Viewing Poster-Sized Stereo Pairs

Stereoscopic pairs are traditionally viewed using a handheld 3D viewer. But when printed in a magazine or shown on a display board, such images are difficult to view unaided, as well as being necessarily very small because the centrelines of the images must match that of the eye. For stereo pairs to have an impact, they must be larger, but a traditional method of viewing larger images requires them to be printed in false colours, thus making them impossible to appreciate without special tinted glasses. In this article, ***David Gibson*** *describes a simple technique that avoids this problem and allows poster-sized full-colour photos to be viewed without any artificial aid. Significantly, this allows them to be fully-appreciated both as flat images and as stereo pairs. Examples are shown on the covers of this journal.*

There are several traditional methods of viewing stereoscopic photos, which I will briefly summarise. For a more detailed treatment, you can refer to Mike Bedford's article in Journal 116 (Bedford, 2021) or, for more articles, run an online search of the CREG journal at **bcra.org.uk/cregj**. The methods you have likely come across will include…

Handheld Stereoscopic Viewers

These have been around since the dawn of photography, in various forms. The main difficulty for public viewing is that they are 'personal' devices. Only one person can use a viewer at a time.

Most viewers use lenses (sometimes with a prismatic component) but some are specifically designed around prisms and some use mirrors. For example, see the Stereoscope and Prism pages at **nvp3d .com/en/how-to-see-3d**.

Polarised Light

Projecting left and right images using polarised light and wearing polarised glasses allows each image to be directed to the appropriate eye, and also means that the colour projections can be viewed 'flat' by people not wearing glasses. Special projection equipment is required.

Red/Green Anaglyphs

Coloured glasses are required for viewing, to direct the red and green images to the appropriate eye. A near-monochrome image is created in the brain by an illusion.

False-colour Anaglyphs

In an extension of the red/green anaglyphs, computer processing is used to re-colour a pair of colour images so that they can be viewed through red/cyan glasses whilst maintaining some of the colour information. The results are not perfect, and the method works best with images that do not have heavily saturated colours.

Problems

The problem with all these traditional methods is that they are…

a) only suitable for personal viewing
or b) not accessible without special glasses
or c) require special projection equipment

Thus, the question arises of whether we can devise a method of displaying stereoscopic prints, e.g. in a magazine or at an exhibition, that counter all the above disadvantages.

It is possible, of course, to train yourself to view a stereo pair without the aid of a viewer. There is a significant limitation, though, which is that the photographs must be small, and printed close together. To view a stereo pair in this manner, you must relax your eyes so that your sight lines do not converge. For larger images, the sight lines would need to diverge, which is not generally possible to achieve. Thus, this free-viewing method is utterly unsuitable for any sort of public display.

The purpose of a traditional handheld stereoscopic viewer is to make the process easier by producing virtual images that are further away from the eye. Essentially, a 3D viewer is just a pair of very strong reading glasses. By very strong, I mean probably at least +6 dioptres. I have measured a 3D viewer I have on my desk and its lenses are +8 dioptres. But although eye strain is eased by using a viewer, the centre lines of the images still need to be maintained at around 70 mm apart, which is useless for posters or exhibition viewing. Some older viewing devices do include an amount of 'prism' to allow contact prints from photographic plates to be viewed. In an earlier article[1] (Gibson, 2001) I described my experiments with adding the large amount of prism needed to view posters – not an ideal solution. I also mentioned, in that article, a much simpler method of 3D viewing, for which the left and right images are swapped when they are printed. To view the images, your eyes now need merely to converge on a point in front of the object, whereupon it will easily snap into 3D.

1 These notes are based on a talk I gave at Hidden Earth 2000, reported in (Gibson, 2001)

Reversed Stereo Pairs

With the stereo pair reversed, there is no limitation on the size of the objects you can view. Consider the pair shown on the front and rear covers. The images are ≈21 cm apart (the paper width) and your eyes are traditionally assumed to be ≈7 cm apart. The figure below (not to scale) shows that, with these dimensions, your sight lines need to cross over at a quarter of the distance from your eyes to the paper. If you hold the images in your outstretched arms (say 60 cm), your sight should converge 15 cm in front of you.

The details of this technique are given in the box on page 24. Clearly, this technique will work for much larger images as well. There is essentially no limitation on size.

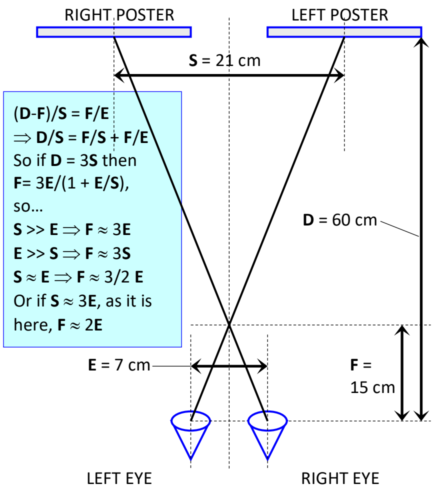
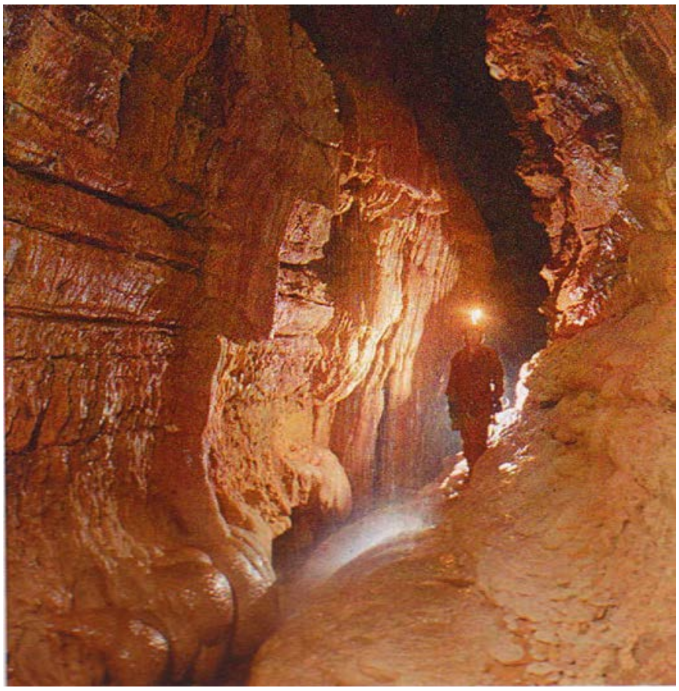
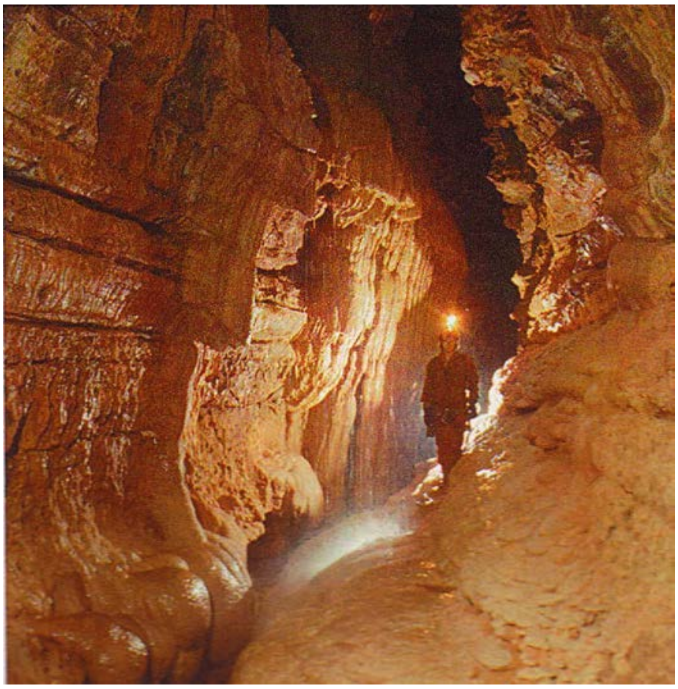


Figure 1 – Viewing Posters as a Reversed Stereo Pair

NB: vertical and horizontal scales not the same.
Suppose your eyes are 7 cm apart and the posters are 21 cm apart at a distance of 60 cm (outstretched arms). Your vision needs to converge on a point 15 cm from your eyes.





Above… Even a low-resolution image like this scan from a book can be appreciated in 3D, because the pixels are smoothed by the process of *binocular gain*.

La Rivière Principale, Gouffre de Padirac, photo by Daniel Chailloux, from his book (1994) Grottes et Gouffres en Relief. ISBN 978-2-910745-05-9.

Observations

The Illusion of Size

This method gives rise to some interesting and fascinating effects. Firstly, whether you view the images separately or fused into a 3D image, the size of the image on your retina is clearly unchanged, but *nevertheless,* the 3D image appears to be smaller than the individual images. The image size also seems to depend on the lateral spacing. We could deduce that the brain receives size cues from the convergence of the eyes and that these are overpowering.

This is only to be expected – it can be easy to fool the brain. Try this: hold one hand, palm out, at arm's length, and hold the other at about half this distance. Shut one eye and look at both hands at the same time. The nearer one will, of course, be twice as large. Now, with both eyes, concentrate on the nearer hand and then suddenly switch your view to the further hand. It will appear to be the same size as the nearer hand. Clearly, your brain 'knows' how large a hand is supposed to be and compensates. As a child, you probably noticed a similar effect when you made a 'telescope' out of a toilet-roll tube. Even without lenses, looking through a tube appears to make things bigger.

3D Depth

The second observation is that you can vary the depth of the 3D image. Once you are locked in to the images, move closer towards them. You will notice your eyes begin to strain, but you should be able to stay locked in for quite a distance. You will notice that as you get closer, the 3D result becomes flatter, i.e. less three-dimensional. Conversely, when you move further away, the image becomes deeper.

This raises the interesting question of what is the 'correct' distance at which to view the images. Also, you might wonder why the question of the 'correct' distance does not arise with conventional stereo pairs – but of course, it *does*, in the guise of the distance apart that they are printed.

The examples given here are not ideal because, at a comfortable viewing distance, and without unacceptable eye strain, there is not quite enough 3D depth.

We can ask what rules we should follow that relate the separation of the camera lenses, the size and separation of the printed images and the distance at which we should view the reversed stereo pairs. Such guidelines are straightforward to determine – it is only trigonometry, after all – but unfortunately, there isn't enough room in this article – I hope to return to this topic in Journal 118.

Images with Reduced Data

A few years ago, I wrote an article in the CREG Journal entitled Stereoscopic Vision with Reduced Definition in One Eye (Gibson, 2015), which explained that an adequate stereoscopic image could be obtained even when one of the images was defocussed or pixelated. Extending that, we can observe that visually acceptable 3D images can be formed from low-resolution images. This is one manifestation of a process known as binocular gain. Consider Daniel Chailloux's photo of Gouffre de Padirac, on this page. I scanned this from a book and so the resolution is limited, but it still makes a striking 3D photo, with the dripping water in front of the caver.

A similar example of a flat image that looks impressive in 3D is Michael Perryman's photo in Ogof Marros on the front cover. As a flat image, this photo isn't particularly striking, but it stands out in 3D. Unfortunately, this argument somewhat undermines my suggestion that exhibition images can be viewed as flat images as well as in 3D.

I was at an international caving event a few years ago, where I overheard the competition judges discussing a 3D poster of the type I am promoting here. They didn't even bother to try to view it in 3D, thus suggesting that you might need to ensure that your stereo pairs still look outstanding even as flat images.

Concluding Remarks

I have described a technique of *Reversed Stereo Pairs,* where the left and right images are swapped. These can be free-viewed without any artificial aid by allowing the eyes to converge on a point in front of the images. There is no size limitation to the images, which can vary from thumbnails to exhibition-sized posters. *No other technique allows presentation-sized stereo pairs to be viewed without a special viewing device.* Additionally, even if you cannot get your eyes to lock in, you can still appreciate the pictures as presentation-sized images.

...continued on rear cover (page 24)

Continued from page 23…

References

Bedford, Mike (2021), *Stereo Photography from the Basics to the Experimental*, CREGJ **116**, pp3-6, Dec. 2021.

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Nvp3d web site at **nvp3d.com/en/how-to-see-3d**. (Last retrieved 11-Feb-2022)

Cover Illustrations

Thanks to Daniel Chailloux and Michael Perryman for permission to use their photos.

Above and front cover: Breccia, Lechuguilla Cave, photos by Daniel Chailloux.

Front cover: The Streamway, Ogof Marros, photos by Michael Perryman.

How to View Reversed Stereo Pairs

Start by placing your eyes at a distance from the images that is roughly three times their spacing, i.e. about 60 cm for the pair on the front & back cover of this journal.

Now hold a finger vertically in front of your nose at a distance from your eyes that is roughly twice the distance between your eyes – about 2/3 of a hand's breadth, or 15 cm – it does not have to be exact.

Looking with your right eye (i.e. with your left eye shut), align your finger with a feature near the centre of the left image.

Now, looking with your *left* eye (i.e. with your *right* eye shut), try to align your finger with the same feature near the centre of the *right* image. This will involve a certain amount of moving your finger left to right and forwards and backwards.

When you have the correct alignment of your finger, open both eyes, focus on the tip of your finger, so that your sight lines converge on your finger to view the now correctly aligned images behind your finger. The images should spring into 3D.

It is worth persevering with this – rather than just being recalcitrant and declaring that it "doesn't work" – because it *does* work and once you have mastered the technique, you will find it so simple and easy that you can dispense with the alignment procedure altogether and just focus on a point in front of the stereo pair, whereupon it will immediately snap into 3D. The salient point is that, once your brain gets an inkling of what is required, your optical subsystem will take over from your conscious control and will align the images for you.

As discussed in the main text, you can then experiment with moving closer or further away from the images. They will stay locked in whilst you do this, and you will see a greater 3D depth as you move further away.

Note that the *finger-at-⅔-hand's-breadth* rule needs to be modified when viewing very small or very large images. For very large images, start at a hand's breadth. For very small images, the distance should be three times the image separation.

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RIGHT EYE

LEFT EYE

Images: Bottom – Michael Perryman, Top – Daniel Chailloux

How to View Poster-Sized Stereo Photos

Hammer Drill Modifications, Photographic Enhancement of Cave Paintings, Lunar Lava Tube Exploration, Wireless Network for Cave Data, Chain Codes for Positioning

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