Editorial

Reflections on principal principles of reflections

Principles employed by any theory of why mirrors seem to reflect left-right but not up-down must be consistent with the principal facts. This is not different from any theorising. What is unusual is the variety of principles that have been, and still are, accepted as candidates for understanding why plane mirrors (usually) reflect right-left (R-L) and not up-down (U-D)—although when normal (at right angles) to the observer mirrors are optically symmetrical.

There are two principal questions: Where does the reflection asymmetry come from? Why is R-L 'preferred' to U-D reflection? These questions have been asked ever since Plato's *Timaeus* (c. 340 BC). A brief history in time is to be found in *Odd Perceptions* (Gregory 1990).

There are many opinions in these papers, but as these are opinions rather than scientific papers they have not been fully refereed. So here we have a special section of opinions. The aim of this Editorial is to try to pin down—pinion—these opinions. It is interesting that presented in isolation they appear remarkably implausible. Paradigms seem to be capable of distorting conceptions and perceptions. But this is for the reader to judge.

Previous (and some present) suggested principal principles

The words 'right' and 'left' lack clear meaning, though 'up' and 'down' do have clear meanings. (This is a philosopher's suggestion.)

BUT: Although these words can be confusing, 'mirror reversal' is an observation—making for example 'mirror writing' hard to read. No amount of defining or redefining can change the observation, which can be recorded and measured objectively, including by photographs from mirrors.

SO: Language can be confusing, but this does not cause the visual asymmetry.

Plane mirrors produce optical reversal in depth; this somehow produces R-L but not U-D reversal. (There is indeed optical depth reversal, as a nearer object, or part of an object, has a longer reflected light-path.)

BUT: Depth is orthogonal (at right angles) both to the right-left and to the up-down axes. So the R-L reversal is not explained.

SO: Depth reversal is not adequate to explain L-R reversal, because depth reversal is orthogonal (symmetrically related) to both the horizontal and the vertical axes. [In general, asymmetry cannot be produced by symmetrical optical systems. An object lying parallel to an orthogonal plane mirror is in a symmetrical situation. So the mirror cannot produce R-L (or U-D or any other orientation) reversal parallel to its surface. The depth reversal is irrelevant.]

Optical ray diagrams can show the horizontal to vertical asymmetry.

BUT: A ray diagram cannot by itself show preference for R-L or U-D because the diagram can always be rotated; it has no absolute orientation. (This is like a map. Maps can only show where, for example, North is when they are correctly orientated. But this needs some outside criterion or evidence. There is no such criterion or evidence for mirrors.)
SO: Perhaps surprisingly this asymmetry cannot be shown or explained by an optical ray diagram. (This might be why such diagrams are not to be found in optics books: They don't work!)

As our eyes are separated horizontally, this produces the mirror asymmetry. (Suggested in conversation by a professor of psychology.)

BUT: Shutting one eye makes no difference; a person blind from birth in one eye sees the usual reversal; tilting the head (including placing the eyes vertically) makes no difference.

SO: That our eyes are horizontally placed is not relevant.

Mirror reversal is cognitive mental image reversal.

BUT:
(i) Known mental image rotation is slow even for simple objects—but mirror reversal is immediate, even for the most complicated objects or scenes.
(ii) Why should mental image rotation be around a vertical axis? It has been suggested, because we are more symmetrical horizontally than vertically. But any asymmetrical object or scene (usually) appears R-L and not U-D reversed.
(iii) Mirror reversal occurs with clean and so invisible mirrors, with no frames or other indication that a mirror is present. Then there is no clue or cue to trigger a mental rotation.
(iv) A mirror frame without a mirror does not produce a rotation, though on this suggestion the frame should indicate that rotation would be appropriate.

SO: Cognitive mental image rotation is not involved in mirror rotation. (And neither are asymmetries of object, or observer, relevant.)

Editor’s principal principles

Writing (or whatever) on a transparent sheet does not show any reversal when the sheet is held before a mirror—unless it is rotated. If rotated around its vertical axis, its mirror image is R-L ‘mirror-writing’. When turned around its horizontal axis, the mirror image is upside-down and not right-left reversed.

Writing (or whatever) on an opaque sheet must be turned round to face the mirror behind it. Then what happens depends on whether it is turned vertically or horizontally. Usually we turn objects (or ourselves) around the vertical axis—producing right-left reversal and not up-down reversal. When, however, we turn an object upside down (or ourselves on our heads), we get an up-down, and not a right-left, mirror image.

A tilted, or slanting, mirror (such as a lake reversing up-down a distant scene) produces asymmetrical effects because the optics is now asymmetrical. This can be shown with a ray diagram.

General conclusions

The R-L rotation is not optical or cognitive. It can be photographed and measured, so it is objective and is not a perceptual phenomenon.

‘Mirror rotation’ does not require mirrors or optics. The same rotation of the object is involved, and required, for example in printing. Type has to be made in ‘mirror writing’ because the paper is rotated when lifted from the type. This is exactly the same principle, though no mirror is involved. This is not principally or in principle optical or cognitive.

It is what you do to an object or to yourself that you see in mirror rotation.

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Reference
Gregory R L, 1990 “Reflecting on mirrors”, in Odd Perceptions 2nd edition (London: Routledge) pp 76-83