Railroading Ponzo’s illusion©

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Abstract
The common practice of locating figures of the same size on pictures of railroad tracks to illustrate inappropriate constancy scaling in Ponzo’s illusion is shown to be a category mistake. It is argued that such figures are cases of perceptual incoherence analogous to experiences evoked by impossible figures and not to experiences evoked by geometrical illusions.

For over 50 years, the dominant explanation of geometric illusions such as those illustrated in Figure 1 has been a perspective theory, a variant of which was offered by Richard Gregory in 1963. Gregory argued that 2-dimensional drawings

![Figure 1(A). Ponzo illusion. (B). Müller-Lyer illusions](image)

contain features that represent depth in the 3-dimensional world. He pointed out that a fundamental aspect of 3-D viewing is size constancy whereby distant objects are perceptually enhanced and near objects are perceptually reduced in order to

![Figure 2 (A). Objects in the 3-D world (A) represented by 2-D sketches (B). (Adapted with permission from Schloss & Prinzmetal, 2012; original drawing by Preeti Talwai)](image)
equalize the identity of the same (or similar) objects. When viewing 2-D pictures, size constancy operates \textit{inappropriately} and causes illusions of apparent size.

To illustrate his point about a Müller-Lyer configuration, for example, a picture of a building such as the one shown in Figure 2 is presented. The edge of the window on the left is closest to the observer and is (inappropriately) reduced whereas the interior corner on the right is farther from the observer and is phenomenally enhanced.

Inappropriate constancy scaling theory explains Ponzo’s illusion in Figure 1A by arguing that the long converging lines are the classical perspective cues to depth so that the upper horizontal line appears farther away and is phenomenally enlarged. Inappropriate constancy scaling reduces the subjective size of the lower horizontal line because it appears to be closer to the observer.

Just as flat roofed buildings are a favoured means of illustrating how a Müller–Lyer operates in the “real world”, adherents to Gregory’s view choose railway tracks to illustrate “real world” versions of Ponzo’s illusion. One example is provided in Figure 3.

\begin{figure}[h]
  \centering
  \includegraphics[width=\textwidth]{figure3.png}
  \caption{A railway track illusion. The bear at the bottom left appears smaller than the one above it despite the fact that the same picture of the bear was used in both places.}
\end{figure}

According to the rule proposed by inappropriate constancy scaling theory that distant objects are phenomenally enlarged and near objects are perceptually shrunk, the bear in the upper part of the picture looks larger than the twin below.

Unfortunately, there is a bit of cheating going on here. Examples that purport to support Gregory seem to focus only on distant objects to illustrate the expansion but never on nearer ones to illustrate shrinkage. For example, Goldstein (2010, p. 251) writes, “…the top animal appears larger because…the converging railroad tracks make the top animal appear farther away. Thus, just as in the Müller-Lyer illusion, the scaling mechanism corrects for this apparent increased depth…and we perceive the top animal to be larger.”
The purpose of this report is to show that if we try to validate Gregory’s theory by focusing, not on the *enhancement* of distant objects but on the *reduction* of near objects, then what dominates is the weirdness and perceptual incoherence of the entire display rather than the difference in size of particular objects.

*Figure 4. The Trans Canada highway in Saskatchewan*

Consider Figure 4 and ask whether there is anything obviously wrong with the picture. Other than wondering whether carrying out ablutions in public is acceptable, most observers see nothing amiss. Now, consider Figure 5 in which the car on the left is exactly replicated and placed on the road above the camper.

*Figure 5. The same scene as in Figure 4 except that the car on the left, in its exact size and form, has been relocated on the road above the camper.*
According to Gregory the car on the right has been perceptually shrunk. As Goldstein would say, “Thus, just as in the Müller-Lyer illusion, the scaling mechanism corrects for this apparent decreased depth…and we perceive the car on the right to be smaller.”

A skeptic would probably reply, “Really? Cast your gaze at Figure 6 in which

![Figure 6. Scene drawn in proper perspective](image)

the car on the right has been drawn in proper perspective. That car is now about 600% larger than the one on the left. That is one powerful scaling mechanism, one

![Figure 7. Is this size constancy scaling in which nearby objects are perceptually reduced?](image)
huge Ponzo illusion!

It is not difficult to buttress the point illustrated in Figure 5, and Figures 7 and 8 do just that. In Figure 7, the size of the man at the bottom left simply does not fit the size of the tracks and the diminished size of the man has nothing to do with the relative distance of the man or the tracks to the viewer.

An analogous effect is illustrated in Figure 8 where the size of one feature of a familiar object (the mouth of a face) is enlarged and substituted for the normal mouth. Once again, the result is a startling percept, which is due to a mismatch between figure and its ground and is not an “illusion” in the way that we normally use the word.

Figure 8. The large mouth on the right does not fit the face in the same way that the small man in Figure 7 does not fit the railroad track.

The argument that I wish to make is that a Ponzo illusion and the railroad track illusion are fundamentally different and that the existence of the latter provides no evidence for the cause of the former. In Ponzo’s classical illusion, the line near the apex of a wedge appears modestly larger than the line below it and the difference often must be pointed out to a naïve observer. In the railway track “illusion” the perceptual experience is one of dramatic perceptual incoherence. Phrases such as “That’s ridiculous!” and “Hey dude, can’t you draw?” seem appropriate. If pressed, a naïve observer will sometimes say that the distorted figure “does not fit” especially when presented with displays such as those illustrated in Figures 7 and 8. But, the phrase “it does not fit” is completely inappropriate for Ponzo or Müller-Lyer figures.

The experience evoked by a railroad “illusion” is similar to one that is produced by the so-called impossible figures (e.g. Figure 9), by a rotating trapezoidal window, and by Ames’ distorting room. Indeed, what we see in Figure 7 is very much like the distortion that appears in Ames’ room.

It is instructive to revisit Figure 1 in light of the view that a “railroad Ponzo” evokes an entirely different kind of experience from the kinds that are evoked by the classical geometric illusions. The figure itself is an excellent example of the
kinds of illustrations that are provided to support scene-based theories of illusions (Redding & Vinson). A striking feature of Figure 1 is that the amount of distortion in 1A is markedly larger than that which is observed in 1B.

But that may not be the major point. The question is why would one even ask whether the frame of a window appears equal in size to an entire wall. In the natural world, windows are encased within walls and are, by their very nature, smaller than walls. And so, in a pictorial representation of a scene, to see the edge of a window that is physically equal to the edge of a wall as smaller than that wall is a perfectly *rational* solution as the visual system strives to achieve coherence.

The problem can be approached from a slightly different perspective. Suppose Schloss & Prinzmetal (2012) had drawn the windows some 20% larger than the size they chose. To the viewer, there would be no discernible “strangeness” to the picture and, indeed, to ask why the two critical edges do not appear equal would make no sense. Like some impossible figures, the “weirdness” appears only under highly restricted conditions. For example, a crate for shipping optical illusions can be built in the 3-D world but it can appear as shown in Figure 8 only if viewed from a very specific vantage point.

The argument outlined here is reminiscent of a caution that was promulgated in the 1950s. Gilbert Ryle, a British philosopher, argued that a “category mistake” is made when entities or phenomena from different categories are conflated. One variant of this proposal is that “phenotypic identity does not guarantee genotypic identity”. In other words, a common cause cannot be attributed to the fact that observed features might be identical. So, the position that I have taken here is that popular writers and authors of textbooks such as Goldstein are committing a category error when they attribute a common cause to a Ponzo illusion shown in Figure 1A and a railway track distortion as illustrated in Figure 3.
An enduring puzzle

I am troubled by a very simple question. When Goldstein (2010), for example, chose to print his version of the railroad track “illusion” to demonstrate the idea that distant objects are perceptually enlarged, did he not experiment with his drawings to see whether near objects are perceptually reduced? And if he devised such an illustration, did he actually believe that the figure exemplified inappropriate constancy scaling? Whatever the answer, it seems that he, like many modern scientists, has adopted what can be called the Johnny Cochrane principle—“If it doesn’t fit, you must omit!”

But that does not make for good science.

References

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