BY **MIKE WOOD**

How bright is bright

Part 2

LAST ISSUE I INTRODUCED THE CONCEPT of perception being stronger than reality with particular emphasis on how the human eye/brain makes brightness and intensity judgments based on the entire field of vision rather than taking absolute spot measurements, as you would with a light meter. This time I want to expand on that concept with particular reference to the huge importance contrast has to how bright something looks and the effect this has on us when viewing the effects of lighting.

The illustrations presented in the last issue would have been familiar to many of you, these kinds of illusions have often been shown before. This time I am going to concentrate on some newer examples in this field with some illustrations that you might not have seen before as well as the application of these to our real world of lighting.

Peaky versus flat

Ask 100 lighting folks to evaluate the performance of a spotlight and 99 of them will point it at a cyc or white wall, put it into hard focus, turn all the other lights out and take it from there. Is this realistic and fair? Clearly we rarely use the products in this manner but is it a reasonable way to judge them? Well, perhaps for some applications it is, but I suggest that the results can be very misleading.

For example, take a look at **Figure 1**, which shows a simulation of how three lights might look when projected on a wall with no other ambient light. The three spots have been adjusted so they each have precisely the same total light outputs; the field lumens are the same. However spot A is brighter in the center, spot B is completely flat and spot C is brighter round the edge with a darker area in the center. The lamp adjust on standard ellipsoidals allows you to set any of these conditions easily, although most luminaires are set to be peaky. On a black wall spot A, the peaky one, looks to be the brightest.

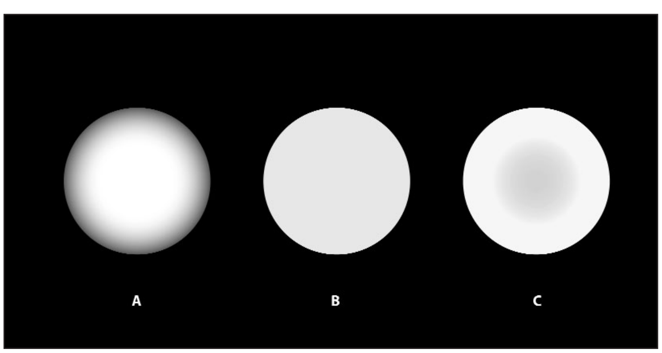

Figure 1 – No ambient lighting

Start turning up the ambient light though and things start to change. **Figure 2** shows the same three spots but this time with a low level of background lighting. Now spot A, the peaky luminaire, is starting to look less bright and spot C, the one with the black hole, starts to predominate.

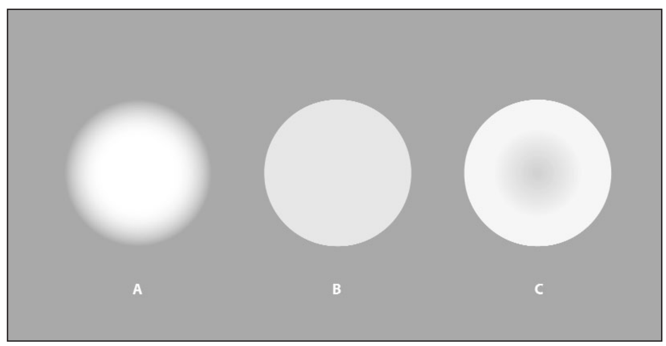

Figure 2 – Mid level ambient lighting

Figure 3 shows the same spots again but this time with a high level of ambient lighting. Now the differences are striking. The peaky luminaire, spot A, is only just visible; and the flat luminaire, spot B, has completely disappeared into the background. Only spot C with the black hole in the center stands out and now looks significantly brighter than the other two.

So, we go from perceiving the peaky spot as being the brightest when viewed in low ambient light levels to seeing the spot with the hole as brightest when viewed in high ambient. The flat one never wins! If you are a manufacturer of spotlights wanting to show your luminaire off to best advantage, what do you do? If you want it to look good in a dark room then make it peaky, if you want it to look good in high ambient light then make the edges bright!

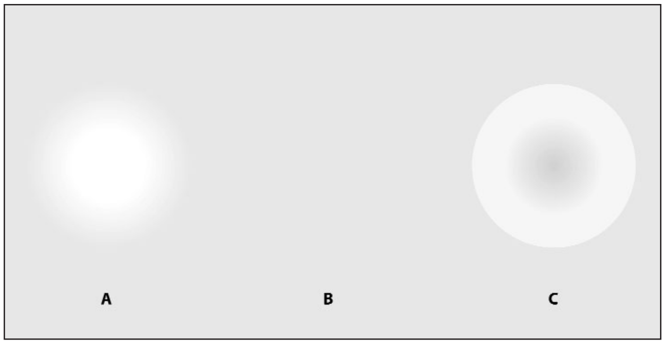

Figure 3 – High ambient lighting

Note that this has nothing to do with the way you might actually use the luminaire for real, then you may well want the luminaire deliberately peaky to allow good blending or flat for clear gobo or image projection.

Why does this happen? Well, as we established in the last issue the eye is pretty poor at judging absolute levels of brightness. What we see best is contrast so edges are incredibly important to our perception of brightness. In **Figure 3** the spot that has the dark center and bright periphery gives us clear demarcation between the spot edge and the background. This leaps out at us and leads us to judge, erroneously, that the rest of the spot must be bright too.

I suspect that you could take this to extremes and make a follow spot that just projected a bright ring of light with a sharp edge on the outside of the spot and a slow fade to nothing on the inside. As long as there was reasonable ambient light on the stage to illuminate the performer the perception of a follow spot would still be strong, even though it was not lighting the performer at all! The bright edge surrounding the performer like a halo would convince you that they were in a follow spot.

Flat cycs

Lighting a cyclorama is one area where we very often want flat lighting. We may want to light a backdrop in a completely flat manner so that it recedes into the distance and gives an illusion of great depth to the stage for a sky. Here is where knowledge that the eye sees contrast rather than absolute levels can help us.

Take a look at **Figure 4**—I imagine you see, as I do, two grey areas with a vertical join between them with the area on the left brighter than the one on the right. Now try taking a pencil or some other object and put it on the page to hide the vertical line in the center of the image. Hiding the area of high contrast allows you to see the situation as it really is; in fact both areas of grey are identical in brightness. We are fooled by the step in the center. The line below the image shows what is going on; this is a brightness profile across the image. Working from left to right the first grey

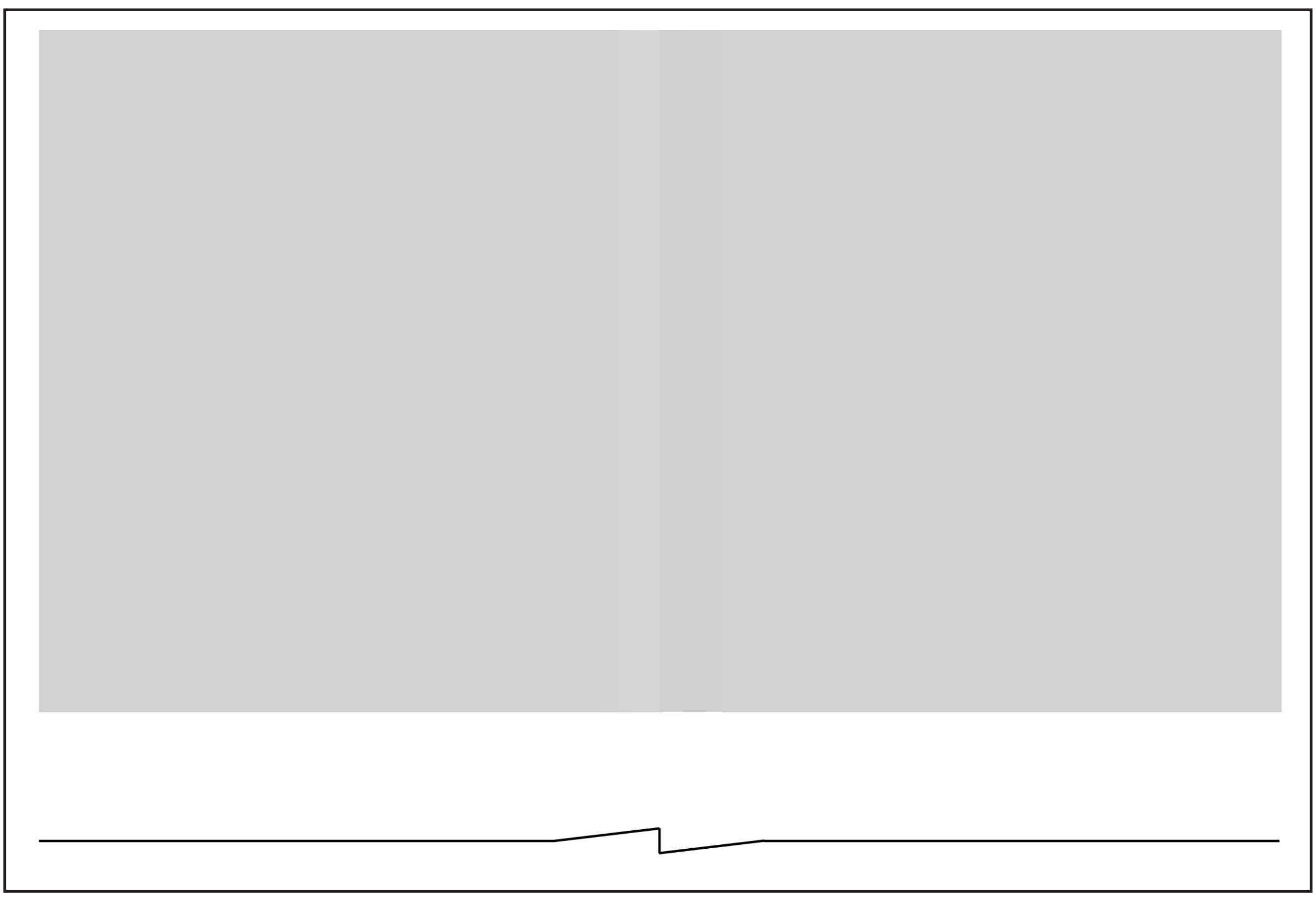

Figure 4 – Demonstration of the Craik-O'Brien-Cornsweet effect

area is mostly flat but then starts to rise slowly towards the center. This change is slow enough that we cannot see it. We then have an abrupt drop in brightness as we move to the second grey area before a slow rise back to the original level. All we notice is the high contrast step in the middle and the slow changes are invisible to us. If we see the brightness step down in level, then we make the assumption that the left hand area must be brighter than the right hand one. Why else would there be a step?

In fact, you can have huge changes in brightness on a cyc, perhaps as much as 50%, and not see them, as long as they are slow and subtle enough. However, put in a 2% step and it sticks out like a sore thumb! This confirms what we already know from experience, it is the joins and blending between adjacent cyc light units that are the critical areas. Within a single light the variation is usually subtle enough that we do not see it.

This effect where contrast prevails over slow changes in brightness (known as the Craik-O'Brien-Cornsweet effect) can appear in other variants. **Figure 5** shows an image with rows of diamonds.

Each row clearly appears darker than the one above it. In fact all the diamonds are identical and all have a slow fade from a darker to a lighter grey as you go from top to bottom. The contrast at the edges predominates in your vision though and you are barely aware of the level changes (in this case the brightness at the bottom of each diamond is twice the brightness at the top). Making this as wallpaper would drive you crazy!

A third dimension

I had not planned to move into three dimensions until the next article but the Cornsweet effect is so important that I think it justifies a preview demonstration; this time with a three dimensional image which reinforces the effect even more.

Note: Thanks are due to Dale Purves MD, Director, Center for Cognitive Neuroscience at Duke University for permission to publish this image.

Figure 6 is a three dimensional variant on the effect demonstrated in **Figure 4**. The addition of the third dimension significantly strengthens the effect as it gives the eye/brain an excuse for perceiving the levels differently. In this case depth shading gives our eye a reason for seeing it wrong! As with the earlier image, the two large blocks in the middle of the image are the same. Put something over the horizontal join between the two to convince yourself or you will never believe it! We are very used to viewing objects in real lighting with all the associated shadows and shades of brightness.

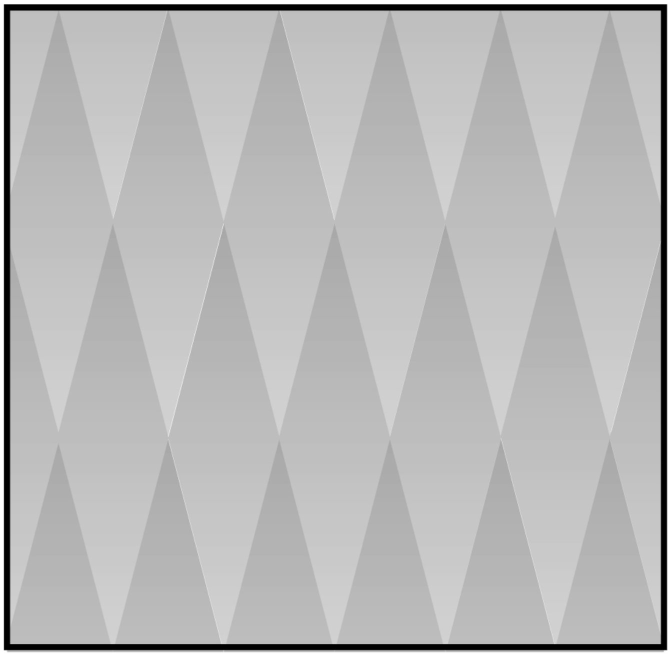

Figure 5 – Infinite Diamonds

This experience leads us to make assumptions that may not always be correct.

This issue we have concentrated on how bad we are at judging brightness when that brightness changes slowly and subtly but, conversely, how good we are at seeing even small edges or step changes in brightness. Knowledge of this can help us in judging and designing lighting and figuring out how to make a cyc cloth look good. Next time we move further into 3D and start to introduce color. ■

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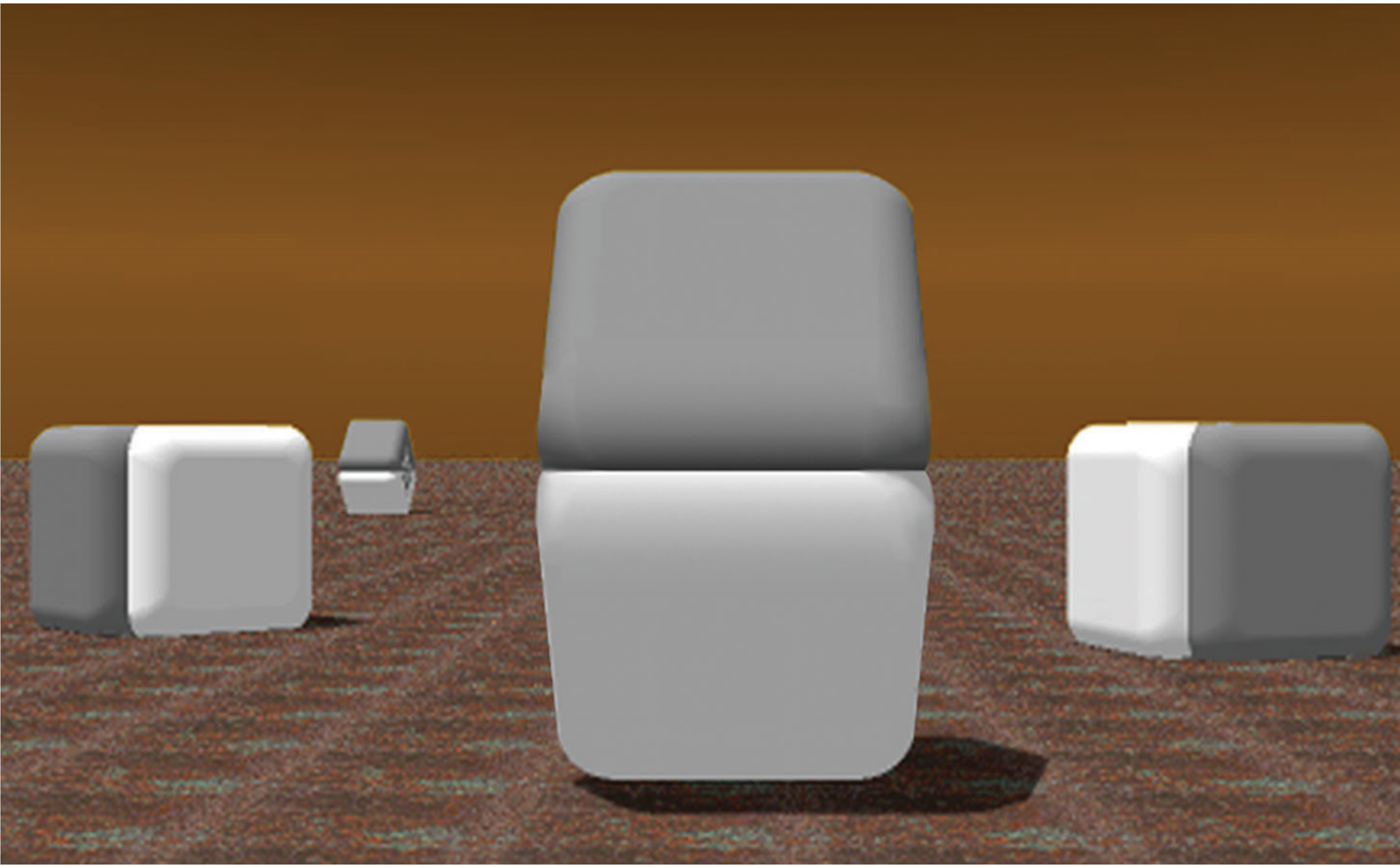

Figure 6 – Purves's and Lotto's Cornsweet effect