Exploring Stereo Fundus Photography Beyond the Fundus Camera

STEREO FUNDUS PHOTOGRAPHY HAS LONG BEEN USED TO DOCUMENT THE EYE AND ITS VARIOUS PATHOLOGICAL CONDITIONS. THE ART OF STEREO PHOTOGRAPHY CAN BE DIFFICULT TO LEARN. YET STEREOPSIS – THE ABILITY TO PERCEIVE THE SOLIDITY OF OBJECTS AND THEIR RELATIVE POSITION IN SPACE – IS A DELICATE TASK THAT OUR EYES AND BRAIN HAVE PERFORMED EVER SINCE OUR VISUAL PATHWAYS DEVELOPED AT A VERY YOUNG AGE. THE UNIQUE PHOTOGRAPHY THAT WE PERFORM ON A DAILY BASIS CAN ALSO BE USED IN REAL-LIFE PHOTOGRAPHY, EITHER TO TEACH NEW PHOTOGRAPHERS THE CONCEPT OF STEREO, OR TO BROADEN OUR OWN HORIZONS.

THE FIRST STEREO PHOTOS OF THE EYE WERE PERFORMED AS EARLY AS 1909 BY DR. W. THORNER.¹ FOR ALMOST A CENTURY VARIOUS CAMERA SYSTEMS, STEREO SEPARATORS, AND OPTICAL SYSTEMS WERE CREATED TO CAPTURE STEREO IMAGES, AND FOR THE MOST PART WERE EVENTUALLY ABANDONED FOR ONE IMPRACTICABILITY OR ANOTHER. THE "STEREO SHIFT" UTILIZING THE MOVEABLE BASE OF THE FUNDUS CAMERA IS THE MOST SIMPLE METHOD OF CAPTURING THESE IMAGES.

IT IS IMPORTANT TO NOTE THAT IN ORDER TO SEE IN STEREO, ONE MUST HAVE GOOD VISION IN BOTH EYES. BINOCULAR VISION IS DEPENDENT ON AN EXQUISITE BALANCE OF MOTOR AND SENSORY FUNCTION.² THE EYES MUST BE PARALLEL WHEN LOOKING STRAIGHT AHEAD, AND EACH EYE MUST HAVE GOOD VISION BECAUSE A CLEAR IMAGE AND A FUZZY IMAGE CAN NOT BE FUSED (SUPPRESSION).³ THERE ARE SEVERAL OCULAR, EYE MUSCLE, AND VISUAL PATHWAY CONDITIONS THAT CAN PREVENT ONE FROM BEING ABLE TO APPRECIATE DEPTH PERCEPTION, INCLUDING BUT NOT LIMITED TO: AMBLYOPIA, CONVERGENCE INSUFFICIENCY, PHORIA OR TROPIA (EYE MUSCLE DEVIATIONS), LESIONS OF THE OPTIC TRACT AND/OR VISUAL FIELD DISTURBANCES, UNCORRECTED REFRACTIVE ERROR, OR ANY OTHER CONDITION, INHERITED OR ACQUIRED, THAT CONTRIBUTES TO POOR VISUAL ACUITY IN ONE OR BOTH EYES.

APPLICATION OF STEREO IN OPHTHALMIC PHOTOGRAPHY

STEREO PHOTOGRAPHY OF THE EYE ALLOWS THE PHYSICIAN TO DETERMINE AND DOCUMENT AT WHAT LAYER OF THE RETINA A SPECIFIC DISEASE PROCESS IS OCCURRING, AND WHETHER OR NOT THE AREA IS ELEVATED. STEREO PHOTOGRAPHY CAN ALSO BE PERFORMED EXTERNALLY, IN THE ANTERIOR SEGMENT, OR OF GROSS SPECIMENS (SEE “BEST OF SHOW” 2001, OPS SCIENTIFIC EXHIBIT). THERE ARE DIFFERENT METHODS EMPLOYED BY THE CAMERA OPERATOR TO ACHIEVE THIS EFFECT; THE PAIRING OF A CENTRAL IMAGE WITH A PUPILLARY SHIFT TO THE LEFT, OR RIGHT TO CENTER, OR FAR RIGHT TO FAR LEFT (FIGURE 1). THE LATTER METHOD CREATES MORE OF AN EXAGGERATION, OR "HYPERSTEREO" EFFECT. THE METHOD USED WILL VARY DEPENDING ON THE PERSONAL PREFERENCE OR CAPABILITIES OF THE PHOTOGRAPHER, THE PHYSICIAN WHO REQUESTED THE PHOTOGRAPHS, OR LIMITATION BY THE PATIENTS OCULAR ANATOMY. A SMALL OR IRREGULAR PUPIL, OR CAPSULAR OPACIFICATION POST CATARACT EXTRACTION, CAN LIMIT STEREO SHIFT. ON THE OTHER HAND A CENTRAL CORNEAL

Fountain at Cafe DuMonde, New Orleans, LA (no DFS or SS needed)
scar, or a dense anterior or posterior sub-capsular cataract that creates a central blur, allows for only the exaggerated technique to be implemented.

Several textbooks of ophthalmic photography contain sections on stereo fundus/anterior segment photography and sequential stereo fluorescein angiography, and can be referenced if a more detailed description or further instruction is needed.

**APPLICATION OF STEREO IN DAILY LIFE**

Certain visual clues enable us to see spatial relationships of objects even without binocular vision, and these are often taught to patients with poor eyesight at low vision evaluations. A one-eyed person learns to estimate depth with monocular clues. When we drive, the relative size of a vehicle in front of us can allow us to judge how close we are to them. When gazing at a distance, parallel lines converge the farther away they become. We know that we are to them. When gazing at a distance, parallel lines converge the farther away they become. We know that we are to them.

When we view two separate images that have been taken with a stereo shift and fuse them, we create a conceptual three dimensional image that allows us to appreciate an elevation, indentation or shallowness or depth, that a single one dimensional image could never provide. We learned some of these basic visual clues in our first elementary school drawing class. Sometimes we need to relearn them when we no longer have the binocular vision required to perform our daily activities.

When we view two separate images that have been taken with a stereo shift and fuse them, we create a conceptual three dimensional image that allows us to appreciate an elevation, indentation or shallowness or depth, that a single one dimensional image could never provide. The same technique we use to capture our fundus images can be utilized when photographing a landscape, a rock formation, a building, or a statue – with a standard 35 mm camera.

In real-life stereoscopic photography, there are several different makes and models of cameras such as the Stereo Realist, Kodak Stereo, Revere, Wollensak, TDC, Busch Verascope K40, Belaplascra, or Argus Point-and-Shoot 3D Camera.* The previous mentioned models all employ a two-lens system with the lenses placed at an approximate pupillary distance. This fixed lens system does not allow for variation in stereo shift. Other methods of obtaining real-life stereo images is with a matched pair of 35 mm cameras used in tandem with a twin cable release for synchronization. A single 35 mm camera can also be used, with a horizontal shift between exposures. For our purposes, the single camera method will be discussed.

**TECHNIQUE FOR REAL-LIFE STEREO PHOTOGRAPHY**

The method of real-life stereo photography requires the basic tools needed for any type of photography: camera, film, light, and subject. The camera can be any 35 mm of your choice. I would suggest starting with a 35-80 mm or wide-angle lens, although I have experimented with longer focal lengths (up to 300 mm), but with less predictable results. Point and shoot cameras will work too, it you have a manual focus option. A differential focusing technique may be appropriate if there is a wide disparity between your foreground/background and subject. The film of choice can be black and white or color slide film of various speeds, depending on your lighting conditions. The subject can be any stationary subject that you feel may be a good stereo subject. For example, if you are shooting a bench in a park, shooting the bench alone will not be as dramatic as shooting the bench, the flagstone path in front of it, and the graceful oaks behind it. Think of composing your stereo pictures with the subject in the middle of the picture, that is, the middle of the foreground and background, not from side to side. Think three dimensional as you compose your shot.

Now that you have your camera, film, and subject, and you are thinking in 3-D, walk around your subject and experiment with different angles. There are a few basic rules you may recognize from fundus photography. The stereo base formula is 1 unit sideways for each 30 units of distance from the observation point.4 A wider stereo shift than the 30:1 rule creates a more dramatic “hyperstereo” effect, as in fundus photography. One should also keep in mind that in auto load 35 mm cameras, film will move through the camera right to left, therefore shift left to right when shooting, as opposed to right to left for a manual load camera, or you will have to wait until all your slides are mounted to actually see your stereo pictures correctly (provided you will view them in proof sheet format or uncut rolls of processed E-6). I prefer to take three to four shots of the same subject and match them up after the film is processed to find the most dramatic examples of stereo. And as in fundus photography, you must stay vertically stationary to align your views properly. A tripod works best, but for those of us who find them cumbersome or impractical to take along, a steady stance and arm-locked position will suffice.

The following examples show the unique insight we gain from shooting our subjects in 3-D. Real-life stereo images make you feel as if you are part of the actual

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* Editor’s note: Most purpose built stereo cameras can only be obtained on the second hand market, as they are no longer manufactured.
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DFS = distance from subject, SS = stereo shift, *D focus* indicates good example of differential focus technique.

T-max 400/DFS = 30 in / SS 2 in. *D focus* Laguna Beach, CA

T-max 400/DFS = 40 ft / SS 1.5 ft. Laguna Beach, CA

Fujichrome Pro 400/DFS = 7 ft / SS 3 in. Mammoth Caves Nat’l Park, KY

Sensia II 100/DFS = approx 100 ft (aerocar) / SS 3 ft. Niagara Falls, Ontario
Agfapan 400/DFS = 7 ft (center of stairs) / SS 1 ft. Cumberland Falls, KY

Sensia II 100/DFS = 25 ft / SS 1.5 ft. New Orleans, LA

Sensia II 100/DFS = 10 ft (stairs) / SS 1.5 ft. Cumberland Falls, KY
picture. Keep in mind this is also the perspective we are providing the physicians, whose stereo fundus photographs and angiograms give them a unique look into the ocular pathology they are identifying and treating.

Since shooting a single 35 mm camera allows us to create sequential stereo as opposed to simultaneous stereo, any movement within the frame, such as cascading water, wind-blown branches, or waves on a beach will cause visual confusion when attempting to view the pairs. Avoid including people or animals in your pictures. Look for subjects that are stationary, as well as free of any movement in the foreground or background.

**CONCLUSION**

The stereo photography we perform of the eye can also be applied to real life subjects. As new photographers learn about the concept and procedure for performing this type of photography, they will encounter numerous obstacles in working with actual patients. Shooting high magnification photographs through a space 6 or 7 mm wide, on a patient that is constantly moving, blinking, and tearing, can be a challenging forum for practicing one’s new skill. But practicing on stationary subjects allows one to learn and improve confidence at shooting stereo photographs, along with taking some extraordinary pictures.
The exquisite balance of motor and sensory function that allows us to view stereopsis is a physiologic marvel, and understanding this concept gives us insight into our own three dimensional world. Binocular vision helps us navigate through our daily activities. The ability to perceive the solidity of objects and their relative position in space can also be captured through the fine art of stereo photography, not only of the eye but of real-life subjects and places. And for those of us who have been doing stereo photography of the eye for years, real-life stereo is an interesting variation and use of our unique skills as ophthalmic photographers.

REFERENCES