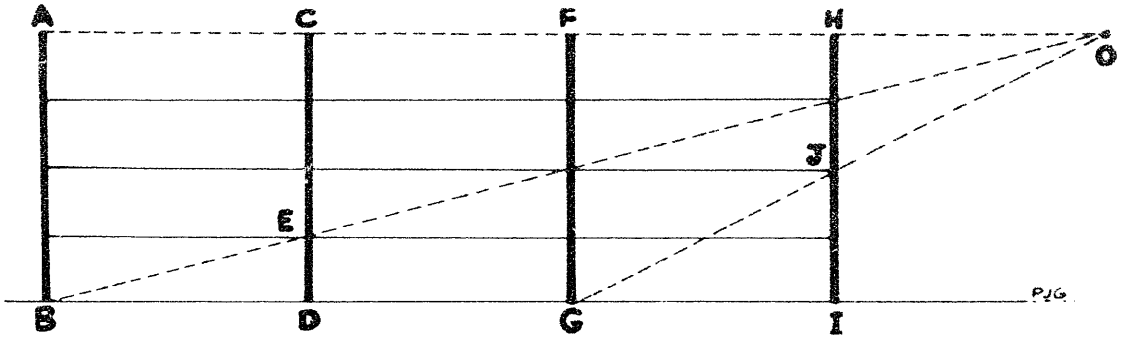


Fig. 2. Diagram to show cause of size-illusion (see text)

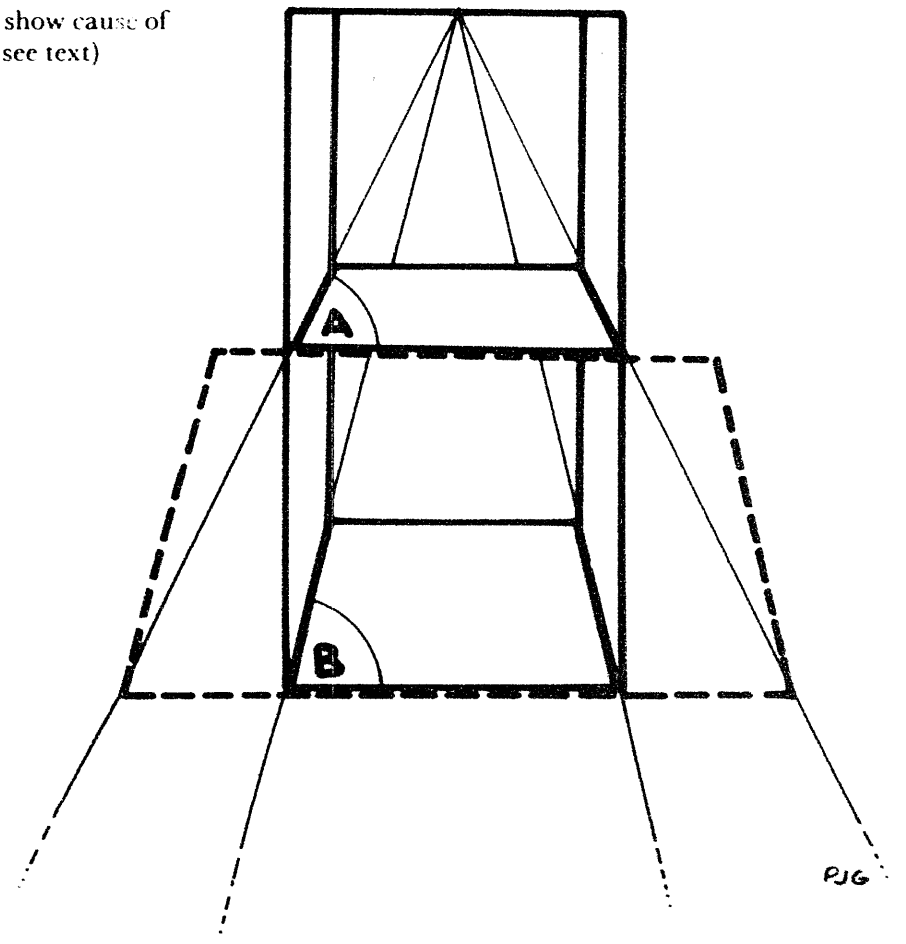
circumstances. Three examples will serve to illustrate this. First, when the subject is surrounded by two or more other birds (in a flock on the ground or in flight) of known size. In such cases, the eye would be able to compensate for the effects of size-illusion (as it can for even-sized objects, such as bricks). Secondly, when the other bird or birds are certainly at the same distance from the observer. Thirdly, in careful, close-range, naked-eye comparison with a nearby species or object of known size.

Cause of size-illusion

Figs. 2 and 3 are attempts at diagrammatic explanations of the rather complex 'optical physics' which causes size-illusion.

In fig. 2, thick lines represent objects at various distances from the

Fig. 3. Diagram to show cause of size-illusion (see text)



viewing point O. Thin lines are included to give a size scale. Broken lines represent angles of vision. When objects AB and CD are viewed with the naked eye, AB in this example will appear to be 75% (CE) the size of CD: this is normal perspective, and the eye will correctly interpret these relative sizes and the two objects will be correctly perceived as being the same size. At closer range, the difference in the relative sizes of objects FG and HI (which are the same size and spaced the same as AB and CD) will be greater. In this example, FG will appear to be 50% (HJ) the size of HI, and it can be envisaged that the nearer or farther the objects, so the difference in the relative sizes will be greater or less respectively. When objects are magnified, the relative sizes within the magnified image remain the same as when viewed with the naked eye, but the eye perceives the objects as closer than they really are, and interprets the apparent relative sizes for that perceived distance, causing size-illusion in which the farther object will appear larger than it really is in comparison with the nearer object, or *vice versa*.

In fig.3, thick lines represent a frame with three equally-spaced shelves, the top one viewed end-on at eye-level. The thin lines are converging perspective lines. It can be seen that the converging perspective lines form a more acute angle at A than at B, and it can be envisaged that the nearer or farther the plane moves towards or away from eye-level, so the angle will become more acute or obtuse respectively. If the bottom shelf were to be viewed through 2× binoculars, all its dimensions (as seen with the naked eye) would be doubled, with the perspective angles remaining the same as when viewed with the naked eye. The broken line represents that double-sized image of the bottom shelf. The eye perceives the magnified image as being twice as near (i.e. half the distance), and—importantly—on a higher plane (in this example, in the same plane as the middle shelf). Because the perspective angles remain the same as when it was in its actual lower plane, however, size-illusion is created, making the far end of the shelf appear wider than the near end. Alternatively, the eye may interpret the illusory perspective angles in a way which gives the impression that the magnified shelf is tilted towards the observer.

Acknowledgments

I thank the many observers with whom I have discussed this topic for their interest and opinions, especially David M. Cottridge who carried out research which resulted in fig. 2 and its explanation. I am grateful to the observers who carried out for me the size-tests in Falsterbo, Sweden, in September 1982 and at Santa Barbara, USA, in January 1983. I am especially grateful to Dr Richard Chandler and A. W. Martin for taking photographs specially for this paper, and Philip Chantler who explained the need for question 4 in the size-test. I thank Keith Atkin and Dr Pamela Harrison for supplying photographs.

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