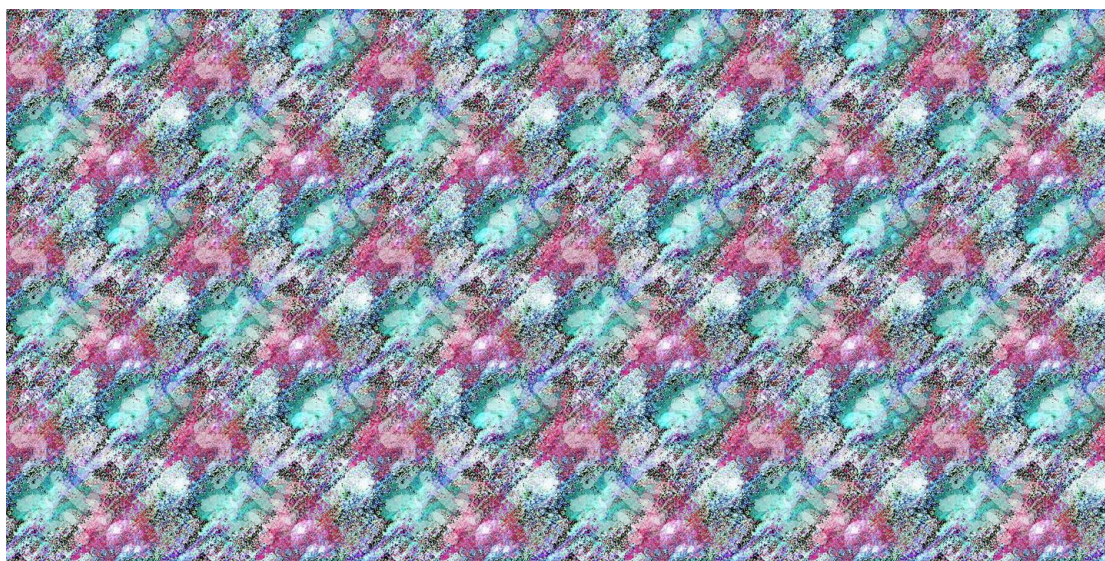# Example of Autostereograms in Varied Linear Spacing

Shark with divisor 10   Teapot with divisor 20

Plane with divisor 30   Shark with divisor 50

Tricks to See the Images in Autostereograms [1]

Method 1:

Take your finger for example. Bring it close to your eyes. The idea is to make your eyes look behind the finger and, instead of one finger, you will want to see 2 fingers. This is exactly what we want to achieve: to <u>move the focus of the eyes behind the actual image</u>. When looking at objects really close its easy to have the eyes out of focus.

Method 2:

Bring the stereogram image really close to your eyes (until you touch it with your nose). At this distance your eyes cannot focus on the image and they look somewhere behind the image. Now, slowly push the image away from you, while trying to keep the eyes off focus. At some point you will see the hidden image.

Method 3:

Take an object and put it behind the image (about half of meter behind it). Now, focus on the object behind the image while keeping the eyes looking at the image.

Reference:
[1] Easy Stereogram Builder. (n.d.). https://www.easystereogrambuilder.com/

Concepts

Wallpaper Effect

Julesz' postdoctoral student, Christopher Tyler, invented magic eye pictures based on the Wallpaper Effect. [1] Wallpaper is made of vertical patterns repeated horizontally. Each vertical strip is the same, but there is often a little deviation from one to another. If a person can look at the wallpaper with crossed or uncrossed fusion (focused short or beyond), then different parts of the wallpaper are on each eye. If the two images are similar enough, there will be fusion. If different enough, there will be disparity that can be detected as depth.

Depth Map

Image where the value of each pixel represents a depth value, which is the distance from the eye to the part of the object represented by that pixel. Depth maps are often shown as a grayscale image with light areas for nearby points and darker areas for points farther away. The whiter the points, the closest the points are to you. The subtle changes in the distance between the stereogram points can create the illusion of a continuous passing in depth. Each colour in the depth map is translated in a certain distance between the points on the resulting image.

Different Vergence of Eyes

There are three types of vergence:

- Aligned vergence
- Cross-eyed vergence
- Wall-eyed vergence
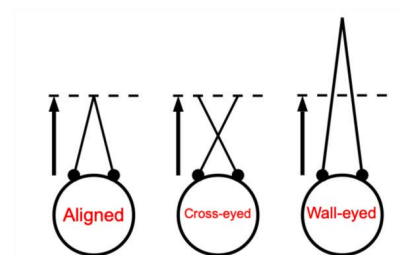
An autostereogram can be viewed by both cross-eyed and wall-eyed vergence. An autostereogram designed for wall-eyed viewing will appear to "pop out" of background if viewed in parallel way. If it is viewed in cross-eyed vergence, it will instead appear as a cut-out behind the background.

Reference
[1] Stinson, L. (2022, May 5). The hidden history of Magic Eye, the optical illusion that briefly took over the world. Eye on Design.
https://eyeondesign.aiga.org/the-hidden-history-of-magic-eye-the-optical-illusion-that-briefly-took-over-the-world/

How the questionnaire is designed?

The questionnaire is designed and carried out online.
For each question, a timer is set to record the time taken to answer the question.

Questionnaire before correction
1. Describe what did you see in the image ____ [Cup with divisor 10]
2. Describe what did you see in the image ____ [Teapot with divisor 20]
3. Describe what did you see in the image ____ [Plane with divisor 30]

Questionnaire after correction
1. Can you see a shark in the image? (Yes/No) [A shark image with divisor 10]
2. Describe what did you see in the image [Cup with divisor 10]
A Shark   B Cup   C Jelly   D Other ___   E Can Not Tell
3. Describe what did you see in the image [Teapot with divisor 20]
A Seahorse   B Tortoise   C Teapot   D Other ___   E Can Not Tell
4. Describe what did you see in the image [Plane with divisor 30]
A Plane   B High Jumper C Bookshelf   D Other ___   E Can Not Tell

The images in the questionnaire has **linear spacing** in **descending** order.
There is a **half-minute break** between each question for interviewees to have a rest and reduces potential fatigue or carry-over effects.
Use of **iPad/laptop/computer for the best experience** (since images are too small on the mobile phone and the focus centre is far too small compare to the disparity baseline)

Why there is a new question at the very beginning of the questionnaire?
The purpose of Question 1 in questionnaire after correction is to let interviewees to know what are we going to do in next few questions. This question is timer-free so as to make the interviewees to know how this questionnaire works. The result of this question does not matter. We just want the interviewees to perceive depth and understand the method. If we straight up to the real Question 1, the interviewees might take more time to understand how it works and take less time to solve the second and the third images as they familiar with the questionnaire after Question 1.

Why use the form of multiple choice rather than fill-in-the-blank?
If we decided to use the form of fill-in-the-blank, the time recorded would be much longer since the interviewees cannot respond quickly as expected since the time taken to fill in the blank is also recorded in the total time. So later we change the form

How to evaluate a sample is invalid?
If the sample has two or more "Can Not Tell" choices in three autostereograms, it will be considered as invalid sample. This is to filter interviewees who are not able to use the correct way to reveal the image hidden or have potential binocular or stereo vision impairments.

Autostereogram Survey Questionnaire

Please note that the timer opens on each page for data collection. To relieve fatigue, please do not close the questionnaire during the rest page between each question! Open this questionnaire with iPad or computer for the best experience. Thanks again for freeing up your time to complete this questionnaire.

Before starting the formal survey, make sure you have read the introduction of this questionnaire and then identify the following stereograms
Stereogram observation method:
Try viewing the following images with the parallel eye

Can you see a shark?
If you can't see it, there are some ways to help you with this:
Method 1:
Take the finger as an example. Close your finger to the eye. The idea of this approach is to get your eye out of focus, not to focus on a finger. We want to look at the image in an out-of-focus / parallel eye way.
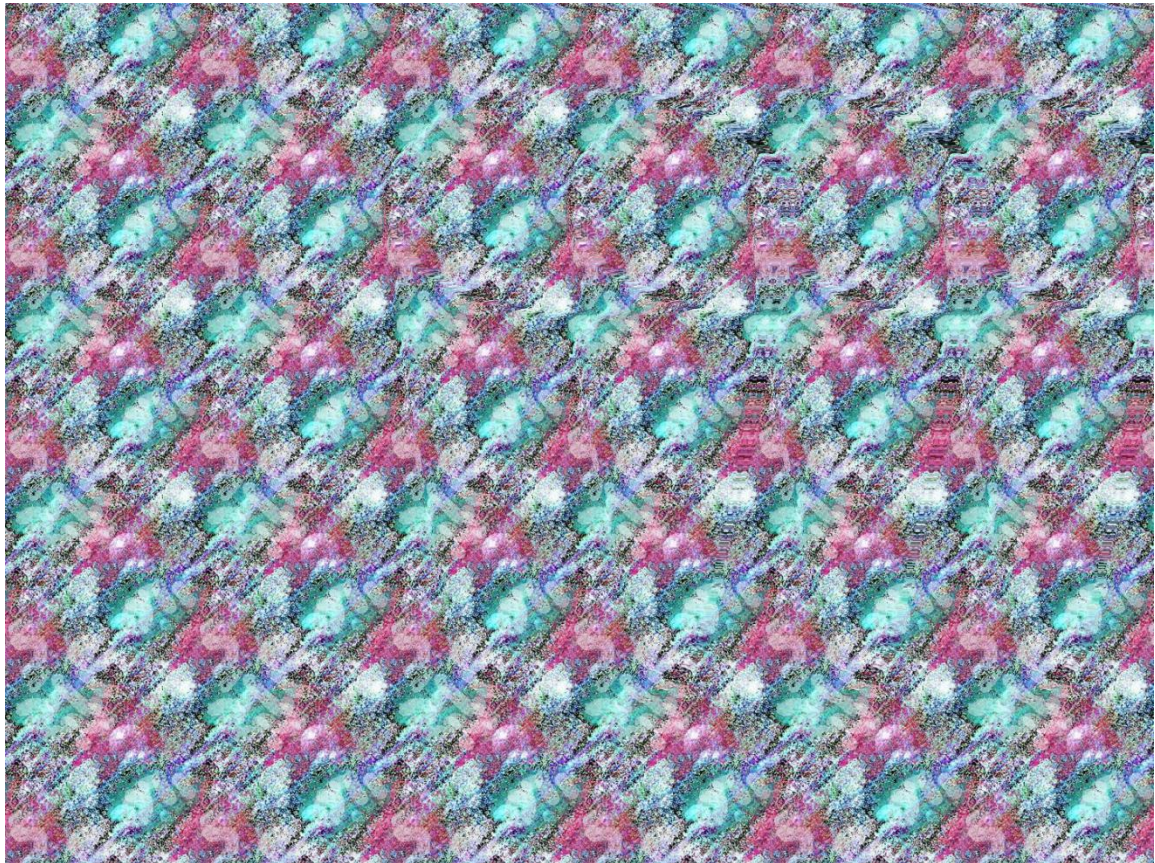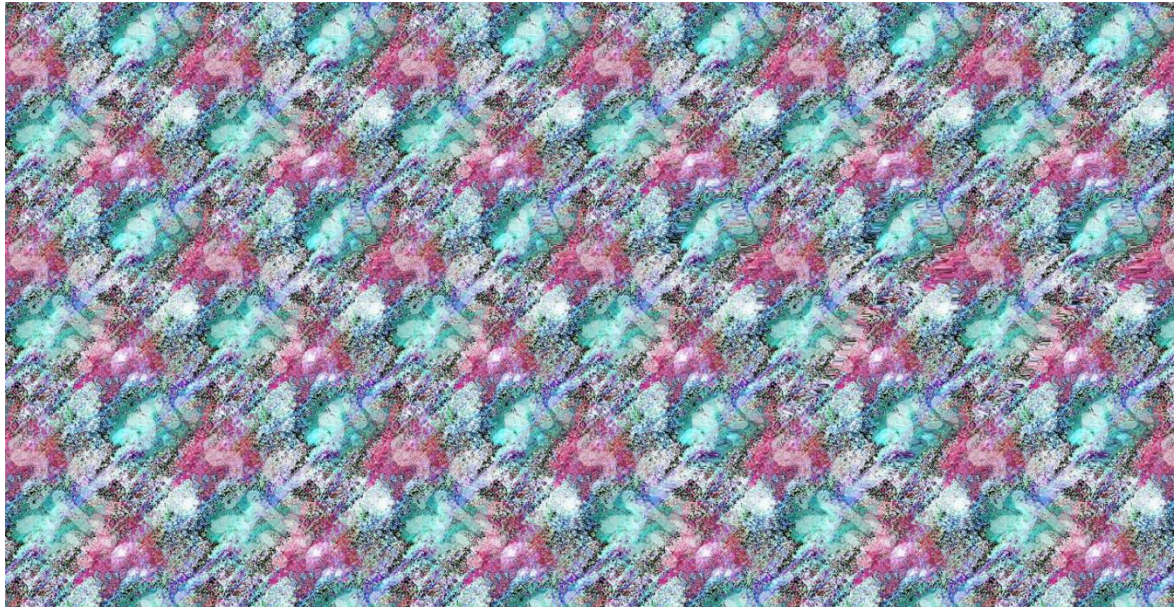 Method 2:
Close the stereogram to the eye (until the nose touches). At this distance, the eye fails to focus on the image, and they look somewhere behind the image. Now, slowly move the image away from the eye, while trying to keep it out of focus. At some point, you will see the hidden image.

○ Yes

○ No

What do you see?

If you can't see it, there are some ways to help you with this:

Method 1:

Take the finger as an example. Close your finger to the eye. The idea of this approach is to get your eye out of focus, not to focus on a finger. We want to look at the image in an out-of-focus / parallel eye way.
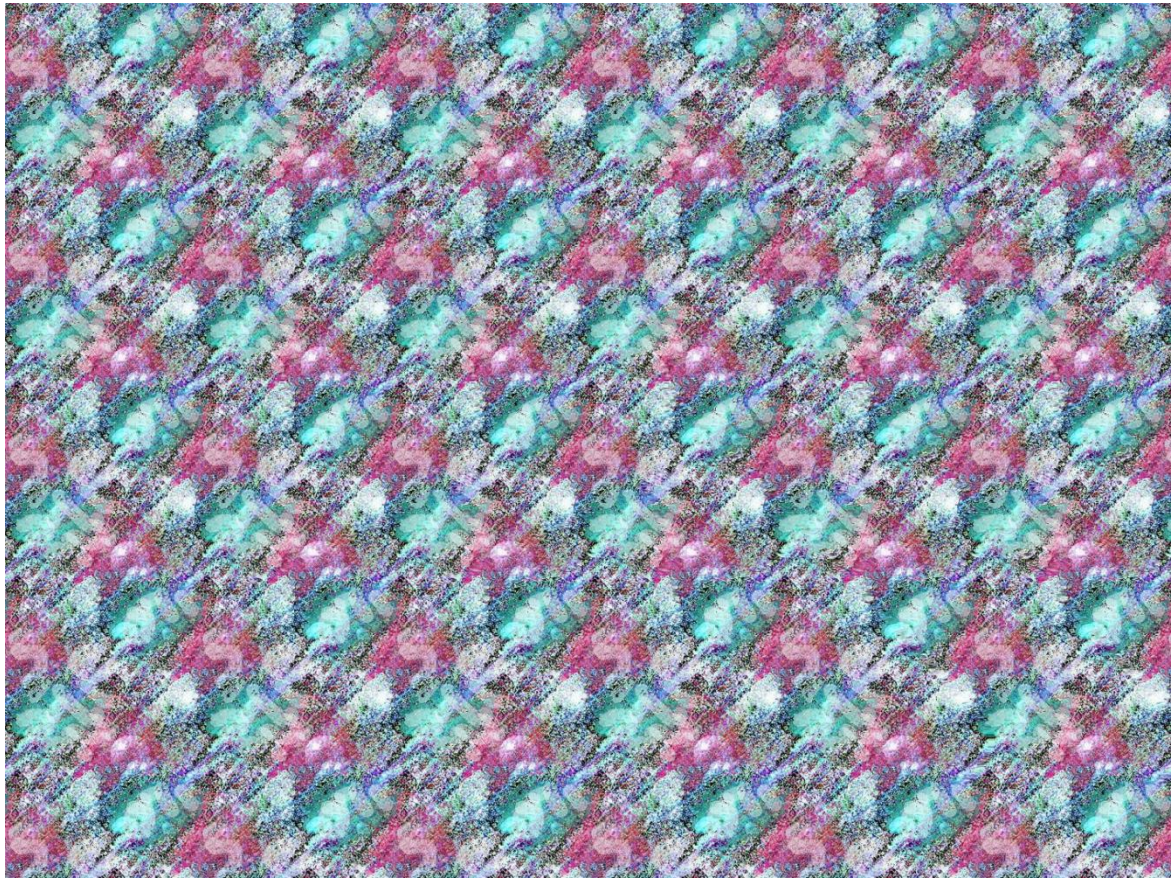
Method 2:

Close the stereogram to the eye (until the nose touches). At this distance, the eye fails to focus on the image, and they look somewhere behind the image. Now, slowly move the image away from the eye, while trying to keep it out of focus. At some point, you will see the hidden image.

○ Shark

○ Cup

○ Jelly

○ Other _____

○ Can Not Tell

What do you see?

○ Seahorse

○ Tortoise

○ Teapot

○ Other _____

○ Can Not Tell

What do you see?

If you can't see it, there are some ways to help you with this:

Method 1:

Take the finger as an example. Close your finger to the eye. The idea of this approach is to get your eye out of focus, not to focus on a finger. We want to look at the image in an out-of-focus / parallel eye way.

 Method 2:

Close the stereogram to the eye (until the nose touches). At this distance, the eye fails to focus on the image, and they look somewhere behind the image. Now, slowly move the image away from the eye, while trying to keep it out of focus. At some point, you will see the hidden image.

○ Airplane

○ High Jumper

○ Bookshelf

○ Other _____

○ Can Not Tell

What inspire you to do this project?

A video about autostereograms inspired me a lot. It triggers me curiousity of knowing how the autostereograms work. I am interested in computer science. So I wonder if I can generate the autostereograms by using my computer science knowledge and programming skills. It is undoubtedly a great challenge to me because I did not learn professional knowledge such as how the brain process the binocular vision.

What did you learn from mistakes?

I learned the basic routine of how to write an academic report and how to cite other professors' article and used in my report as references. I also learned that I have to consider all the possibilities of a practical situation to minimise the mistakes. For instance, when I designing my questionnaire. I didn't consider the time taken for interviewees to enter what they see behind the image. So data collected at first includes the time taken for interviewees to type their answers in the boxes. But fortunately I found my mistakes and corrected it by feedback from several interviewees and changed my questionnaire to the form of multiple choice.