

Size-distance illusion

When the object is closer to the viewer, its visual angle increases, which makes the object appear larger. As the object moves away from the viewer, the gradual decrease in the visual angle leads to the object appearing smaller and smaller. Our perception of an object's size mainly depends on how close or far away we think the object is from us.

There are various cues that help us perceive this depth, like background, surrounding objects, gradients, etc. For example, the moon appears to be larger when it is near the horizon than when it is overhead. Even if the visual angles for both moons are the same, the presence of trees, buildings and other cues near the horizon make the moon appear bigger.

Sometimes, we fail to perceive the actual distance of an object due to the absence of these cues. This false perception of the distance of an object from the viewer may sometimes cause the object to appear bigger or smaller than it actually is. This is called size-distance illusion.

Can you guess the size of this cobra?



Though the texture of the background may give us certain hints to guess that the cobra is very small in size, there are no specific distance or depth cues to indicate its actual size.



Whereas in this image, the presence of the millipede close to it is a cue which gives us an idea of the approximate size of the cobra. In reality, its body is only around 1.5 centimeters in diameter.

What are the various cues that give away the size-distance illusion?

Difference in clarity or focus



These images are intended to create an illusion of the girl touching the Rubik's cube with her index finger. But why doesn't it look that way?

What gives away the illusion?

In the image on the left, the girl is in focus and the Rubik's cube is out of focus. In the image on the right, the Rubik's cube is in focus and everything else is blurred. This difference in focus acts as an obvious depth cue in an image because of which we perceive a significant distance between the Rubik's cube and the girl.

Difference in texture (gradient)



The grass on the ground is a clear indicator of depth here. Around the feet of the girl, the grass is tall and sparse. It is gradually getting shorter and denser around the boy which makes us perceive the distance between them.

Repeating objects



Similar objects repeating across the image acts as a gradient because of which we can perceive depth in this image. The marigold flowers are bigger at the front. They keep getting smaller and closer at the back.

Reflection



The image is intended to look like the baby is standing in the palms of the lady. But both the lady and the baby cast separate reflections. Since the reflection is not the exact water image, the illusion is given away.

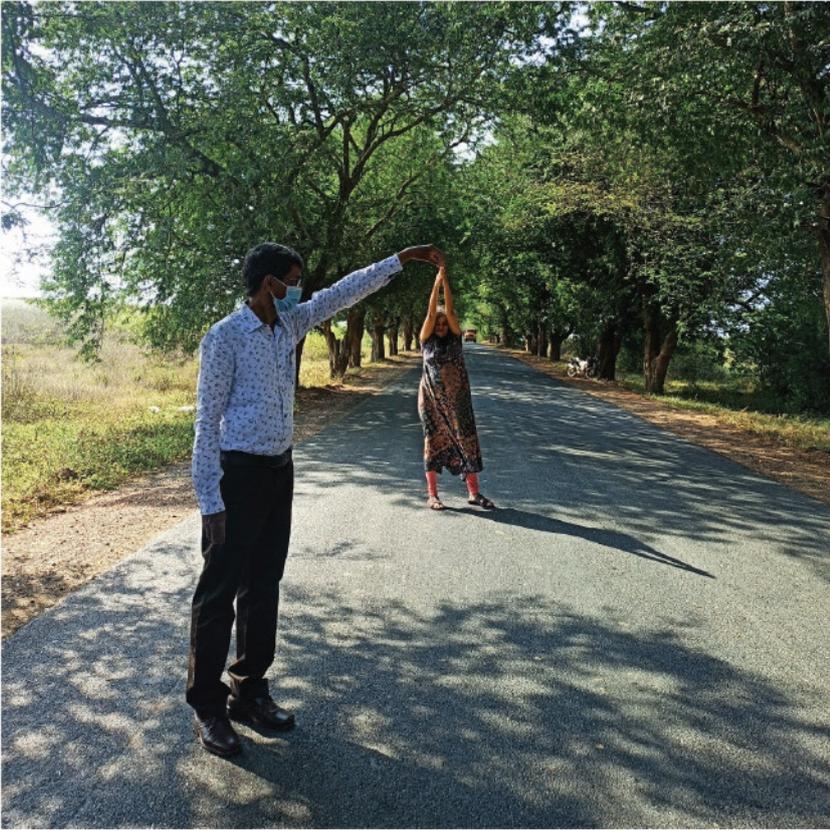
Shadows



Two connected entities casting separate shadows give away the illusion. The distance between the two is clearly visible in their shadows.



Whereas, if the entities are separate, it is less noticeable.



Similar is the case in this image.



But here, the shadow of the woman is carefully merged with the shadow of the trees and the shadow cast by the man is cropped, to reduce the depth cues and thereby enhance the illusion.

Light and shadow



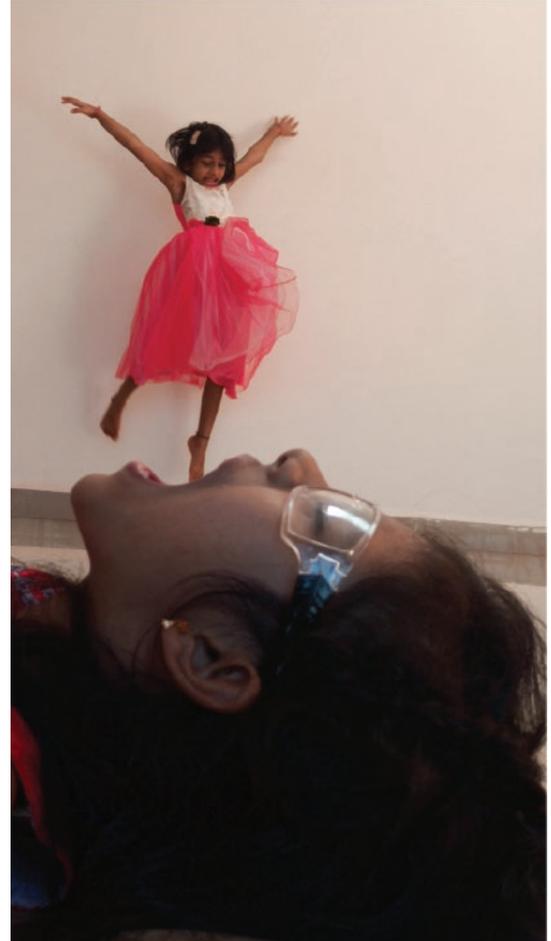
In the same set of images, it can also be observed that reducing the difference in brightness and contrast between both people enhances the illusion.

Occlusion



Occlusion is when an object is partly hidden by another object, which makes us perceive that the hidden object is farther away. It can be clearly seen in this image that the girl is behind the mouth, giving away the illusion.

Background



A cluttered background can also take away the effect of illusion as it can add more cues to perceive depth.

In the image on the left, the floor tile joint at the front, the railings, its reflection on the floor and the beam on top create a vanishing point that indicates depth. In addition to this, doors are one of the familiar objects which give away the actual height of the girl due to our prior knowledge. It can be observed that just by cropping the background, these cues are eliminated which makes the illusion is much more enhanced.

Camera angle



Similarly, changing the camera angle to reduce the cluttered background also helps with the illusion. In the image at the bottom, the gradient on the ground is reduced due to the change in the camera angle. As we eliminate the depth cues, the size-distance illusion keeps getting enhanced.

Vanishing point

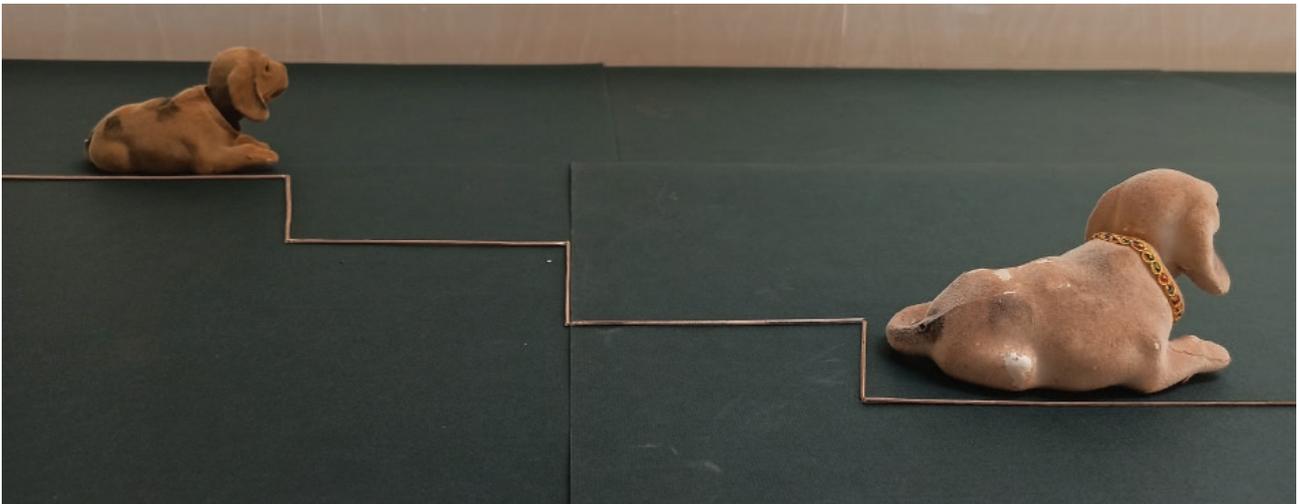


A vanishing point is an obvious cue to perceive depth. The floor tile joints, column bases, grooves on the columns and the tip of the arches are appearing to meet at a common point. Due to this perspective convergence, we can easily perceive depth in the image. Since we know that the columns, arches and tiles are repeating elements of the same size, we perceive the people to be of similar height.

Forced perspective

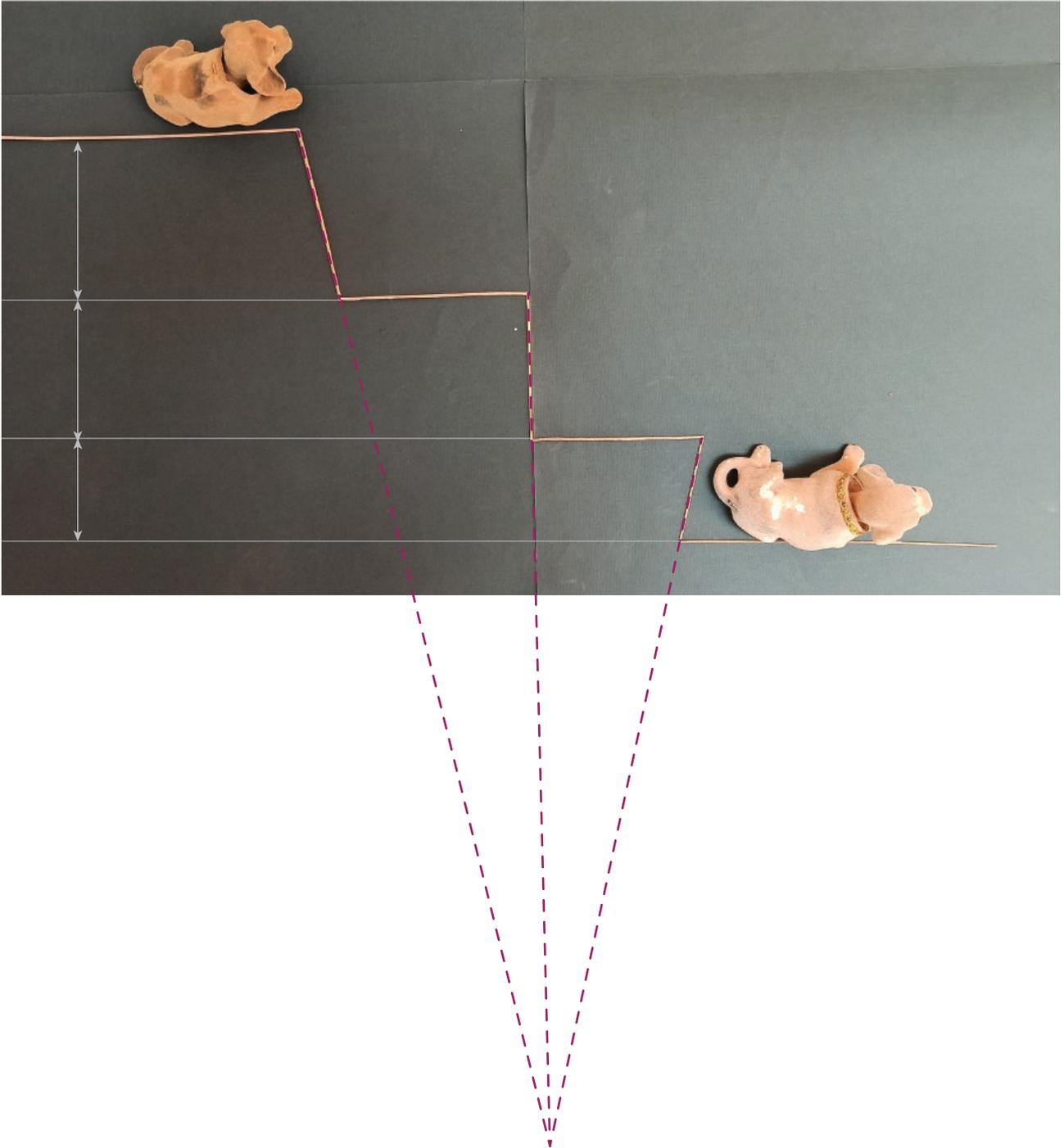


Both the dogs are of the same size but placed at different distances. Of course, the white dog appears bigger since it is closer to the camera. The dogs are also connected by the sticks on the ground to make it look like they are sitting on a makeshift flight of stairs. The length, thickness and alignment of the sticks and the distance between them are creating a forced perspective. But, the gradient on the ground and vanishing point created by the pavement blocks are the depth cues that are giving away the illusion.



Here, the depth cues are eliminated by using a plain background to intensify the effect of the size distance illusion caused by the forced perspective.

To achieve the forced perspective, the length and the thickness of each stick are gradually increased towards the back, since the sticks at the back appear smaller and thinner. The distances between the sticks have also been increased. Also, it can be seen that the sticks are not perpendicular to each other. The angles have been modified to obtain the required vanishing point.





Placing some of the sticks vertically, i.e., perpendicular to the ground helps to obtain a better illusion.



The side view shows how the sticks are actually placed to force the perspective. As you move towards the brown dog, the length and thickness of the sticks are gradually increased along with the distance between them, resulting in the appearance of a flight of stairs when seen from the front.

Familiar objects



Familiar objects like the sun, moon and clouds can give away the illusion due to our prior knowledge of their sizes. We tend to judge a distance based on surrounding objects that we already know.

Here, the absence of other depth cues might make us perceive that the girl is exhaling smoke through her mouth. Had there been another prominent cloud in the view, the illusion would be much weaker.

Objects with similar colors



The toy car and the bus are of similar colors against a contrasting background. According to Gestalt's law of similarity, we tend to group them together and perceive them as one, thereby ignoring other depth cues. Hence the significant difference between their sizes and the distance between the two objects are not that evident even with the presence of gradient on the ground.



The lady is wearing an outfit similar in color to brinjal which helps us to group them together and ignore other depth cues which are present, like occlusion.

Relative height



Even though the image is intended to look like the girl is being crushed by two tiny vehicles, the relative heights are playing a role in reducing the effect of the illusion. If the point of contact of an object (in this case, the girl) and the ground is lower, we perceive it to be closer to us and as it goes higher, we perceive the object (the bus) to be located farther away.



Similarly here, the point of contact of the boy and the ground is lower than that of the bus and the ground, making us perceive the bus to be farther away.



Changing the camera angle can also help to enhance the effect of the size-distance illusion. It can be observed that lowering the camera angle has helped to shorten the distance between the point of contact of the girl and the ground, and that of the people at the back and the ground, hence intensifying the illusion.

Relative size



The object that is closer to us will take up more field of view than the object that is farther away. Because of our prior knowledge, we know that both humans are of similar size. Hence we perceive the boy to be standing much farther away than the girl.

Black and white v/s color



The depth cues are more prominent in color images than black and white pictures. As a result, we perceive the illusion better.

How can size-distance illusion be used in design?

Advertisements and posters:

The depth cues can be negated to make an object look bigger or smaller than it actually is, especially in product photographs.

Movies:

Size-distance illusion can also be used in 3 dimensions to create a false perception of size in movies, for example, Ames' room.

References:

Bahrens, R. R. (1986). *Illustration as an art*. Prentice-Hall.

Goldstein, E. B. (2013, June 25). *Sensation and perception* (9th ed.). Cengage learning

Perceived visual angle. (2021, September 13). In *Wikipedia*.

https://en.wikipedia.org/wiki/Perceived_visual_angle