Public perception of perception

Two recent editorials (Perception 2000 29 1273 – 1278, 1399 – 1402) discuss public understanding of science, especially hands-on Science Centres, and their relation to museums. Now we come to sharing our perceptions of perception with the public.

Most, if not all, Science Centres present phenomena of illusions. They are attractive and popular; but seldom, if ever, is the range and structure of an exhibition sufficient to bring out their significance for perception and its relation to the physical world. This may be because there is not sufficient room available; that they are not organised from sufficient understanding; or it may reflect a much deeper problem—in the subject itself—that experts (we!) disagree on fundamentals of perception. It is right to be wary of presenting controversial concepts and explanations without qualifications, but ifs and buts can confuse the public. I confess to this inhibition, wishing now that I had been bolder; but it is hard to be bold without being also arrogant and dogmatic. Putting this aside, I will try now to set out an ideal exhibition of Perception and Illusion. Will any colleague agree with it or wish to be associated with its contents or philosophy? It would be nice to know.

Suggested contents

(i) Most important is a wide range of phenomena with plenty of hands-on interaction. There should be experiments allowing adjustments for exploring the limits of phenomena and making measurements. (The Exploratory had adjustable versions of phenomena such as the Müller-Lyer illusion and brightness contrast which went much further than can be shown in a book—justifying the trouble of visiting an exhibition.)

(ii) Alternative versions allow a quick introduction, with further exploration in more sophisticated versions. Alternative versions can be adapted to children and adults; also when necessary to the handicapped. By being different, they show what is essential for the effects. Duplications and alternative versions can minimise queuing; though, of course, there is a cost in the room they take up.

(iii) Primary phenomena should be presented with working models rather than computer screens. Distortion effects, for example, are far more convincing with ‘real’ displays than on screens; for anything goes on a screen, where cartoon figures may defy gravity or anything else.

(iv) Computers can, however, be extremely useful and in some cases are essential. They shine for phenomena of movement, and are necessary for showing eye movements, real-time data, and for providing explanations.

(v) Dramatic effects such as tilted rooms and the Ames demonstrations must be ‘real’, not on screens. When presented well, they are unforgettable—surely worth the space and the effort to build them.

(vi) Hands-on experiments are very attractive and self-motivating. In the Exploratory, we found that tracing objects on a glass sheet (‘Leonardo’s Window’) illuminates representing three dimensions on two like nothing else; with perspective and size constancy thrown in, as the drawn objects at various distances look very different in size, though almost the same when seen ‘directly’. Colour mixture (additive, subtractive, and pointillism) is a must, preferably related to colour printing and colour television. Finding absence of brown in the red, green, and blue phosphors of a TV screen, viewed with a magnifying glass, is amazing. Comparing Young’s three-colour mixing with two
Land colours shows the subtlety of colour vision. Estimates of colour anomaly are also interesting, though care is always needed when revealing individual differences.

Assumptions and explanations
Here controversies rage, for the bases of perception are controversial. (There was a story of a conference on colour vision with twenty-five delegates and twenty-six theories—one delegate defending two theories!) Though exciting for scientists and philosophers, controversy may be a turn-off for the public wanting quick, easy answers. Should an exhibition present conflicting views? This is certainly so for students, but the public could be confused and bored. Perhaps it is best to present major divisions and show how experiments are relevant. This can give drama and point to experiments in the exhibition, while illustrating methods of science.

Explanations ride on general assumptions (mental models or paradigms) seldom made explicit by practising scientists. An adequate exhibition demands that we come clean on our assumptions and philosophy. This is rewarding for the exhibition designers and the interested public. It is important to admit when we know we don’t know, as for consciousness.

Basis assumptions might go like this, though no doubt not universally accepted:
(i) Mind depends on physiological processes, which obey laws of physics, including chemistry and so on. So physiology and anatomy are extremely important for psychology.
(ii) Cognition, however, goes beyond physics—with the powers of symbols. This may be compared with the physics of hardware and the software rules and data represented in hardware. (Even though the brain is not a digital computer. Is it a bunch of analogue neural nets? Nets, with digital AI, should be in the ideal exhibition.)
(iii) Brain, mind, and the senses have evolved by natural selection. The public should warm to Darwin’s Cold Shudder, when he anticipated his critics’ reaction to the evolutionary origins of the eye. Such human episodes add greatly.
(iv) Though the proximal senses of smell and taste monitor quite directly important properties for survival, such as toxic or nutritional surrounding substances—information from the distance senses, especially vision, is highly indirect requiring interpretation and guessing. The eye’s owner cannot eat or be eaten by its images. They are only useful when they warn or promise significant object-properties—which are not optical. So cognitive processing and the importance of implicit knowledge enter the scene with eyes.
(v) How images are formed, and may be ill-formed, is obviously important; leading to the concept of the retina as transducer to neurally coded signals read by the brain. The notion of channels and specialised processing regions is not too hard to grasp. Localisation of function, with its new techniques is extremely interesting, though logical traps should at least be hinted at. (How can we localise functions before we know what they are?)
(vi) Phenomena of adaptation—for motion, tilt, curvature, colour, and so on—introduce the phenomenal side of the physiology. It is truly exciting to see such psychophysical relations; though again, with traps for the unwary. Who doesn’t like to see workings of one’s own brain, from both sides of the brain coin that is the currency of mind?
(vii) So we enter the realm of phenomena of illusions: perceptual departures from the world of physics. But what physics? What are the reference truths, from which illusions depart? As all perceptions are so different from accounts of quantum physics, this can hardly be the reference for illusion. Indeed all perceptions would be illusions on this criterion, which would simply destroy the meaning of the word. The reference physics seems to be common-sense ‘kitchen physics’, of simple measurements with rulers, scales, thermometers, and so on. (Kitchens are effective psychophysical laboratories, where illusions are courted with great success for controlling consciousness.)
So, the illusion demonstrations and experiments use quite simple familiar kinds of measurements. This makes this section an ideal start of a Science Centre—and who isn’t interested in himself/herself? The reading of facial expressions is a good next step, introducing other minds.

Structure of an exhibition is important. A clear structure removes the initial appearance of illusions as merely trivial. The main phenomena can be classified into four groups: ambiguities, distortions, fictions, paradoxes. (These terms apply also to errors of language, which may be no accident.) Causes in many cases are controversial; but setting up a classification reveals gaps of understanding, and may raise questions suggesting new experiments. For vision at least, the main kinds of causes seem to lie in: optics, physiology, cognition. The last divides into general rules (such as the Gestalt laws and perspective setting size constancy) and knowledge of objects. We may set this out in a table, with as many examples as needed. Something like this could be the explicit or implicit structure of the exhibition.

**Periodic table of the elements of illusion**

| Phenomena by appearance | Causes |
|-------------------------|--------|
|                         | physical cognitive |
|                         | optics physiology rules knowledge |
| Ambiguities             |        |        |
| active                  | Mist, fog Red + green = monochromatic yellow |
| Cataract                | ?      | ?      |
| passive                 | Atmospheric rivalry Figure – ground |
| turbulence             | Retinal rivalry Vase – face |
| Laser speckle          | Migraine patterns Necker cube? |
| Distortions             | Stick bent in water Müller-Lyer |
|                         | Café wall Size – weight |
|                         | Müller-Lyer (smaller object feel heavier) |
| Astigmatism            | Tilt aftereffect Ponzo |
| Mirages                 | Pulfrich pendulum Poggendorff |
| Paradoxes               | Looking-glass (oneself doubled) Impossible triangle |
|                         | (expands without getting larger) (figure and three-dimensional model) |
|                         | Impossible triangle Magritte mirror |
|                         | (back of head reflected instead of face) |
|                         | Devil’s fork |
| Fictions                | Rainbows Subjective contours |
|                         | Afterimages and surfaces Faces in the fire |
|                         | Moiré patterns Ink blots |

It may be noted that ‘ambiguity’ may be passive or active; for it can mean that different stimuli or objects are not discriminated, or that different perceptions are evoked by a stimulus or an object. (‘Ambiguity’ is, unfortunately, ambiguous in the literature of perception.) It may also be noted that some familiar phenomena, such as the stick bent in water and rainbows, are given here as illusions though they are phenomena of physics. They become illusions when they mislead—as when we expect to walk through a rainbow as though it were a solid arch—but this does somewhat extend our definition of ‘illusion’. It moves ‘perception’ towards ‘conception’, which might be useful.
It is great to link art with science by perception and illusion. Will we ever get an opportunity for presenting an ideal exhibition? Would we have sufficient agreement on its conceptual bases and aims to make it possible?

Richard Gregory