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Words in **bold** are explained in the glossary on page 94.

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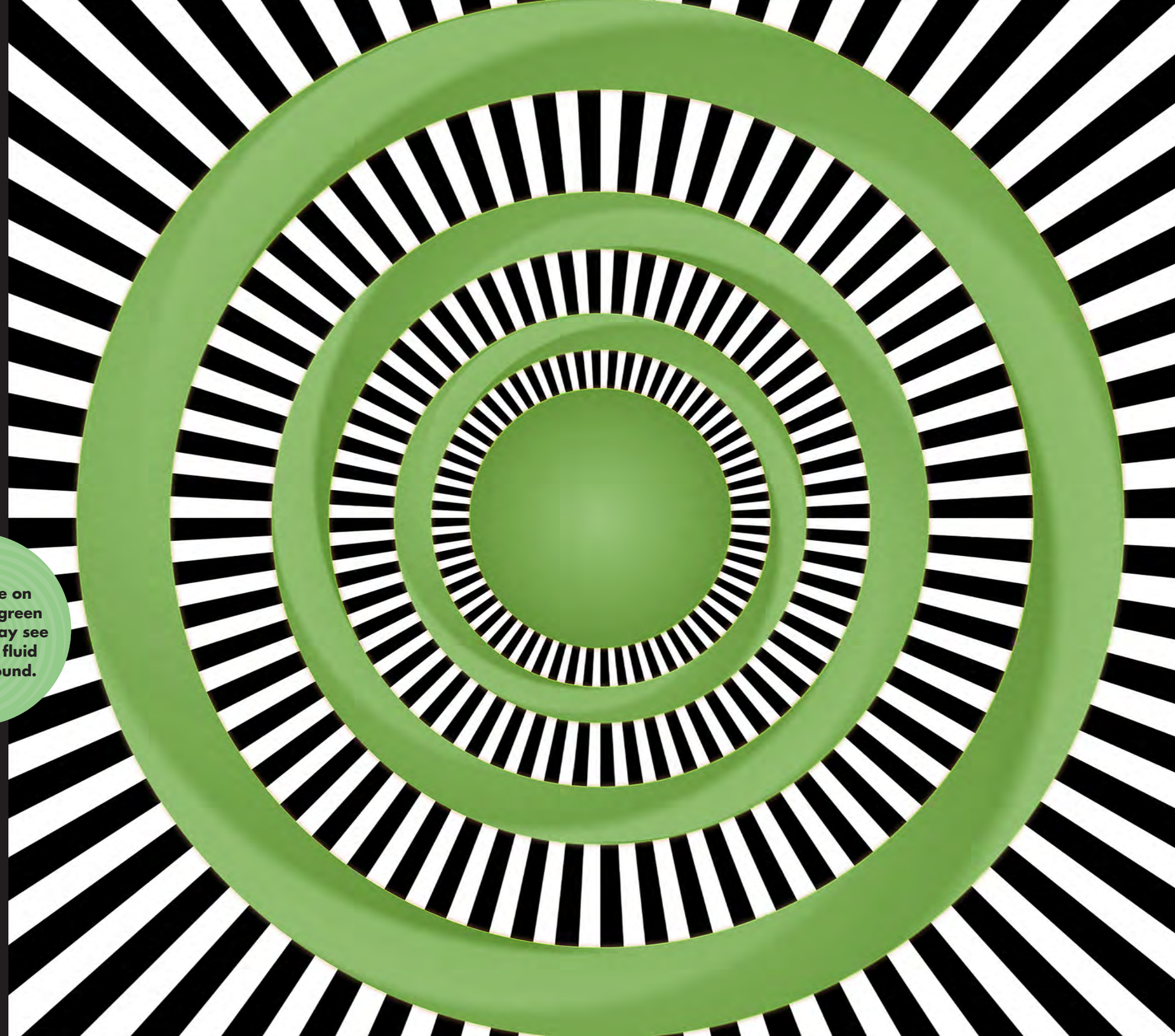
MOTION

Everything moves and everything changes. The Greek philosopher Heraclitus once said: "There is nothing that will always exist, except change." Motion is a part of life. Some objects move very quickly and others so slowly that they seem still – such as a growing tree.

Your eyes are so sensitive to light and motion that, sometimes, you see movement even when there isn't any. This is because your eyes make tiny movements that you are not aware of. When you look at an image you do not actually look at it in a steady way. Instead, your eyes constantly jerk around, locating interesting parts of the scene to build up a mental 'map' of the whole picture. Scientists call these random eye movements '**saccades**'. You can find out how to make your own motion illusion on page 82.

If you concentrate on the circular green rings, you may see a vibrating fluid moving around.

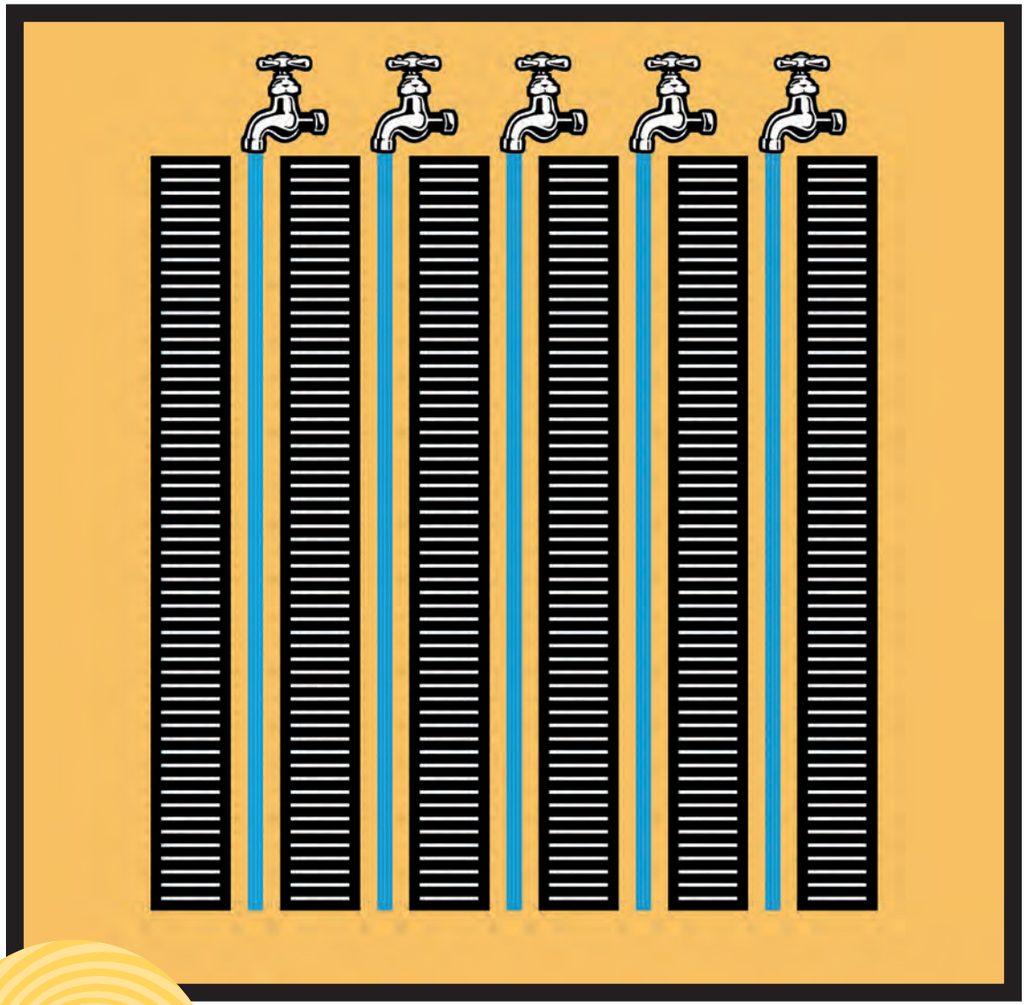


Visual **Flows**

what's going on?

The combination of the black-and-white lines and eye saccades create different after-images. These merge with the green rings, producing a swarm of visual images, which your brain translates into a flowing movement.

Running **Water**



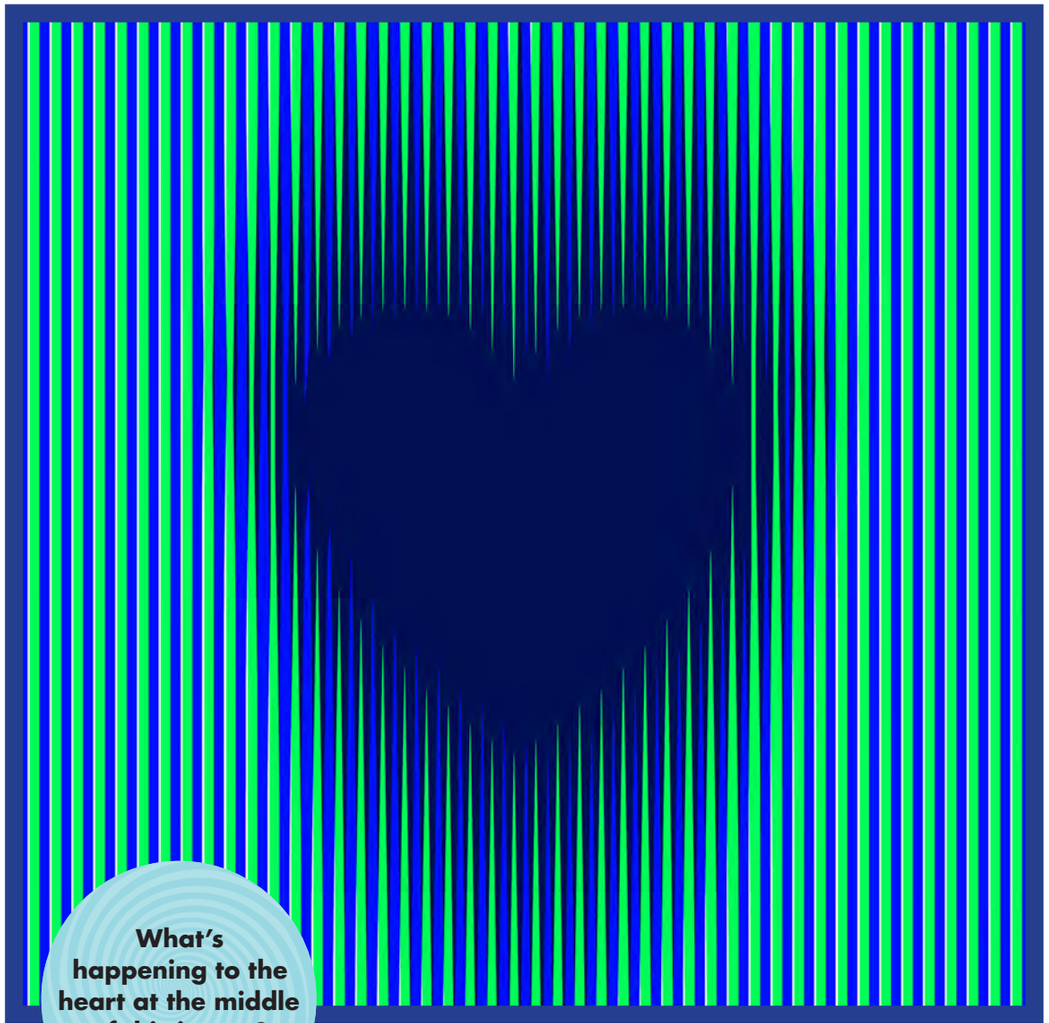
What's happening to the long blue lines?

When you stare at the image, it looks like the lines are twisting up and down, like flowing water.

what's going on?

As you look at this illusion, after-images are produced each time your eye moves. These overlap and compete with the previous after-images, creating an amazing flowing or winking effect. The effect is endless because your eye moves continuously in saccades!

Expanding **Gothic Heart**



What's happening to the heart at the middle of this image?

Try staring at it then closing your eyes. You will see a white heart appearing.

After a short while, the dark heart looks like it is growing.

what's going on?

The solid central heart is not expanding at all. Instead it is the outer 'blurred' surrounding of thin bright lines that is slowly shrinking because of poor visual stimulus. This gives the impression that the heart is expanding.

Swirling **Whirl**

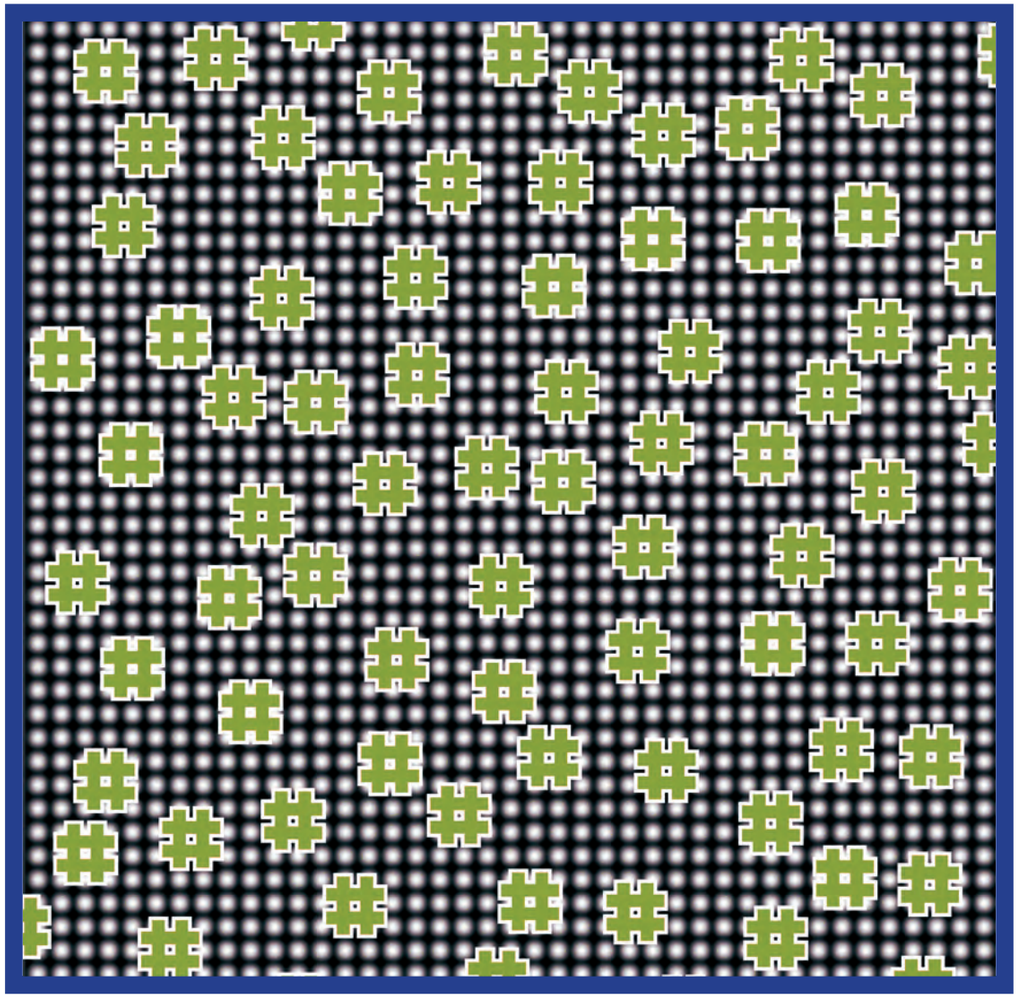
Does this pattern appear to whirl and shrink?

Try looking at the pattern out of the corner of your eye.

what's going on?

Repeated colour and brightness contrasts can create a feeling of motion. Our visual system, especially our **peripheral vision**, processes bright colours faster than dark colours, and this difference tricks us into thinking that things are moving.

Hovering **Hashtags**



Look at this image for a while. Do the hashtags start to float and swirl above the background?

what's going on?

This happens because our brain interprets the sharp, in-focus images (the hashtags) as being separate from the blurred background. Moreover, most people believe there are two or three different types of hashtag, but there is only one! They look different because the regularity of their shape is disturbed by the background.

Roman **Temple**

Do the columns of this Roman temple converge or diverge from each other?

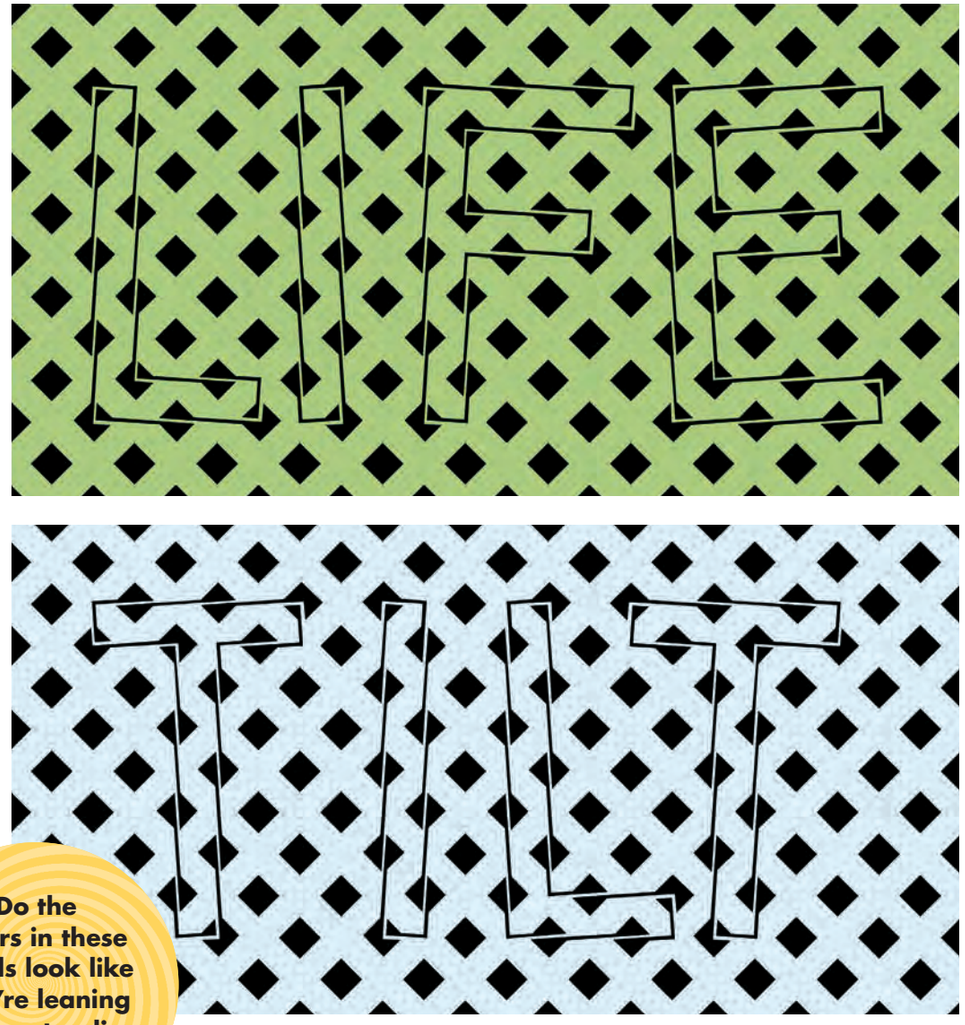
The Latin words on the temple mean 'the world wants to be deceived, so let it be deceived'.

The columns of the temple are, in fact, perfectly straight and parallel to each other. Check them with a ruler!

what's going on?

This interesting illusion shows how vertical bars which contain patterns that are tilted to one side can look like they are leaning slightly over.

Tilted **Letters**



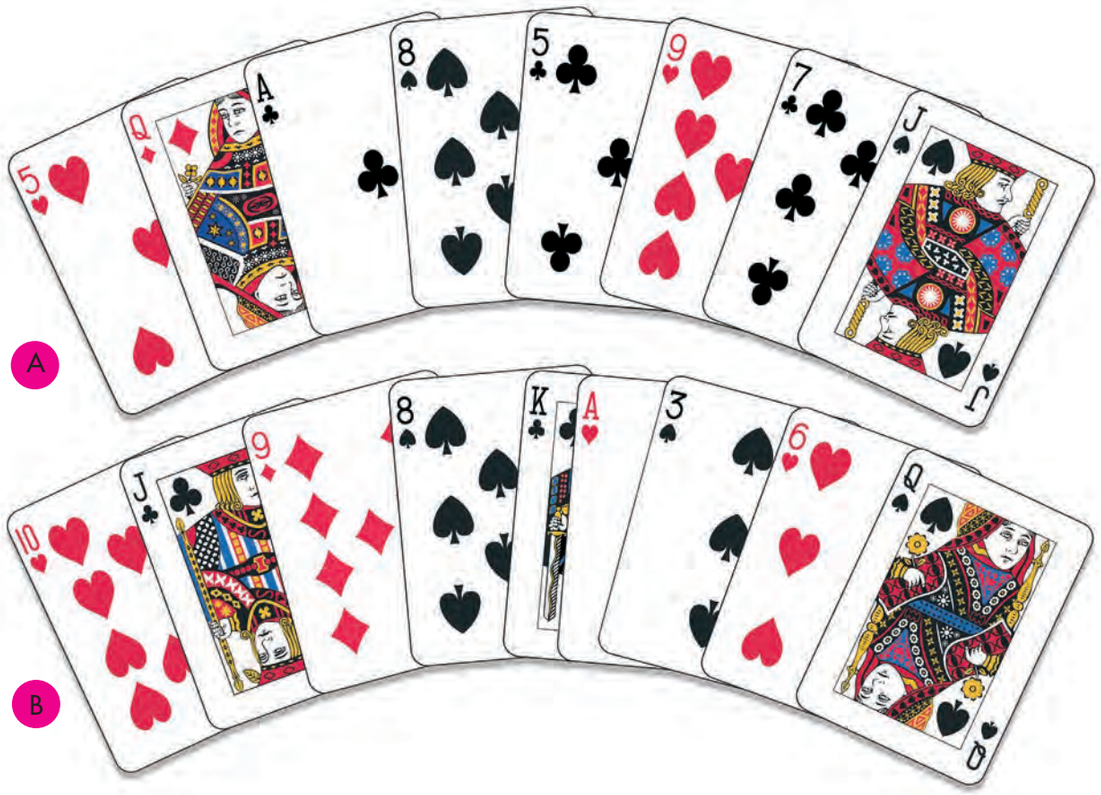
Do the letters in these words look like they're leaning over or standing straight?

The letters are, in fact, perfectly straight – use a ruler to check.

what's going on?

When a straight line is formed from a number of tilted segments it appears to be tilted itself. This visual effect is called the 'Fraser illusion', after the Scottish psychologist James Fraser, who first described it in 1908.

Amazing **Jastrow Playing Cards**



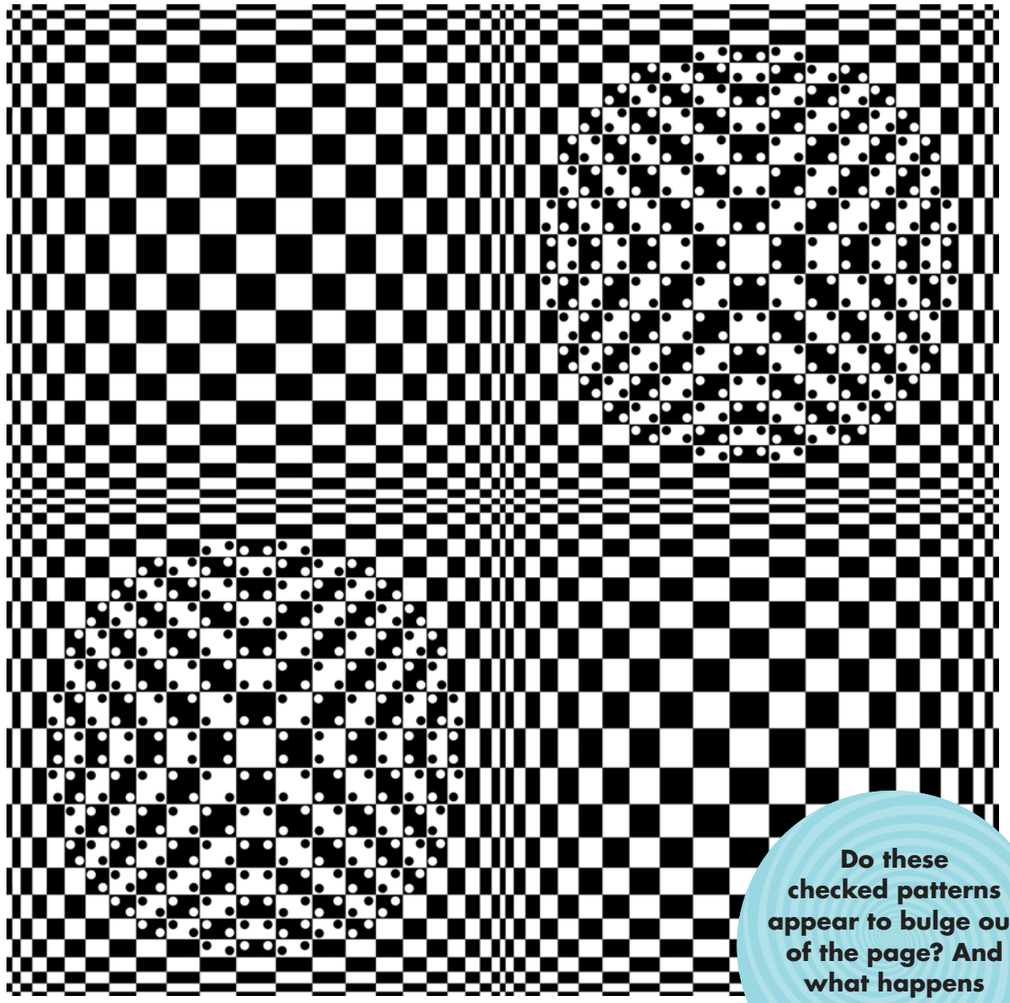
Which of these fanned-out sets of cards is the widest? A or B?

Both sets are, in fact, the same size and width.
Turn to page 93 for proof.

what's going on?

When two curved shapes are arranged one above the other as shown here, the lower one always appears wider because your brain believes it is nearer! This illusion is named after the American psychologist Joseph Jastrow. The instructions on page 83 and templates on page 91 will show you how to make your own Jastrow illusion.

Bulging **Shapes**



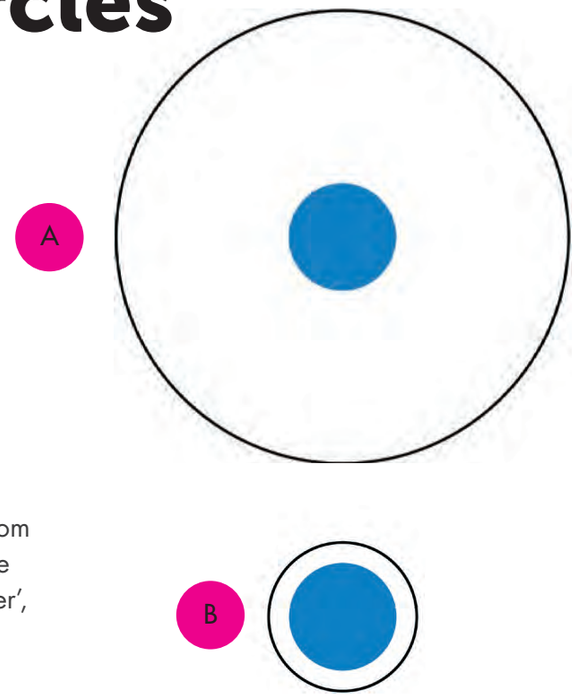
Do these checked patterns appear to bulge out of the page? And what happens when you add dots?

what's going on?

Because of our assumptions about perspective, our brain assumes that narrow rectangles are farther away than wider rectangles, creating the effect of depth. The small black-and-white dots create the impression of slanting lines which increase the bulging effect.

Incredible **Circles**

Which of these blue circles is the biggest? A or B?

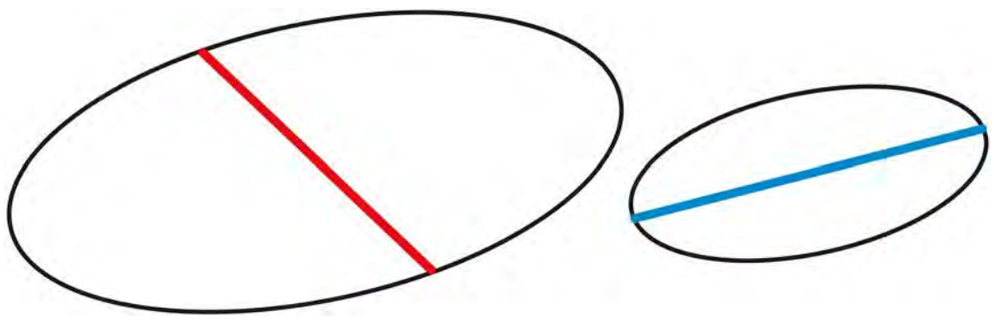


Both circles are actually the same size.

what's going on?

This is known as the 'Delboeuf Illusion'. The bottom blue circle seems larger because it is close to the edge of the outer circle, making it appear 'tighter', and therefore bigger.

Sarcone's Ellipses

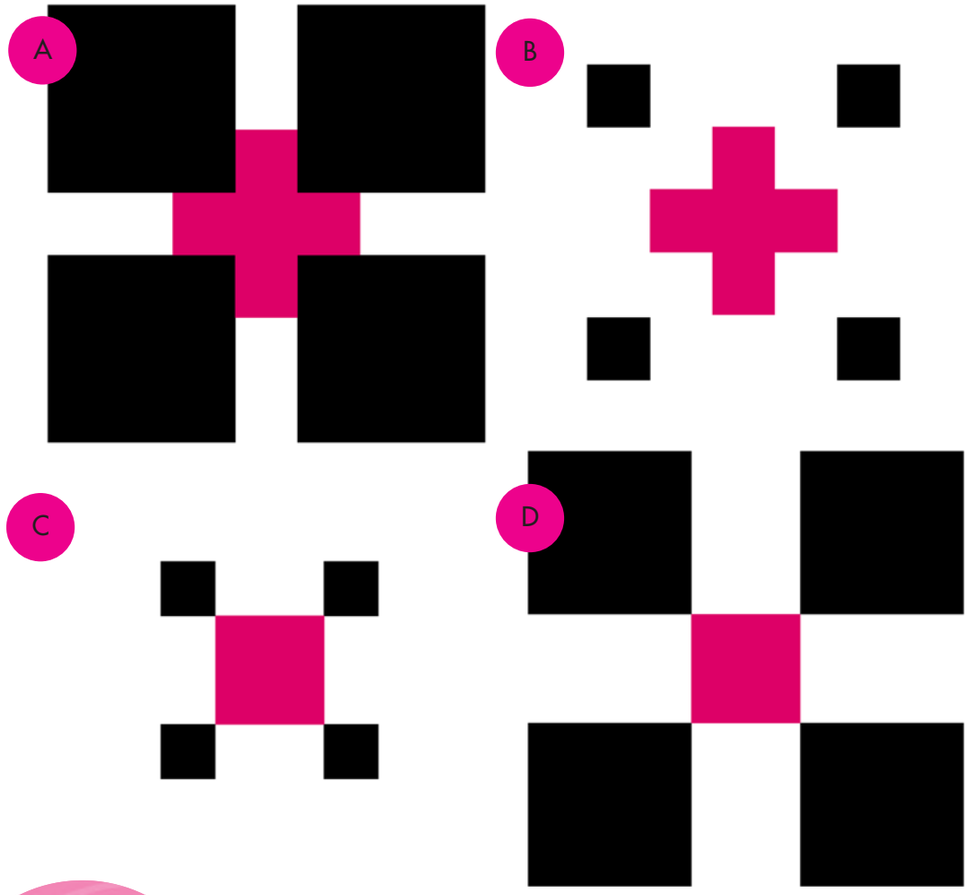


Which line is longer? The red one or the blue one?

what's going on?

Ninety per cent of people will say the red line, but the blue line is actually longer. Your brain gets it wrong because it assumes that the larger ellipse must contain the longer line, so it believes the red line is longer than the blue one, even though the opposite is true.

Bigger or **Smaller?**



Which pink cross is the biggest? A or B? Which pink square is the biggest? C or D?

Most people think that cross A is bigger. However, you may be surprised to learn that crosses A and B are the same size. Similarly, most people believe that square C is bigger than square D, but again, both squares are the same size.

what's going on?

The cross illusion is known as 'Sarcone's Cross Illusion', while the square illusion is called 'Obonai's Square Illusion'. They show that the apparent size of an object can be affected by other objects that are placed close to it, although the effects can vary.

Hybrid **Illusion**

Is this clown sad or is he smiling?

What happens when you step back about two metres and look at him?

When you look at the image close-up, the clown seems sad, but as you step back he will begin to smile.

what's going on?

This type of illusion is known as a cryptic or hybrid optical illusion. It is made by merging two photos with different resolutions. The result is that one of the photos is hidden depending on your distance. When you see the picture close-up, the fine details dominate (the sad clown). When you look at it from a distance, the larger, more blurred tones become visible and the grinning clown appears.

Leaning **Towers**

Were these two photos taken from the same angle?

The towers appear to be leaning more in image A. But the two photos are exactly the same – yet they seem different! You can see proof of this on page 93.

what's going on?

Both photos have the same perspective and the same **vanishing point**. But when they are placed next to each other, your brain interprets them as a single scene with two different vanishing points and it gets confused by the rules of perspective. The leaning effect occurs because the two vanishing points are interpreted as divergent, which is why the tower on the left appears to lean more than the one on the right.

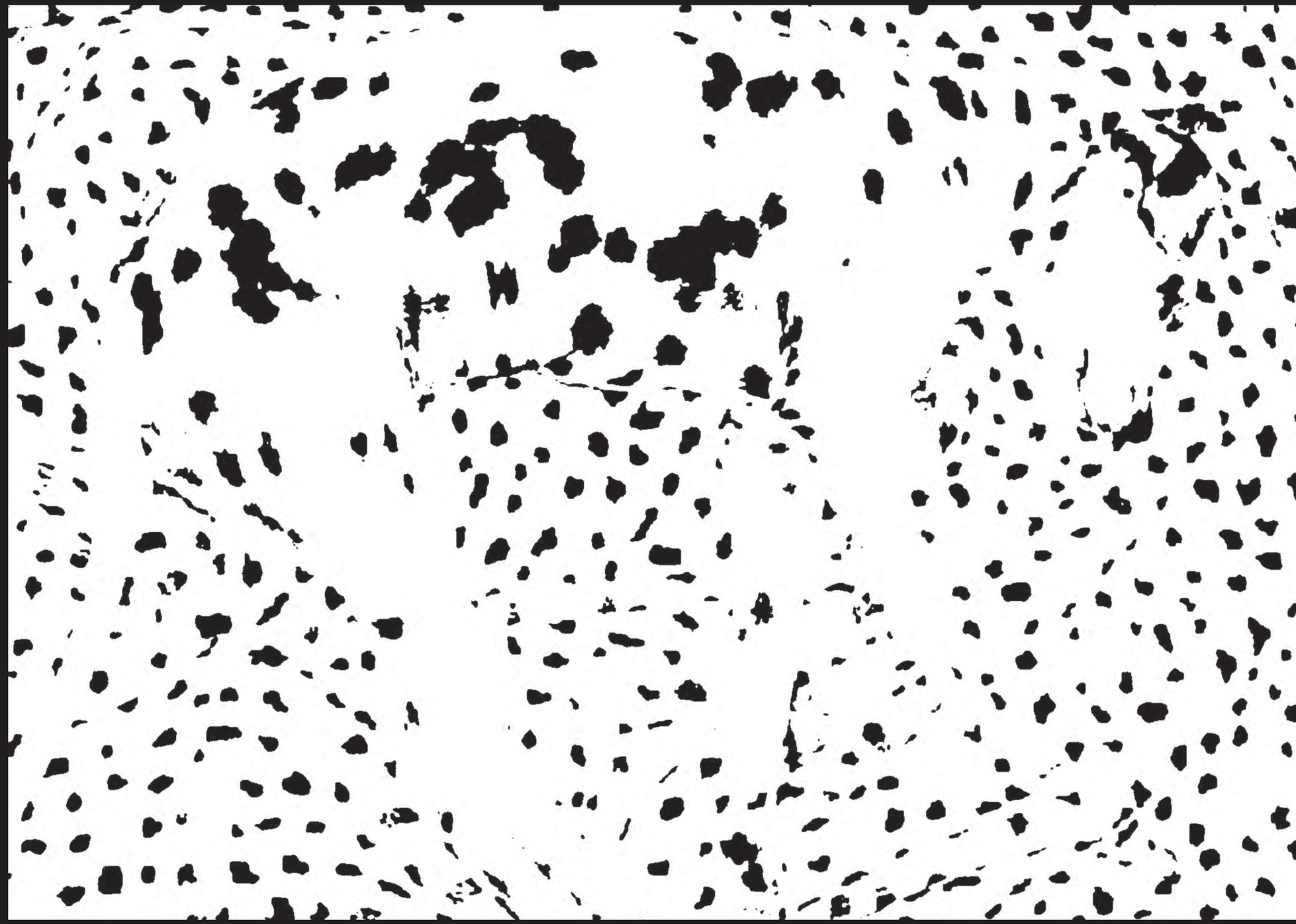
Disrupting **Patterns**

What's hidden in this black-and-white image?

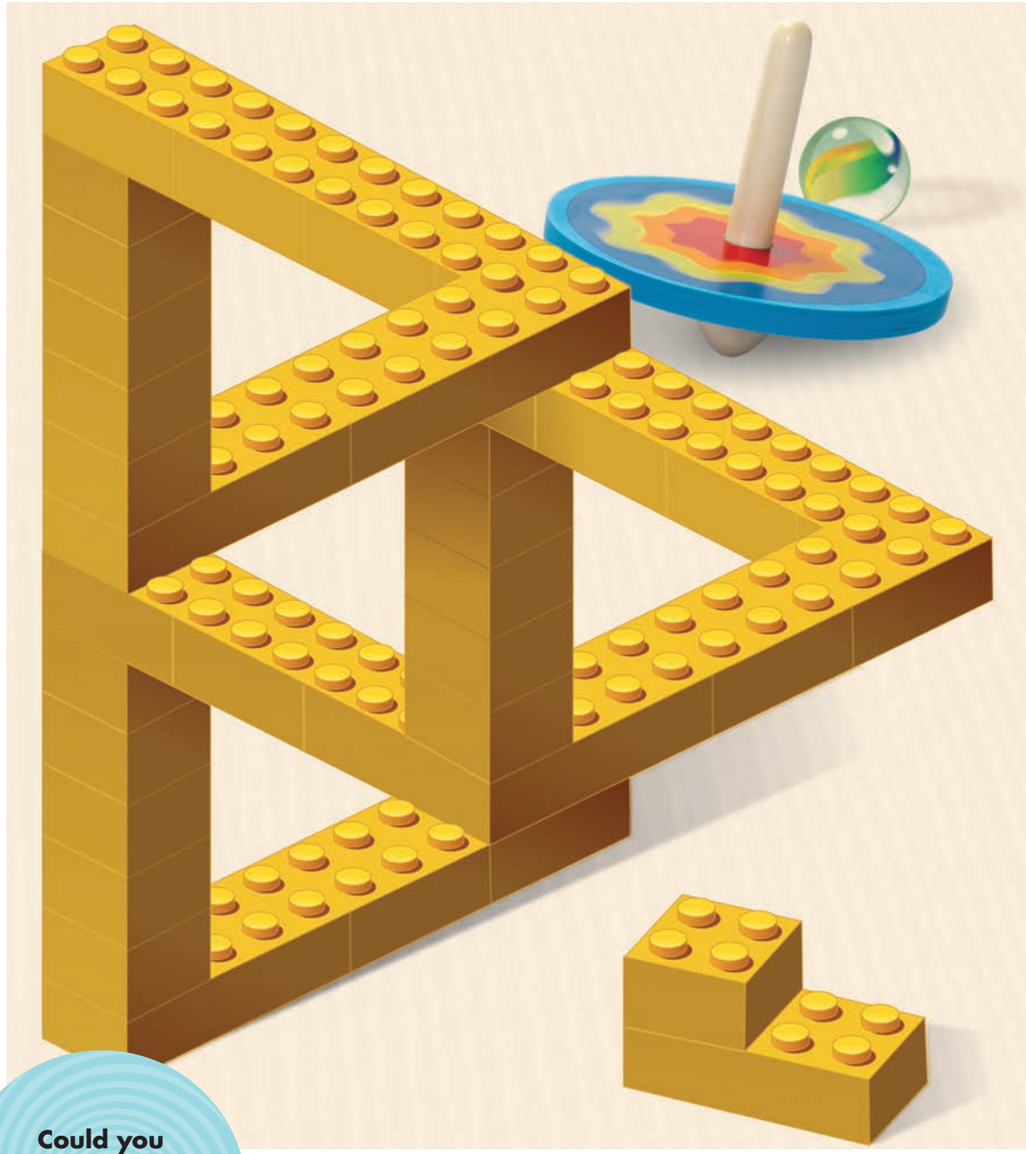
This black-and-white image contains a black-and-white Dalmatian dog lying on a black-and-white spotted rug (turn to page 93 to see it more clearly).

what's going on?

The dog and the background have been obscured to show how prior knowledge of an object can help you understand an image. For example, you can't see the outline of the dog so you don't recognize it in the image. **Disruptive patterns** like this often occur in nature. The black-and-white stripes of thousands of zebras confuse predators because they cannot focus on an individual animal to catch.

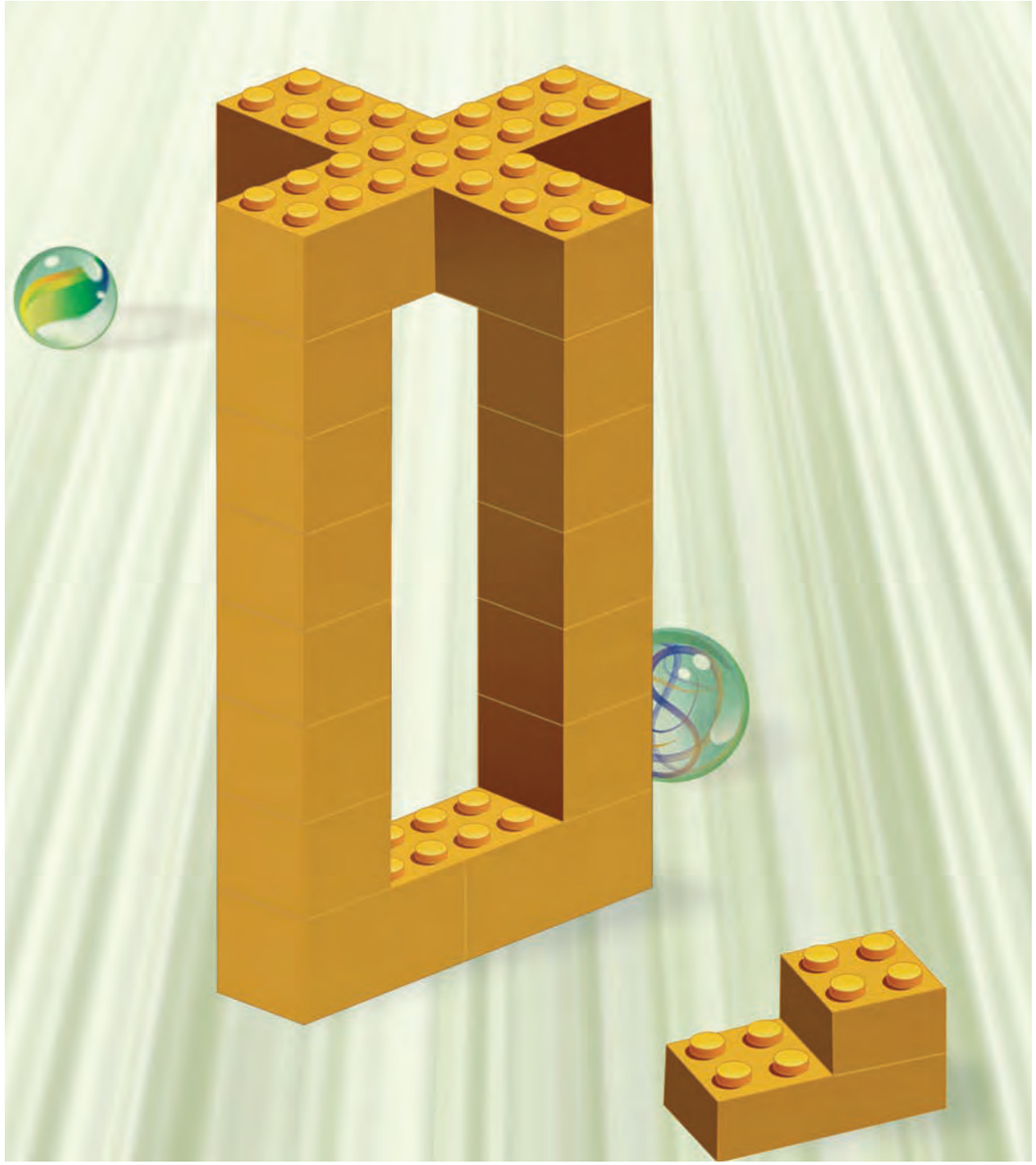


Impossible **Structures**



Could you construct these models with building blocks?

No, these are structures that no one could ever build, no matter how many blocks they have. They are known as '**impossible structures**'.



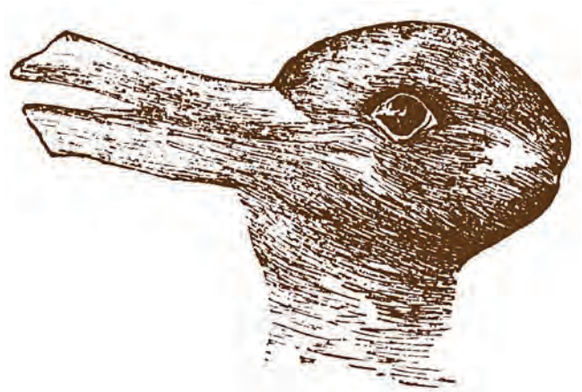
what's going on?

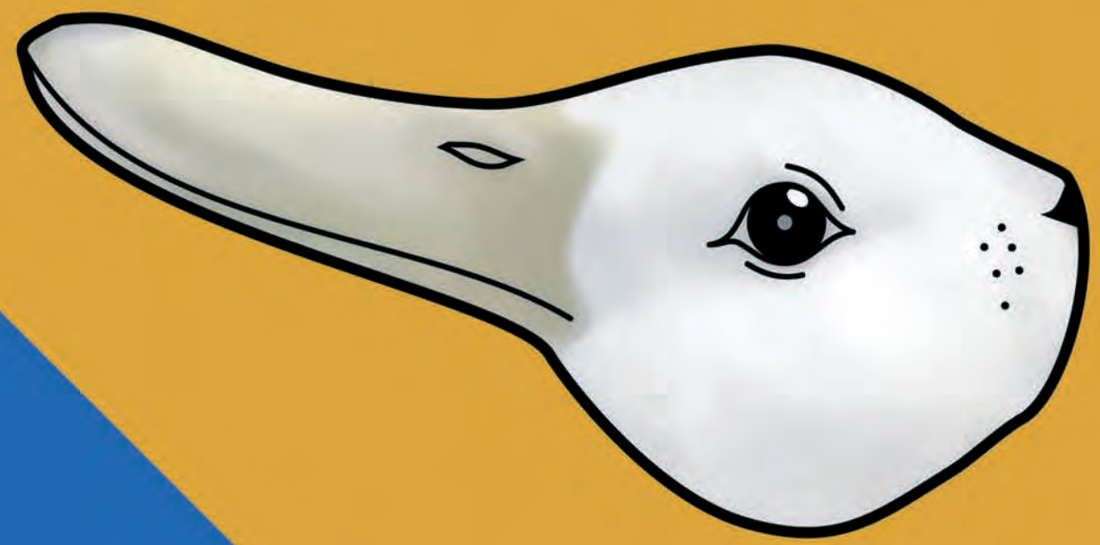
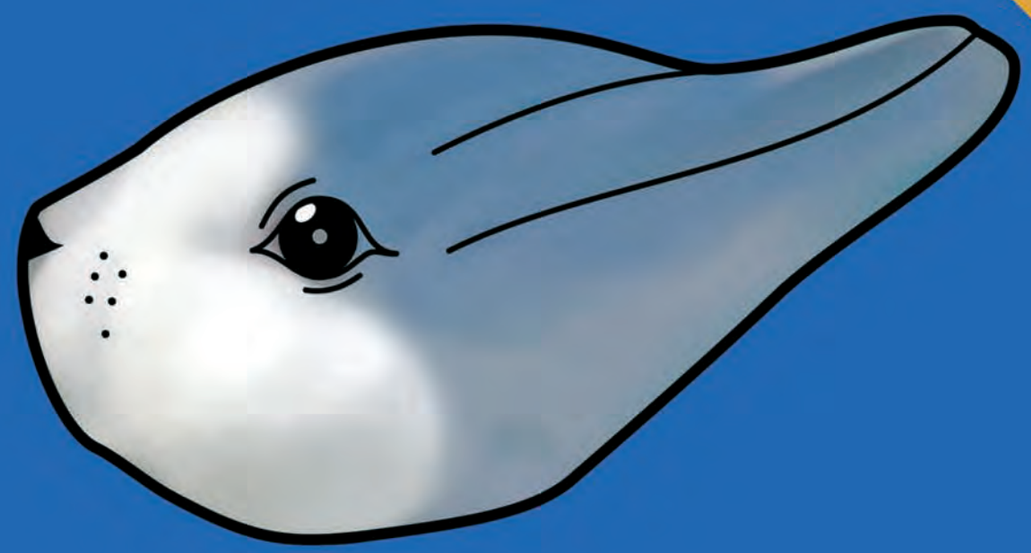
Impossible structures are objects that cannot exist in real life. But that doesn't mean you can't draw them or even create your own illusion of one – the experiment on page 69 shows you how to make your own impossible structure. Generally, when part of an object looks like it's in the wrong place, such as behind, in front, above or below another, then the chances are it is part of an impossible structure.

Bilateral **Animals**

What can you see here? Ducks, rabbits or dolphins?

The 'Duck or Rabbit' illusion is probably one of the oldest intentionally **ambiguous figures** created for psychological tests. Thousand of variations of the 'Duck or Rabbit' illusion exist. The original illusion (see the image below) is usually credited to the American psychologist Joseph Jastrow who was the first to use it in an article. However, there's every chance it's much older than that!



what's going on?

This illusion is a good example of what scientists call 'rival-schemata ambiguity'. In other words, even though the image is ambiguous, there is no 'dominant' shape, as both images (such as the duck or the rabbit) can be seen at the same time.