BY **MIKE WOOD**

How bright is bright

Part 3

THIS IS THE THIRD IN A SHORT SERIES of articles dealing with the concepts of vision and perception and how the human eye and brain are continually making judgments and assumptions about what we *see*. So far we have looked at brightness perception in two dimensions and how those judgments are often flawed or, at least, skewed!

Now I want to really mess things up and introduce the third dimension which, unsurprisingly, makes an enormous difference to the way we perceive. We live in a three dimensional world and that third dimension brings with it a whole new level of assumptions. Just think about the complexity of the processing our brains have to do. Each of our eyes can only see in two dimensions so our perception of depth and solidity is exactly that, a perception. Our senses are not capable of directly seeing three dimensionally, it all happens in the brain and perception is king.

Shading and shadows

To make sense of the images coming in, and in the absence of getting true 3-D information, the brain relies upon a number of cues and hints. A couple of big hints that are very significant to us and what we do for a living are shadows and shading. Let's look at an example.

Figure 1 shows how the cues of shading and shadow can actually fool us. Take a look at the squares labeled A and B in the image on the left. The cue of the checkerboard (we *know* what a checkerboard looks like; don't we?) compounded by the shadow of the cylinder makes square B look much brighter than square A. In fact, as I'm sure you guessed, A and B are exactly the same brightness, as the image on the right confirms. Our knowledge of the real world and how shadows normally work makes us assume that square B must be brighter than it looks because it's in a shadow. The addition of the two vertical bars on the right destroys that perceived three dimensionality of the image and we see things as they really are. Cut a small hole in a piece of paper to block out the rest of the scene and look at the two squares through the hole if you don't believe they are the same!

Why does this matter? If you were lighting two actors on a set for a television production, one of whom was standing in position A, fully lit, and the other in position B, supposedly in shadow, how would you light the scene to look realistic and make sure the images look correct on camera? If you lit both actors to the same level (as you might be tempted to do to make the camera happy) then the one at position B would look too bright in a long shot, where you could see the shadows, but fine in a close up. Conversely if you lit actor B to look correct in the long shot then they would look too dark in the close up. The lighting requirement varies with how much of the scene we can see and therefore how much our shadow perception comes into play. In a movie shoot we might have the option of shooting the scene twice with different lighting levels to

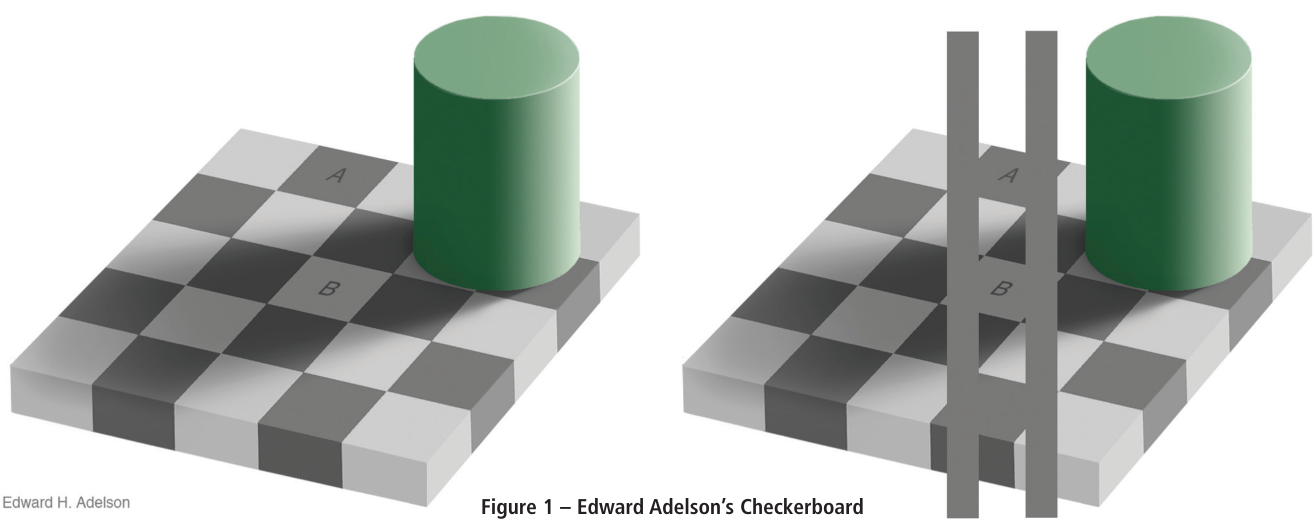

Figure 1 – Edward Adelson's Checkerboard

> "So far we have looked at brightness perception in two dimensions and how those judgments are often flawed or, at least, skewed!"

make it work; once in long shot and again in close up. That isn't always an option in television and a lighting level somewhere half-way between is probably the best we can do. The situation is more manageable on a stage where we know the audience is seeing the scene in long shot. Even then we need to take care not to over-light obviously shadowed areas as our brains will subconsciously increase the lighting level in those areas for us.

In the last issue we looked at the Cornsweet illusion and how it might influence our lighting of a cyc cloth. **Figure 2** shows a very simple three dimensional version of the same illusion.

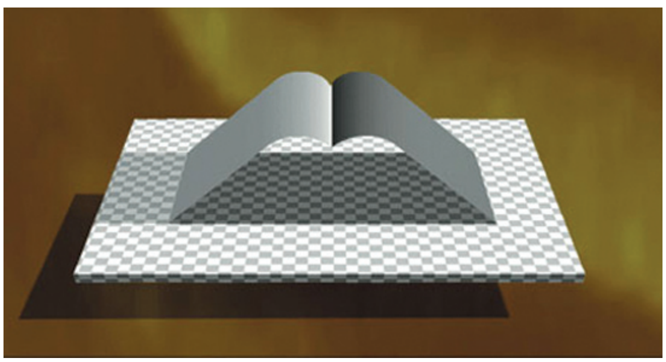

Figure 2 – Cornsweet in 3D

Look back at your copy of the last issue of *Protocol* and you will see how much stronger the illusion is with the extra cues of shadows and shading added. As before both sides of the shape are the same shade of grey. Only the middle of the image around the crease differs.

Real world application

Figure 3 illustrates a more real world example (it's a computer generated image but it could have been set up and photographed in the real world; nothing is faked). Here again we have black and white tiles on the floor and an obvious shadow from the table. The two center tiles in the top row, one white tile under the table shadow and the adjacent black tile in full light, are actually identical shades of grey; really they are! Cover up some of the image with your hand and try and see at what point the illusion fails. I have to cover up most of the table and its shadow before I can see this as it really is. The visual cues we derive from shadows and our experiential knowledge of the world are very strong and it takes a lot to override those perceptions.

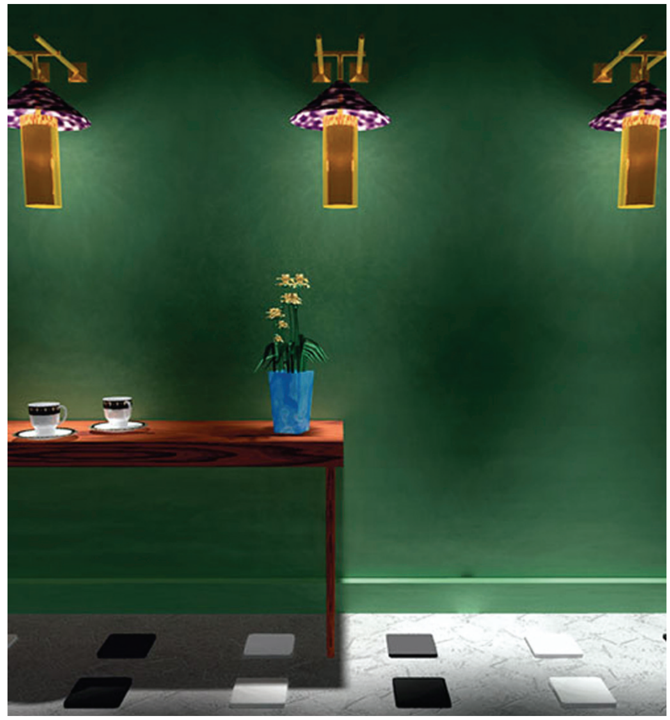

Figure 3 – A "real" scene

One more deceptively simple example; **Figure 4** is clearly a solid striped block lit from behind with the front face in shadow. The grey and white stripes appear continuous and perfectly normal and, indeed, they are. Once again our knowledge and experience of the real three dimensional world makes it pretty much impossible to make objective judgments about brightness levels in the scene. I'm sure you've guessed from our previous examples what's going on here and that the *white* stripes on the front face of the block are identical in shade to the *dark grey* stripes on the top. Both are the same tone of mid grey and identical in brightness. You may need to mask parts of the image before you can get your brain to stop

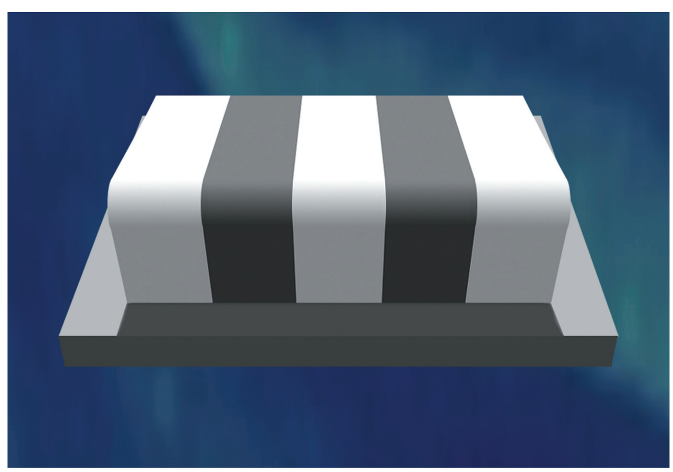

Figure 4 – Subtle shading

making assumptions. Even though it's only a printed flat image on a piece of paper the impression of three dimensionality is so strong that it's very hard to break through it to see the underlying tones. (*It would be very interesting to show these images to people from an ancient culture who didn't share the learned experience we have of looking at three dimensional images on paper to see if the effect was still as strong. Is this an innate perception or a learned one?*)

Unfortunately there are no hard and fast rules to be learnt from any of this when it comes to lighting a performance. Shading and shadow are inevitable and, in fact, we often deliberately add them to help improve an audience's appreciation and understanding of a set and the spatial relationships between objects and scenery. In a large theatre, for example, most of the audience is too far away for their binocular vision to give them any real depth information, our eyes are just not far enough apart to give significantly different views from 200 feet! From the back of the orchestra we get all our depth information from other cues and, as we've seen, some of the most important visual cues are shadows and shading. Light everything to look completely flat and it's boring and tiring to watch. What we need to understand though is, if we have obvious shadows and shading, that light levels may not be exactly what they appear to the eye, and a camera may well not see the same things you do.

What about color?

Although the images we've looked at this time have colored elements, the color itself has not been an important part of our perception. Color however has its own set of vision assumptions and perception concerns and we'll be looking at some of those in the next issue. I can promise you some images and illusions that you just won't believe. For now I want to end this chapter with an illustration which, to me, is one of the best I've seen for demonstrating how strongly our expectations and assumptions influence what we *see.*

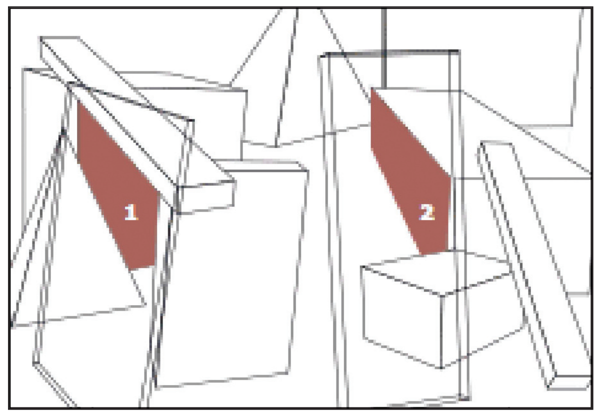

Figure 5 – Now you see it…

> **Each of our eyes can only see in two dimensions so our perception of depth and solidity is exactly that, a perception.**

The scene in **Figure 5** shows a number of colored blocks in a still-life arrangement. Some blocks are transparent while others are solid and there is a wide range of colors and angles. Take a look in the main image at the two areas designated 1 and 2 in the small thumbnail image left. Those two areas are identical in every way; same shape, same color, and same texture. It's very hard to see them that way; to me shape 1 appears as a flat colored orange plane with a solid texture while shape 2 seems hazy, bigger, and a much lighter yellow. Our perception is driven in each case by the surrounding area, not just by the shape itself. We appear to be looking at shape 2 through a piece of red tinted glass; we therefore mentally subtract that red from the color of the shape and so it appears less orange and more yellow. We also *know* that objects seen through colored glass look smokier and less distinct, and so it does. In addition shape 2 is in shadow so we tend to compensate and lighten its appearance. The more you study this image the more it helps you understand the incredible job our brains do at making sense of the raw data coming from the eyes.

Thanks are due to Dale Purves MD, Director, Center for Cognitive Neuroscience at Duke University for permission to publish a number of these images.

Next time we move fully into color and take a look at how we can really mess up seeing those!

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