Chapter 14: Hypernotes

☞WWW☜ 14:1

George Herbert's poem was published in *The Temple*, in 1633, the year of Herbert's death (Tobin, 1991). I have left the original spelling for poetic effect. In his mediation on *Man*, Herbert also mentions, a few lines earlier, the difference between man and beasts, and emphasises "reason and speech we only bring". .

☞WWW☜ 14:2

The Greek word is σύμμετρος. Bochner (1973) starts his account by quoting Pliny's remark, "Latin does not have a word for 'symmetry'" (Rackham, 1952 pp. 175-7); and indeed no other European language would appear to either, all having taken over the Greek word. Bochner (1973 p.346) says that the word "belonged to a group of terms and locutions that designated harmony, rhythm, balance, equipoise, stability good proportions, and evenness of structure".

Translations of Plato do vary, and a standard one Fowler, 1962 p65.a has, "Then if we cannot catch the good, with the aid of one idea, let us run it down with three – beauty, proportion [ξυμμετρία], and truth...". Van Fraassen (1989 p.232) has the rather more evocative image, "Then, if we are not able to hunt the goose with one idea, with three we make take our prey; Beauty, Symmetry, Truth are the three..." Philebus, 65.a. (see Van Fraassen, p.232).

The relation of truth and beauty was put most famously by Keats in his *Ode on a Grecian Urn*, "Beauty is truth, truth beauty, that is all / Ye know on earth, and all ye need to know". The position is not however accepted by everyone, Plotinus for instance reversing the causal relations and arguing that "beauty is what illuminates good proportions [symmetry] rather than the good proportions themselves" (Armstrong, 1988 VI.7.25-7).

☞WWW☜ 14:3

In looking for copies of the Rorschach figures I was surprised by how many introductory textbooks of psychology do not show the actual figures, which are surprisingly rich and subtle (and in colour), but instead show very crude blobs "of the sort used in the Rorschach test". It was only when I asked for copyright permission to use one of the original figures that I realised why – the copyright owners will only allow one of the figures to be reproduced and then at great expense. The figure shown is, therefore, my own. It is the second figure I made, and I found it most intriguing, not least because of what, to my eye at least, appear at the top to be two erect phalluses. These were generated by pure chance, but I couldn't resist leaving them in.

Rorschach himself thought that symmetry was a necessary part of the test stimuli: “Asymmetrical figures are rejected by many subjects; symmetry supplies part of the necessary artistic composition. It has a disadvantage in that it tends to make the answers somewhat stereotyped.” (Rorschach, 1942 p.17). The figures I had hoped to include in the book are cards II (top) and III (bottom). It is said that, “Clinicians generally cite Card II as sexually evocative (with a penis area near the top and a vaginal area beneath)", whereas “Many clinicians place great stock in responses to Card III as an indication of social interaction patterns.” (Aronow, Reznikoff, & Moreland, 1994 p.35). Over a half of subjects see anatomical, animal or human content in the cards (Harrower & Steiner, 1951 p.94). There has been a continuing controversy for the past half century over the reliability and validity of the Rorschach test (Lilenfeld, Wood, & Garb, 2001).

See Meglitsch and Scram (1991 pp. 591-597) for the role of bilateral symmetry in defining organisms.

☞WWW☜ 14:4

A good and very readable introduction to many aspects of symmetry can be found in Stewart and Golubitsky (1992a), where they come up with fine description that “a symmetry isn’t a *thing*; it’s a *transformation* ... a transformation that leaves [an object] *apparently* unchanged”. A similar definition can be found in Van Fraassen (1989 p.262): “The general notion of symmetry is this: *a symmetry is a transformation that leaves all relevant structure the same”*; that word 'relevant' allows a far broader group of phenomena to be included as symmetries.

On the reduction of all symmetries to reflection see van Fraassen (1989 p.263), and Coxeter (1969).

There are several more technical accounts of the applications of symmetry in science (Boardman, O'Connor, & Young, 1973; Wolbarst, 1977).

☞WWW☜ 14:5

Strictly the two-dimensional patterns are conceptualised mathematically as being infinite, although in practice as long as there are three or four cycles the pattern is very visible.

Wyle (1952 p.103) claims that all seventeen patterns were known to the Egyptians, and Stewart and Golubitsky (1992a p.238) say they can all be found in the Alhambra. See also Gombrich (1979).

☞WWW☜ 14:6

It may have taken Ørsted eight years to find his result, but when he did so it was at least noticed. The discovery had also been made in 1802 by the Italian, Gian Domenico Romagnosi, but was published in such an obscure place that it was totally ignored at the time.

A useful biography of Ørsted, along with the background to his experiment can be found in Dibner (1961). The precise date of Ørsted's experiment is not clear, but Altmann (1992b p.13) provides evidence that the critical work was probably done in January to March 1820.

Ampère, who built on and extended Ørsted's work was much influenced by ideas of symmetry (D'Agostino, 2000), which he took into account in the design of his experiments.

☞WWW☜ 14:8

The magnet is what is called an axial vector, in effect spinning on its own length, which gives it an asymmetry (Altmann, 1992b p.22).

☞WWW☜ 14:9

“One would have thought that the lesson learned from the Ørsted paradox would have stopped people from ever again making the same mistake. This, alas, was not so...” (Altmann, 1992b p.35).

☞WWW☜ 14:10

Gleick (1994 pp.306-7) has emphasised that the idea of symmetry for physicists is essentially the same as that for everyone else:

> "Symmetry for physicists was not far removed from symmetry for children with paper and scissors: that idea that something remains the same when something else changes. Mirror symmetry is the sameness that remains after a reflection of left and right. Rotational symmetry is the sameness that remains when a system turns on an axis. Isotopic spin symmetry, as it happened, was the sameness that existed between the two components of the nucleus, the proton and the neutron, two particles whose relationship had been oddly close, one carrying charge and the other neutral, their masses nearly but not exactly identical. The new way to understand these particles was this: They were two states of a single entity, now called a nucleon. They differed only in their isotopic spin, One was 'up', the other 'down' ".

Eugene Wigner won the Nobel Prize in 1963 for his work on symmetries and invariances. He describes invariance thus:

> “In the classic example of the falling body, one can disregard almost everything except the initial position and velocity of the falling body; its behaviour will be the same and independent of the degree of illumination, the neighbourhood of other objects, their temperature, etc.. ... [T]he result will be the same no matter where and when we realise [the experiment]. ... The above invariance is called in modern mathematical parlance invariance with respect to displacement in time and space” (Wigner, 1967 p.4).

Feynman (1963) goes on to describe how the phase symmetry of the wave function means also that there has to be conservation of electrical charge: "This is altogether a very interesting business!", as he adds.

Symmetry arguments in their essential form go back to the beginning of the study of electrodynamics, D'Agostino (2000) showing how Ampère used arguments about the geometric symmetry of electric currents and magnets.

☞WWW☜ 14:11

Van Fraassen (1989 p.242)has put the distinction between the distinction clearly between the two types of symmetry argument:

> "... it is very important to distinguish symmetry arguments *proper* – logical exploitations of the symmetries of a problem as studied – from, arguments based on substantive assumptions about symmetry in the world."

The argument is related to that of Hume, who said that one cannot derive an *ought* from an *is*.

Lee and Yang (1956 p.258), in their seminal paper in *Physical Review,* commented that, "The conservation of parity is usually accepted without questions concerning its possible limit of validity being asked. There is actually no *a priori* reason why its violation is undesirable."

☞WWW☜ 14:12

Steven Weinberg has given a balanced view of the strengths and weaknesses of the Snthropic principle, "the requirement that [parameters] have to be in a range that allows the appearance of beings that can ask why they are and what they are" (Weinberg, 2001 p.50).

☞WWW☜ 14:13

Peter Ayton tells me that the term 'cognitive illusion' seems first to have been used by LJ Cohen in 1981 in a paper in *Behavioural and Brain Sciences*.

Hermann Weyl approvingly quoted Sir Thomas Browne, who said that "nature Geometrizeth and observeth order in all things" (Weyl, 1952 p.64).

☞WWW☜ 14:14

Martin Gardner (1990 p.348) described well the need by physicists for symmetry:

> "There is an old joke about someone who said, 'I'd give my right arm to be ambidextrous'. For some reason many physicists seem willing to give their right arm to make the universe ambidextrous."

Despite his book being called *The ambidextrous universe*, it is not clear that Gardner really believes in such symmetry, the book ending a few lines later with a line reminiscent of Horatio in *Hamlet*, "A man is a small thing and the night is very large and full of wonders".

Johnson (1997 pp.314-5) continues, "Rather than let ourselves be overwhelmed by the messiness, the randomness, the unruliness that so often prevails, we construct our creation myths, we dream of a time when order prevailed".

In my use of Feynman's example of the clock I have conflated two examples (Feynman, Leighton, & Sands, 1963 pp.52-4, 52-11), one of the ordinary clock and the other of a clock which actually is an atomic clock and relies on counting the emission of electrons from the decay of cobalt-60. The difference in timing of the right and left-handed conventional clocks would be vanishingly small, although theoretically still possible.

The first hints that supersymmetry might be experimentally demonstrable came with observation that B mesons did not seem to be exact mirror images of antimatter B mesons (Cho, 2001a), and that there were small discrepancies in the magnetic field of the muon (Cho, 2001b). However subsequent checking of the results has cast serious doubt on those discrepancies (Cho, 2001c). Nevertheless, as Nilles (2002) the "uniqueness and theoretical beauty of [super]symmetry" means that interest in it will continue for many years, even in the absence of experimental support.

The full quotation from Nabokov (1974 pp.144-5) is:

> "We shall imagine then a prism or prison where rainbows are but octaves of ethereal vibrations... Then we give a good shake to the telescopoid kaleidoscope (for what is your cosmos but an instrument containing small bits of coloured glass which, by an arrangement of mirrors, appear in a variety of symmetrical forms when rotated – mark: when rotated) and throw the damned thing away".

☞WWW☜ 14:16

Perhaps most striking about the claim that D-amino acids are found in cancer is that the controversy was conducted entirely at the empirical level, with little or no theoretical discussion of why tumour proteins might or might not contain D-amino acids (Kögl & Erxleben, 1939, Miller, 1950). Such silence suggests almost that the various protagonists regarded it as reasonable that tumours might contain the D-amino acids. Without the reasons for the reasonableness being made explicit, symbolism must remain as a possible explanation.

It must be said that there is something not very logical about the theory that L-sugars will help the obese (Clemmit, 1991). If L-sugar tastes sweet then it must be because it is bound to the same surface receptors as D-sugar. But if that is the case then it may be metabolised by the same mechanism as well, since cells can recognise it. The way mythologies develop is also shown by an article in the Sunday Times (Gram, 1986) where it is said that "Levin's innovation was to taste the stuff and discover that it is indistinguishable from ordinary sugar". It was certainly not his innovation, since the fact that left-handed sugar tastes sweet was mentioned by the physicist Richard Feynman in his Lectures on Physics (1963 p.52-6).

☞WWW☜ 14:19

Harrington (1987 pp. 223-4) describes Jackson's ideas as being "shaped by certain a priori convictions about how the hierarchy of sensory-motor functions in the nervous system 'should' be organised", ideas that she refers to as "semi-aesthetic, semi-philosophical sentiments".

☞WWW☜ 14:20

Altmann (1992b) emphasises that this is the second part of Curie's principle, and that the first part is also strictly correct ("When certain causes produce certain effects, the symmetry elements of the causes must be found in the effects produced"). However while correct it needs using with extreme care – it does not say that the *only* symmetries found in the effects will be those found in the causes (and Altmann provides an example of just such a situation (p.27)).

Van Fraassen (Van Fraassen, 1989 p.240) is pragmatic in his warning about the Curie principle:

> "What is to be said of this fundamental, profound principle that an asymmetry can only come from an asymmetry? The first reply is that *qua* general principle it is most likely false and certainly untenable. ...On the positive side we must say that the conviction is a good guide for humans looking for theories. Their speculation about hidden asymmetries often pays off. It is only important not to raise a tactic to the status of strategy."

For a good account of symmetry breaking see Stewart and Golubitsky (1992a pp.54-72).

☞WWW☜ 14:21

There is, it seems, little of substance to support the story of Buridan's ass (Altmann, 1992b p.8), or perhaps even nothing at all (Zupko, 1998). The ass has even suggested to have been a dog. Buridan's name may have been associated with the story as a later parody of his ideas on freedom of will apparently leading to the absurd outcome of inaction. The modern philosophical interest in the story is a result of it being discussed by Leibniz in his essay on the freedom of man and the origin of evil, where he talks about "the snares of equipoise". In another variant of the story, Leibniz describes the ass as being between two meadows. In the present context the interest is, as Altmann points out, that Leibniz realised that neither the ass nor the universe is entirely symmetric:

> "fundamentally the question deals in the impossible, unless it be that God brings the thing about expressly. For the universe cannot be halved by a plane through the middle of the ass, which is cut vertically through its length, so that all is equal and alike on both sides ... Neither the parts of the universe nor the viscera of the animal are alike nor are they evenly placed on both sides of [a] vertical plane. There will therefore always be many things in the ass and outside the ass, although they may not be apparent to us, which will determine him to go on one side rather than the other. ..." (Leibniz, 1951 p.310).

Van Fraassen (1989 p.239) also points out in similar vein that the animal, which is now a donkey, may have "myopia in its left eye; or a difference between the right and left hemispheres of its brain".

☞WWW☜ 14:22

The same idea was clearly elucidated by Alan Turing in a paper on morphogenesis. He starts with what seems like a problem for his theory – that a cell with perfect spherical symmetry can never lose that symmetry, so how does it become something like a horse, which is clearly not spherically symmetric – and he then explains how the slightest irregularities can lead to an unstable equilibrium: "the presence of irregularities, including statistical fluctuations in the numbers of molecules undergoing the various reacions, will, if the system has an appropriate kind of instability, result in [the symmetry] disappearing" (Turing, 1952 p.42). Turing also discusses the problems of how a system can develop a population level asymmetry of right and left handed organisms.

Stewart and Golubitsky (1992a p.58) have defined the, "Extended Curie Principle: Physically realizable states of a symmetric system come in bunches, related to each other by symmetry. To put it another way, a symmetric cause produces one from a symmetrically related *set* of effects".

☞WWW☜ 14:23

In general by 'harder to see' is meant that it would take longer to decide if a stimulus was symmetric or not in free viewing conditions. If the stimuli were presented for only a few hundred milliseconds in a tachistoscope or on a computer screen then subjects would get the answer wrong more often.

☞WWW☜ 14:25[1]

Mach (1995a) had his own theory of why vertical symmetry was so important: "because our apparatus of vision, which consists of our eyes and of the accompanying muscular apparatus is itself vertically symmetrical", the symmetry being seen in the placement of the two eyes to either side of the nose. Although the theory is not entirely clear, Mach seems to have thought the sense of symmetry came from a 'right-handed' image in the right eye being repeated as a 'left-handed image' in the left eye. Whatever the details, Mach himself provided a clear refutation of his own theory: "The presence of a sense for symmetry in people possessing only one eye from birth, is indeed a riddle". Indeed; and if the symmetry of our two eyes were somehow essential for perceiving symmetry then our sense of symmetry should also disappear as we close one eye, which it clearly does not.

For good recent reviews of the perception of symmetry see Tyler (1995b, 1995c). The corpus callosum seems to play some role in the perception of the vertical, but the effect is limited and cannot account for the overall advantage of the vertical (Herbert & Humphrey, 1996).

[1] **☞WWW☜** was inadvertently omitted from the notes in the book.

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