

INTRODUCTION

Here's one of my favourite philosophy puzzles. Take a look at yourself in a mirror. Now imagine yourself actually standing where the mirror-version of you appears to be standing. Of course, your mirror-self's head is still at the top and their feet are at the bottom. But notice that their left and right sides are switched round. Raise your left hand and wiggle your fingers. It is the right hand of your mirror-self that wiggles their fingers. Mirrors reverse left-to-right. But not top-to-bottom.

But why do mirrors reverse the left-to-right, but not top-to-bottom? What accounts for this peculiar asymmetry? Some of the world's greatest minds – including that of the Ancient Greek philosopher Plato – have struggled with and been defeated by this infernal mystery.

Notice that this left-right switch still happens no matter which way up you happen to be. Lie on your side in front of a mirror and see the result. It is still your left and right sides that are switched round, not your head and feet. Nor does it matter which way round the mirror is. Turn it upside down. The effect is exactly the same.

Sometimes people suppose the effect must be due to our having a left and a right eye, rather than a top and bottom eye (as perhaps some aliens do). But that is not the explanation. Cover one eye, leaving yourself with just the other, and the asymmetric reversal remains.

Can science solve the mirror puzzle?

Might science solve the mirror puzzle? In particular, is the explanation that light is reflected differently left-to-right than it is top-to-bottom?

It seems not. Draw a clock face held up in front of a mirror and draw arrows linking each number on the clock face with the same number reflected in the mirror.

The arrows show that the way the mirror reflects is entirely symmetrical in every direction. The arrows do not cross over top to bottom. But neither do they cross over left to right. It is not as if a mirror reflects rays of light differently depending on whether they are coming from your left and right sides rather than your top and bottom. The light is reflected in the same way no matter where it happens to land on the mirror.

So the puzzle has absolutely nothing to do with how light is reflected off the surface of the mirror. Indeed, the puzzle is not a scientific puzzle at all. Even when we know all the scientific facts about how mirrors and light behave, that still leaves the mystery of why mirrors reverse one way and not the other.

The more we grapple with this mystery, the deeper it seems to become, and the more they seem to take on an almost magical quality. Just why do mirrors do what they do? The profound sense of bafflement raised by this question is typical of that raised by philosophical problems more generally.

What's the solution? Here's my suggestion.

In a sense, mirrors don't reverse anything. So why do we say they reverse left-to-right, but not top-to-bottom? Well, if the mirror before you was replaced by a sheet of glass, and you were to stand behind the glass in just the position your mirror-self seems to stand, then while your head would still be at the top and your feet at the bottom, your left hand would be over to the right, where your right hand appears in the mirror, and your left hand would be to the left, where your left hand appears. That is why we say the mirror reverses left-to-right, but not top-to-bottom.

But notice that we have just taken something for granted: the axis about which we rotate you when we imagine you over there behind the mirror. When we turn something round, we rotate it about an axis. A spinning top, for

example, rotates around a vertical axis. A car wheel rotates around a horizontal axis. When we imagine you over there in the position your mirror-self seems to be in, we mentally put you there by rotating you about a vertical axis. But what if we were to get you over there not by rotating you around a vertical axis, but around a horizontal axis? Then you would be stood on your head. And, compared to your mirror image, your left and right sides would not then be switched round. Your left hand (the one with the watch in the diagram) remains to the left. Which is also where your left hand appears in the reflection. But top and bottom are now reversed. Your head appears where your feet are in the image.

It seems the reason we say mirrors reverse left and right but not top and bottom is due to the fact that we take for granted a particular axis of rotation. But we could just as easily choose a horizontal axis. Then it would be true to say that a mirror reverses top to bottom but not left to right.

So yes, it is true to say mirrors reverse left to right, but only if we choose a vertical axis of rotation. Choose a horizontal axis and they then reverse top to bottom.

Of course, this raises the question of why we take the vertical axis for granted. The answer, presumably, is that people are not in the habit of flying through the air like birds and settling on their heads. When people normally rotate, it is almost always about a vertical axis. So we just took for granted a vertical axis of rotation in this case too.

So this puzzle about why mirrors do what they do is generated by our not noticing what has been taken for granted. To solve the puzzle, we need to take a step back and start questioning what we took for granted.

When only philosophy will do

Notice that, if this solution (or part solution) is correct, we certainly didn't have to any scientific research into how light and mirrors behave. Nor did we have to investigate how

our brains work. Even if we had done that sort of scientific research, it still wouldn't have solved the puzzle. In order to solve this puzzle, we need to stop doing science and start doing philosophy. It is a puzzle that is solved just by thinking.

People sometimes assume all questions can be answered by science. They would assume that the mirror puzzle must have a scientific solution. But it turns out that the mirror puzzle is a puzzle that science cannot solve. It seems that, sometimes, only philosophy will do.

The Door Puzzle

There is similar puzzle about doors. Walk through a door that opens on your left and turn round to come back through it, and the door now opens on your right. But pass through a door that opens at the top (like a cat-flap) and turn to come back through it and the door still opens at the top. Why does passing through a door reverse the way it opens from left to right, but not from top to bottom? What explains the difference?

The solution is much the same as for the mirror puzzle. When you pass through a left-opening door and turn around to come back through it, you would normally rotate about a vertical axis. But what if you were to rotate about a horizontal axis, and you floated back through upside down? Then the door that opened on the left would still open the left on the way back through it, but a door that opened at the bottom would now open at the top. We say that left and right are reversed but not top and bottom only because we take for granted a particular axis of rotation.

In space, where we are weightless, the axis of rotation about which we choose to rotate when turning to come back through a door is less likely to be the vertical axis. You could just as easily spin about a horizontal axis instead. So, after years in space, it might seem as natural to you to say that a door that opens at the top opens at the

bottom when you come back through it as it does to say that a door that opens on the left opens on the right when you return though it.

For creatures that live in a weightless environment, where it is as easy to rotate about one axis as the other, perhaps neither the mirror puzzle nor the door puzzle would even be puzzles.

Stephen Law
Editor