# Uncovering the secrets of 3D vision: How glossy objects can fool the human brain

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It's a familiar sight at the fairground: rows of people gaping at curvy mirrors as they watch their faces and bodies distort. But while mirrored surfaces may be fun to look at, new findings by researchers from the Universities of Birmingham, Cambridge and Giessen, suggest they pose a particular challenge for the human brain in processing images for 3D vision.

The researchers have taken advantage of the unusual visual behaviour of curved mirrors to study stereopsis: the process by which the brain combines images from the two eyes to see in 3D.

The work, published online today (January 21 2013) in the **Proceedings of the National Academy of Sciences (PNAS) (http://www.pnas.org/)** , used mathematical analysis and perceptual measurements to show that people often see the 'wrong' shape for glossy objects (like chrome bumpers or brass door knobs) because of the way the brain employs 'quality control' mechanisms when it views the world with two eyes. This reveals how the brain checks the 'usefulness' of the signals it receives from the senses, explaining why we sometimes misperceive shapes and distances. It also has some connections with the design of robotic systems.

'We often think that the 3D information we get from having two eyes provides the gold standard for seeing in depth; but glossy objects pose a difficult challenge to the brain because the stereoscopic information often indicates depths that don't match the physical shape of the object' explains Dr Andrew Welchman, a Wellcome Trust Senior Research Fellow at the University of Birmingham. 'We found that the brain is sometimes 'fooled' into seeing the wrong 3D shape, but this depends on statistical properties of the stereo images that indicate how 'useful' the information is,' he adds.

To carry out the project, the team developed mathematical models that calculate the pattern of reflections seen when viewing glossy objects, and measured the perceived 3D appearance of these shapes.

'When a curved mirrored object reflects its surroundings, the reflections appear at a different depth than the glossy surface itself. This makes it difficult for the brain to work out the true 3D distance to the surface' explains Dr Alex Muryy, a research fellow at Birmingham who conducted the analyses. 'We found that even simple objects can produce very complex depth profiles, and reflections can behave very differently from normal stereoscopic information.' Understanding these differences provided the key to reveal the generalised way in which the brain analyses incoming information to judge the circumstances in which information should be trusted.

'Stereoscopic information is often highly informative, but in certain circumstances it can tell us the wrong thing or be unreliable. The challenge is therefore to understand how the brain knows when it should or should not trust this 3D information,' says Professor Roland Fleming, ,Giessen University in Germany. 'We have uncovered signals that are likely to be important in guiding the brain's use of the information by studying glossy objects. In particular, we can understand people's misperceptions because in these circumstances 3D reflections fall within the normal range of values, meaning that the brain takes the depth signals at face value.'

Professor Andrew Blake, team member from Microsoft Research Cambridge, adds:'Understanding human stereo vision is fascinating in its own right and also because of the connections with stereo vision systems used in Robotics today.'