Gregory's theory of visual illusions: A case study of wilful blindness

Two-dimensional drawings, such as a Ponzo pattern shown in Figure 1A and Müller-Lyer figures shown in Figure 1B illustrate the fact that the apparent size of an object can be altered by the context in which it occurs. In a Ponzo configuration, the upper horizontal line appears longer than the horizontal line beneath it. In the Müller-Lyer pattern, outward-pointing fins in the upper figure enhance the apparent length of the shaft between the apexes and inward-pointing fins in the lower figure reduce the apparent length of the shaft.

Not only size, but attributes such as orientation, location, and shape can be phenomenally altered by appropriate manipulation of contexts. Such distortions were, and continue to be, called "illusions" presumably because they are perceptions that falsely represent reality. The study of such errors, it is claimed, allows us to understand how veridical perception works.

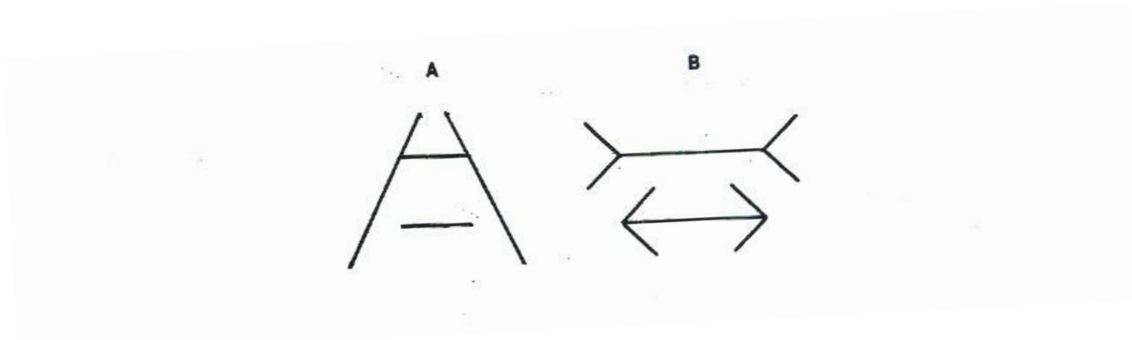

Figure 1(A). Ponzo illusion. (B). Müller-Lyer illusions

The study of illusions began in earnest about 150 years ago. Although popular curiosity drove much of the early effort, an understanding began to emerge among philosophers of mind that it might be possible to develop a science of consciousness. After all, by simply asking an observer to draw a line that appears equal in length to the line between the fins in Müller-Lyer's figure, a *measurement* of experience could be derived. A quantitative measure is the most basic requirement for the scientific method because it allows variables to be manipulated and relationships established. Today, there is exists a rich base of empirical data, but theory cannot make the same claim.

The dominant explanation of many illusions goes back some 60 years when Tausch (1954) and Gregory (1963) proposed that two-dimensional drawings, such as those shown above, represent cues to depth, cues that normally operate in our three-dimensional world but, when applied to drawings, improperly cause distortion. *Size-constancy*, which Gregory emphasizes, refers to the fact that objects that are located at different distances from an observer nevertheless appear equal in size. The face of one person stationed a metre away looks about the same size as the face of another who is two metres away despite the fact that the *retinal image* of the latter is radically smaller than that of the former. Apparently, the brain utilizes cues to distance to compensate for such retinal disparities according to a simple rule: near objects are phenomenally reduced in size and distant objects are phenomenally enlarged. When confronted with a two-dimensional configuration such as the Ponzo in Figure 1A, the slanting lines act as perspective cues to depth just as they do, for example, in a set of railway tracks. The constancy scaling strategies are triggered *inappropriately* with the result that the line near the apex, which is deemed to be farther away, is perceptually enlarged whereas the other line is deemed to be closer and thus phenomenally shrunk.

The first failure

The inappropriate size-constancy scaling theory cannot possibly be correct when one considers the display shown in Figure 2 (Pressey & Epp, 1992). Imagine that you are watching a football game from the end zone and you are about half way up the bleachers. Now, focus hard on the display and imagine that the lines represent goalposts. For many, the effect will "pop out" and the posts on top will look farther away *but the crossbar will appear smaller than the lower (nearby) crossbar*. According to constancy scaling, distance objects should enlarge and near ones should shrink. But here the distant object shrinks and the near one expands. If the rule works for the Ponzo in Figure 1A, why not for the Ponzo-like pattern on the right? (Because, muttered one cynic, it doesn't sell introductory textbooks).

Figure 2. Inverted double Ponzo pattern.

A second failure

It is not difficult to imagine that Figure 3 represents a table in which the edge at the upper part of the figure is farther away than the lower edge. However, the portion of the lower edge is physically equal to the edge above yet it appears elongated. If constancy scaling occurs would we not expect the reverse to be true?

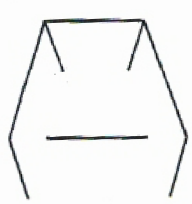

Figure 3. Representation of a table in which the distal edge appears smaller than the nearby portion. This is a variant of a target employed by Prinzmetal, Shimamura & Mikolinski (2001).

A third failure

A rather simple manipulation illustrates another difficulty. If, in Figure 1A, the horizontal lines are replaced by short *vertical* lines directly beneath the apex, the illusion disappears. But if distant objects are perceptually enlarged, why does the enlargement not occur in all dimensions?

Figure 4. A variant of Ponzo's illusion (see Waite & Massarro, 1970).

A fourth failure

Selective amputations provide another problem. Intuitively it would seem that reducing any portion of the converging lines in a Ponzo figure should reduce the effectiveness of the perspective cue and thus reduce the illusion. This prediction is not upheld. If the portion above the upper line is removed, the illusion is *enhanced* (Figure 5B). If the portions below the upper line are removed (Figure 5C), the illusion either disappears or is *reversed* (Pressey, 1974).

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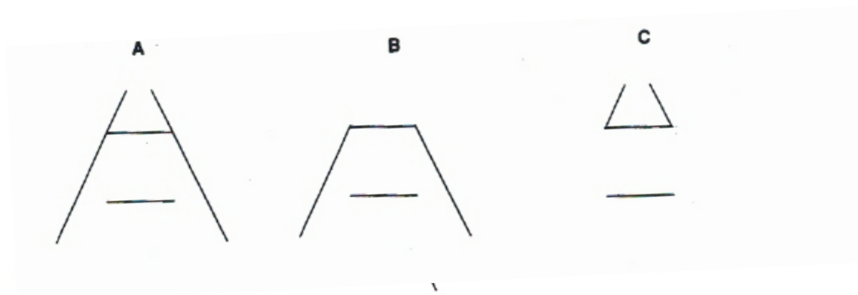

e 5. Amputated versions of Ponzo's illusion.

A fifth failure

The lines to be compared in Figure 6 are the two horizontal lines, second from the top, in the left (A) and the right (B) portions of the display.

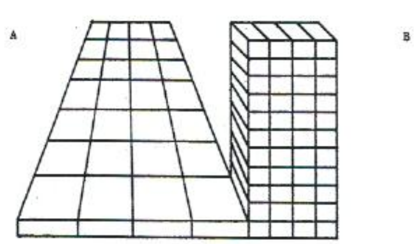

Figure 6. A new illusion involving apparent depth.[1]

The first thing to note is that there is a distinct impresssion of depth with line A appearing to be farther away than line B. Yet, line A does not appear longer than line B as would be expected on the basis of inappropriate constancy scaling theory. If anything, line A appears *shorter* than line B. (There is, however, an ancillary fact that is curious. Many observers report line B to be *lower* than line A. Whether these reports are reliable and whether the phenomenon is due to apparent depth or to the microstructure of the display is yet to be determined).

A sixth failure

In 1971, Pressey, Butchard & Scrivner varied the apical angle in a Ponzo pattern and found that, as the angle increased, distortion increased and then decreased until, at a very large angle, the illusion *reversed.* This finding was replicated and extended in a study by Pressey (1974a) and by Pressey & Murray in 1976. Why the non-monotonic function and the reversal? After 41 years, no theorist who embraces a scene- or picture-based (Redding and Vinson, 2010) theory of illusions has attempted to confront this simple fact.

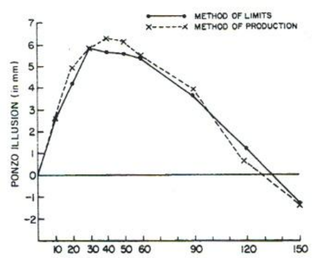

Figure 7. A Ponzo illusion as a function of apical angle as measured by a method of production and a method of limits (Pressey, 1974a).

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The inappropriate constancy scaling theory has also been applied to Müller-Lyer's illusion shown in Figure 1B. It is said that the angles are interpreted as inner or outer corners of buildings; the expansion-form is read as a corner of an interior room, which from, all viewing points, is farthest from the viewer. Since constancy scaling expands distant objects, the illusion of expansion is explained. Similarly, the shrinkage-form represents a corner of a building viewed from outside and, since it is closer to the observer, shrinkage occurs.

A seventh failure

One fundamental empirical fact is that the Müller-Lyer illusion increases dramatically as the angle between the shaft (or its implied extension) and the fin increases and distortion does not decrease until the angle is nearly zero. But, in the natural world, extreme angles are almost never observed. Why does inappropriate constancy scaling work for dimensions in a paper-and-pencil world when those dimensions rarely operate in a natural world?

An eighth failure

A second, well-established, fact is that Müller-Lyer's illusion increases as fin length increases but, for the expansion-form, distortion begins to decline when fin length is about one-half the size of the shaft. But look at the ceiling where it meets the wall in your room and focus on a corner. One is able to see the edge for a distance that much surpasses the height. Thus, once again, the failure to correlate what happens in the real world with what happens in the supposed representation of that world remains a mystery.

A ninth failure

If shrinkage fins are detached from the shaft to create a gap between shaft and fins, the illusion declines and reverses when the gap is very large. Since an illusion occurs, it would seem that the theory would have to argue that we have seen ceilings hang mysteriously above walls and walls float unanchored above floors. Then, when the gaps between floor and wall and wall and ceiling become very large, apparently the corners of the ceiling are perceptually reversed and this produces the reversed illusion!

A tenth failure

Holdings illusion, shown in Figure 8, provides yet another puzzle for Gregory's theory. By simply allowing the fins to point in a single direction an illusion of *location* is produced. Inappropriate constancy scaling theory applies only to distortions of size so why does a rotation of fins cause an illusion of an entirely different sort?

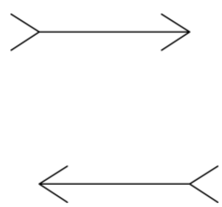

Figure 8. Holding's illusion of location. The lower shaft appears displaced to the right of the one above it.

A final failure

Popular descriptions of Gregory's theory almost always cite the *carpentered world hypothesis* and cross cultural research on visual illusions as evidence supporting the theory.

The hypothesis states that those who live in environments that are rich in buildings with corners and perspective cues will have larger illusions than those whose houses might consist mainly of rounded huts. The research conducted by Segall, Campbell and Herskovits (1966) is usually cited in support of this view. These investigators reported that those who lived in Western cultures had larger illusions than those in non-Western cultures.

There is, however, a fundamental methodological problem with their research because they used the method of constant stimuli to measure the size of illusion. If subjects do not understand instructions or, for whatever reason, respond randomly, a score of zero illusion will be calculated (Pressey, 1987). Since it is plausible to believe that natives who do not speak English and are unfamiliar with tests might respond haphazardly, many illusions of zero size would be recorded and therefore produce the "ecological" difference.

Interestingly, Segall, et al. report a study by Bonte who used a method of adjustment and found no difference between Western and non-Western groups. They wrote, "…we have no doubt of the general superiority of the methods of the present study and must conclude by tentatively disregarding Bonte's data…" (p. 190). Compare what these authors say about Bonte's data with what they conclude about Rivers' (1901, 1905) experiments in which the method of adjustment was also employed. In two studies Rivers found no difference between adults but apparently he did find a "significant difference between the Todas' mean score and that of a sample of English children, a difference showing the Todas to be less subject to the illusion." Their conclusion? "On combining the results of both Müller-Lyer studies the indication is that the nonliterates were less subject to the illusion than were Englishmen" (p.64). Thus, no matter how strained the computation, so long as the data supported their thesis, it was not to be "disregarded."

If experience with corners of buildings influences illusions between cultures, the same logic must apply within cultures. As experience grows, illusions should increase. Therefore, it would be expected that illusions should increase as age increases. Although there are a few studies that support such a trend, once again increases are generally found when psychophysical methods requiring dichotomous responses are employed (e.g., Leibowitz & Judisch, 1967). When direct measures such as reproduction are used (see Pressey, 1974b), illusions tend to decrease with age, a result that contradicts inappropriate constancy scaling theory.

Concluding comments

There is little doubt that Richard Gregory's theory of geometric illusions is a poster child for bad science.

How is it possible for a theory to survive for some 50 years without explaining a single empirical function? How is it possible not to be curious about ambiguous Müller-Lyers, multi-finned Müller-Lyers, reversed Müller-Lyers, amputated Müller-Lyers, Holding figures and all the fascinating individual differences associated with these percepts? Why do so many think that, as long as they accompany pictures of rectangular objects with the words "evolution" and "ecology", they have satisfied the demands of good science?

There are four ways in which bad science can be perpetrated. The first is by means of a hoax.

Perhaps, the most famous scientific hoax was the Piltdown man—an archaeological find in Sussex, England, which purported to be the "missing link" in the evolution of mankind.[2]

Fraud is another means of debasing scientific pursuit. A recent example may have occurred at the University of East Anglia where, critics charge, data were manipulated to support the theory of global warming.

By far, the most common impediment to scientific advancement is simply careless scholarship, a defect that is so common that severe condemnation seems churlish.

Still, none of the above is sufficient to explain why, in the face overwhelming disconfirming evidence, Gregory's theory has remained, for some fifty years, the accepted explanation by both professional and popular psychologists.

The factor that best explains the theory's longevity is called "wilful blindness". Justice Sopinka, a member of Canada's Supreme Court wrote "...wilful blindness involves an affirmative answer to the question: Did the accused shut his eyes because he knew or strongly suspected that looking would fix him with knowledge?" In other words, "...wilful blindness is not simply a failure to inquire but deliberate ignorance."[3]

A good example of willful blindness is provided in the current Wikipedia entry on the Müller-Lyer illusion.[4] "It has been shown," the article states, "that perception of the Müller-Lyer illusion varies across cultures and age groups." However, only the evidence on cross-cultural differences is provided presumably because it supports Gregory's theory. The fact that most illusions decline with age is not mentioned perhaps because the reader would recognize that what is true between cultures must also be true within cultures.

Those who declare themselves scientists take a tacit oath not to engage in behaviour that is antithetical to the scientific method. A hoax, fraud, and wilful blindness corrupt one of the finest epistemological tools invented by mankind.

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Notes

[1]Originally created by Victor Tennant (if I recall correctly).
[2]http//en.wikipedia.org/wiki/Piltdown_Man
[3]http://www.macmillan.ca/Contrived-Ignorance-Wilful-Blindness
[4]http://en.wikipedia.org/wiki/Müller-Lyer_illusion

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Postscript

An early version of the above was written a year ago, after a 17- year absence from academia. The fresh exuberance that I felt then has been replaced by a (once familiar) feeling of distaste for psychological "science".

A historian once observed that it is almost impossible to reject a false theory until the author of that theory dies. Now that Gregory is no longer with us, is there hope? I think not. The new purveyors of scene-based explanations (Howe & Purves; Redding and Vinson) have buzzwords on their side. Research money will flow to their cause, pretty tales will be written, textbooks will select the prettiest of these and history will repeat itself.

Alexander Pressey, Revised April 2013