

Science, fringe science and pseudo-science*

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SUMMARY

We describe the methods of modern science as they developed in the course of the last few centuries. Society imposes limits on scientific research; 'free' science in the strict sense of the word does not exist. Pseudo-scientific statements and fraudulent science are less rare than is often thought. We describe some recent developments related to astrology. We stress the importance of a sceptical attitude towards fringe science and claims of paranormal phenomena, as well as in science in general.

1 THE SCIENTIFIC METHOD

In 1515 a new map of the heavens was published with, in the style of those days, somewhat extravagant and baroque drawings of the constellations (Stabius, Heinfogel & Dürer, 1515; Fig. 1). The maps were the result of a fine cooperation between three scientists: the mathematician Stabius, who determined the stellar coordinates, Heinfogel who calculated their positions on the maps, over which the famous artist Albrecht Dürer drew the constellations. Dürer was an ideal renaissance person, being both artist and scientist. His interest in astronomy dated from his acquaintance with Regiomontanus, in whose house Dürer lived after the death of Regiomontanus.

These new maps marked the beginning of scientific mapping. In earlier times a literary tradition existed in NW Europe in which the primary interest was the constellations rather than the positions of the stars. If stars were added to maps, they were usually just placed at their 'appropriate' positions; e.g. Aldebaran was placed at the eye of the bull, Algol in the head of Medusa, and so on. In the new maps the measured positions of the stars were the basic data. The new methods of rational science that were developed in the renaissance, were based on the gradually emerging concept that observations have to come first and that these are followed by hypotheses or theories that have to explain the observed phenomena. Obvious as this seems to modern eyes, it was a breakthrough of a new method of thinking and one of the markers of the start of the glorious development of science in later centuries.

But modern science did not emerge instantaneously. Particularly at the end of the Middle Ages occultism and science were intertwined. Astronomy had clear astrological roots; indeed in ancient times there was no real distinction between the two. To the ancient peoples in the Middle East the planets,

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trionales cum duodecim imaginibus zodiaci.

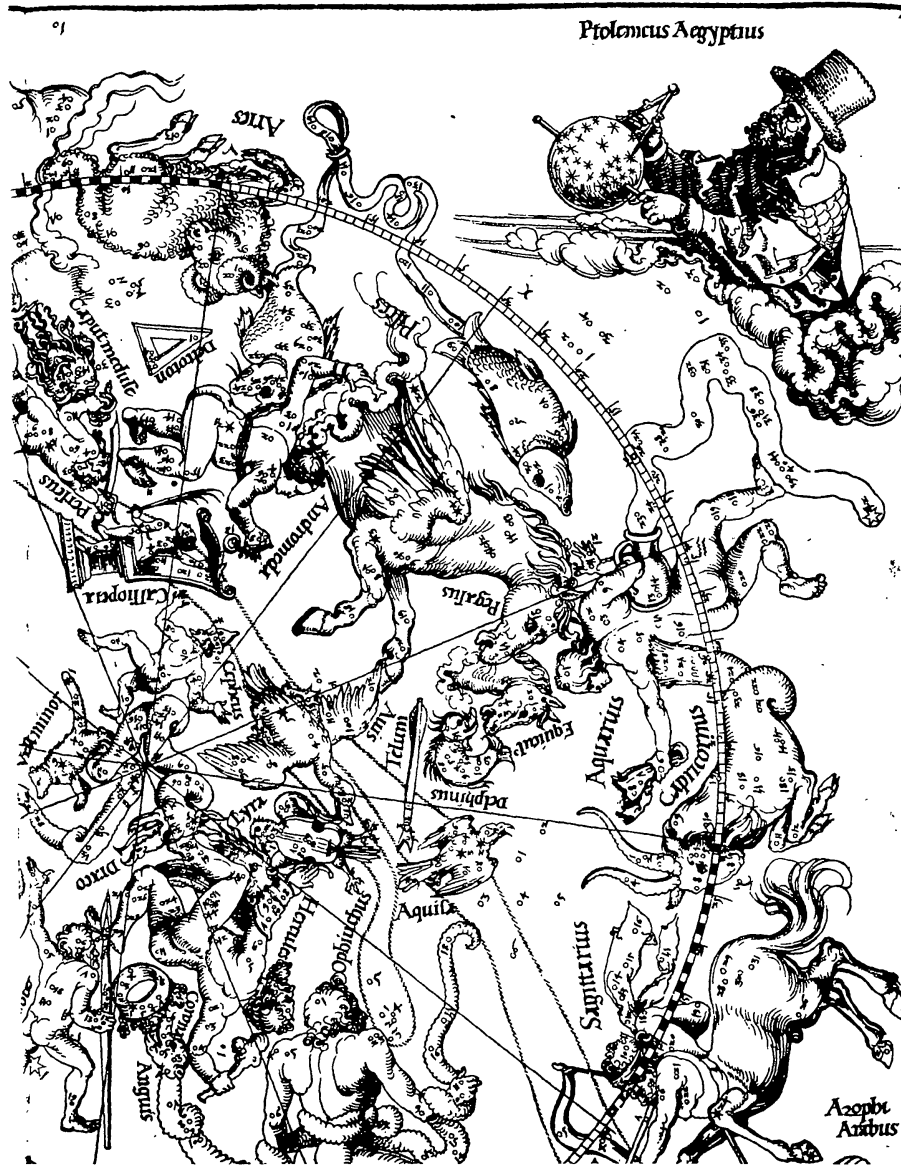


FIG. 1. Detail of the star map by Stabius *et al.* (1515).

wandering across the background of fixed stars at a distance thought comparable to the scale of the Mediterranean area, could hardly be else than light signals bringing messages of the Gods to the earthly mortals. Hence, understanding these messages was of great importance, and careful analysis of planetary motions through the constellations was a first task to that end. Regular patterns in these motions were discovered, and in a way this was the beginning of an analytical approach to planetary motions. Thus began a more modern kind of astronomy, which gradually reduced the significance of astrology, although it was a long process. Kepler still used to produce horoscopes; the one of the famous Bohemian general Albrecht Wallenstein (1583–1634) is well known. It seems, however, that Kepler was not really sure of the value of astrological predictions.

In the same way as physics was intertwined with magic in those days, chemistry was intertwined with alchemy. Bacon and even Newton still practised a form of alchemy.

As a manifestation of the breakthrough of rational thinking based on the experimental method, and in order to promote modern scientific methods against the strong conservative forces, the scientific academies emerged in western Europe. The Accademia dei Lincei in Italy, founded in 1603, was the first academy of the modern kind. The name lincei (lynxes) was well chosen and was meant to illustrate the militant character of the new body and its aggressive attitude to the still strong altarpieces of the past. Not much later, in 1617, the 'Nederduytsche Academie' (also called the Eerste Duytsche Academie) was founded in Amsterdam 'after the Italian example'. The revolutionary aim of this body was to teach in the national language (duytsch, *cf.* oldsaxon: thiudisk, Old German diutisc, which means the people or the people's), in contrast to Latin, which was until then the language of science. This humanistic and libertarian body met with much opposition from the Calvinist clergy, a powerful establishment in seventeenth century Holland:

Het quijl dat loopt hum uit zen mongt,
Zoo schelt hij d'Akademy,
[Slaver spills from his mouth,
As he abuses the Academy.]

one of the academy members wrote.

In 1662 the Royal Society was founded in London. Its aims, particularly the experimental base and the rejection of mysticism, were clearly defined; the Society was founded "to improve the knowledge of natural things, and all useful Arts, Manufactures, Mechanic practices, Engynes and Inventions by experiments – not meddling with divinity, metaphysics, moralls, politicks, grammar, rhetorick or logick".

In 1666 the Académie des Sciences was founded in Paris and many more followed. The 'Koninklijke Nederlandse Akademie van Wetenschappen' was only founded in 1808, after the unification of the Seven Provinces into the Kingdom of Holland.

The modern scientific method, as it has been established over the centuries, can be illustrated by the development of ideas on the planetary system and of celestial mechanics. The systematic observations of the planetary motions led the ancient Greeks, notably Ptolemaeus, to develop the geocentric system of planetary motions. The introduction of the heliocentric system by Copernicus was partly based on neo-platonic considerations, but although his theory still deals with epicycles, the new developments started by him can be seen as an application of Occam's razor, still one of the basic principles of the empirical method.

William of Ockham, the fourteenth-century English philosopher and theologian who died in 1349 (probably in the Great Plague) introduced the principle: "Non sunt multiplicanda entia praeter necessitatem", which means that things should not be multiplied beyond necessity. In still other words: if several explanations are proposed for an observed phenomenon, the simplest explanation, demanding the least number of hypotheses, is most likely to be the correct one.

Typical cases of not using Occam's razor are statements like the following:

“There are pyramids in central America. The natives there could not have invented pyramids independent of the Egyptians. This proves ancient Egyptians have travelled to Central America”. It is easier to think the natives were intelligent enough to develop fairly basic structures like a pyramid;

“Human beings are too dumb to do certain clever things. These could only have been done by extraterrestrials. This proves that extraterrestrials have visited Earth”. It is more likely that humans do possess a fair amount of intelligence;

“A contemporary Indian Saint, by the name of Sai Baba, is able to create material objects out of nothing, thus violating well-known physical conservation laws”. A simpler explanation is that Mr. Baba is a skilful magician.

After Copernicus a long struggle with facts was needed before the heliocentric system was generally accepted. For more than half a century Copernicus's system was hardly known. Johannes Kepler, using Tycho Brahe's magnificent observations, introduced elliptic planetary motion, but he still had to discover his three laws to describe the motions properly. At about the same time, Galilei's telescopic observations gave additional but indirect support to the heliocentric system through observations of Jupiter's satellites and the phases of Venus. The main significance of Galilei is, however, his work on the fundamentals of mechanics, and, in addition, that his action substantiated the fundamental question of who should decide what is true – the Church or scientists?

Further progress came when Kepler's three laws were reduced to one by Newton, who demonstrated that all celestial motions can be described by the law of universal gravitation – another obvious case of Occam's razor. The next step came with Einstein's further refinement, which explained certain hitherto unexplained aspects of celestial mechanics, that had come to light thanks to new and better observations.

This brings us to two of the great developments of our century: those of quantum mechanics and of relativity. With all their apparent paradoxes the ideas developed in the sciences of the very small and very large are often counter-intuitive. This is perhaps the reason why many authors of popular literature postulate that a change of paradigm (= a complex of generally accepted views) should have occurred in science with Bohr and Einstein. Also, many non-physicists have misconceptions about quantum mechanics, the most remarkable being the statement, sometimes heard (historical!) that “After Heisenberg it is clear that everything is uncertain in the surrounding world”, which is thereupon used to postulate the reality of certain paranormal phenomena! But both the layman and the more philosophically oriented person are in that case making the same mistake when they ignore the fact that these branches of physics obey exactly the same principles as those on which earlier scientific developments were based. To be specific, the new developments:

- are based on observational evidence;
- arose from classical physics and its laws, notably the conservation laws;
- are based on the assumption of isotropy (= being valid in the whole Universe).

Undoubtedly, the new 'laws' will, in turn, be changed or refined when more and better observations become available. Hence, there is no discontinuity in the scientific method and, while the new results may seem odd to laymen, they are forced upon us by the overwhelming evidence of a wealth of coherent and reproducible observations.

The preceding discussion illustrates the methods of modern science. The basis is empirical evidence, but the 'laws of nature' are not proofs in the mathematical sense. Any such law derived from the study of observations and cemented by theories can be no more than a transient step in the progress of science. "Conclusions, based, as they must be, on rational evidence can never be more than tentative" (Asimov 1986). Some scientists therefore say that there is only one certainty in the scientific process – the rational view. Or they say, with the Dutch writer Multatuli (1820–1887): "Nothing is certain, not even this statement".

2 EXTERNALLY IMPOSED LIMITS TO SCIENCE

Science is perhaps the most powerful tool developed by mankind to influence his destiny, but society is not always pleased with the results of scientific research. When these threaten to lead to harmful applications or to undermine established authority, it may happen that society or social groups wish to prevent them from being made public. Examples are available even to the present day.

Galilei is, of course, the classical example. When his ideas seemed to conflict with current religious views he had to abjure them in public. It seems absurd, but the inquisition had the power. This attitude is still encountered daily. In modern times Nazi authorities, sadly enough supported by a few prominent scientists, forbade the study and teaching of relativity, because it was 'Jewish science' and for not being 'völkisch' – indeed, relativity does not respond to common experience. Lysenko is another notorious example: he suggested, against evidence, that genetic properties might be lastingly acquired from the environment. By itself it is not wrong to make such a statement for in a way it is an aspect of Darwinism. But it was well known that the evolution of species takes a very long time – a rough estimate is 10000 yr for the origin of one new biological species. Lysenko stated that a few years were sufficient. But he postulated his ideas primarily because they were assumed to be in accord with dialectic materialism and he did not verify his claims in a scientifically rigorous way.

In my own country, where freedom of thought is assumed to be one of the fundamentals of society, a storm arose a few years ago when Buikhuizen in Groningen (and later in Leiden) wanted to study the biological basis of criminality. His opponents feared that his results might eventually support racial discrimination. This all finally led to a lamentable embargo on the continuation of his research. Just recently (1988), a nearly similar case arose, when Swaab, in the Netherlands Academy Institute for Brain Research, found some indications that homosexuality might be related to slight differences in the structure of the hypothalamus (a part of the brain that is involved in many human actions and sentiments). When this hypothesis appeared in the press the reactions were numerous; various opponents,

including a university professor, stated that such results should not be published because they would tend to isolate homosexuals in society. It was gratifying that in this case the research did go on when the initial turmoil had abated.

We see that scientific progress may be endangered by the resistance of established social groups, or even society as a whole, to ideas that seem to conflict with their current views or ideologies. The upheaval caused by the recent publication of S. Rushdie's book does not exactly fall in this category but it is a related phenomenon.

On the other hand, the horrible reminiscence of the kind of 'research' performed in Nazi concentration camps makes it clear that there is a very justified fear of intolerable scientific research. While this example remains an exception, there is a general fear of undesirable applications of scientific results. In this connection voices are sometimes heard advocating the prevention of nuclear research (because it produces atomic bombs and radioactive matter), or of DNA research and genetic engineering (because it may eventually allow mankind to control genetics), and more such examples could be given. The point that should be made here is that science can always be applied for the better or the worse. Society should not try to prevent research – in actual fact, society cannot if powerful groups are strongly interested in the research. Society should, however, develop systems to control the *applications* of science. This is a problem for society as a whole, but it is indispensable that in its practical realization politicians are supported strongly by science.

3 FRAUD IN SCIENCE

Scientists are human; they may err, like others. Sometimes they publish fraudulent results – unacceptable, but a sad truth. The usual picture of the honest and unimpeachable scientist is not correct in every case.

We have our little sins. Observed data are plotted and the result would show a number of points only slightly scattered about a nice straight line, were it not that two of the ten points are grossly deviating. The scientist then looks again at these two points; checks the observations and their processing and is finally pleased to see that either these two data points can be deleted because the observations were made in bad circumstances, or an error has been made in the discussion. There is nothing, in principle, against a corrective treatment if it is done honestly and if the same additional care is given to all other data points. Maybe points that still lie on the straight line would appear to be greatly deviating after such a correction! Still worse is the attitude of deleting points just because they are deviating. Rejecting undesired empirical data is called 'immunizing'. It is known that Mendel fiddled with his results, and Nobel prize winner Millikan, the first to determine the charge of the electron, immunized his data by deleting deviations; thus he got 'more consistent' data. In Millikan's case the results still happened to be correct; guided by the right intuition he appeared to have deleted the right data, but in how many unknown cases is the literature polluted with erroneous results because people wanted to present 'nice' data?

It is hard to state in all cases whether a result is really due to fraud. Blondlot's 'discovery', during the early part of this century, of the N-rays was certainly not. His finding was simply the result of his strong desire to confirm the existence of the rays whose presence he suspected from a first experiment. His co-workers did not want or dare to oppose him. Twenty papers on the N-rays had been written before the matter came out into the open. A similar situation may be at the root of the recent finding by Pons and Fleischmann who claimed to have discovered the secrets of nuclear fusion at room temperature. Intriguing as the results seemed to be, they prompted many laboratories to try to repeat the experiment in spite of the fact that there were so many inconsistencies in the communicated results that many specialists immediately expressed doubts. All experiments done elsewhere invariably yielded negative results. Most laboratories have now stopped their 'cold fusion' experiments.

Cyril Burt, from the study of twins that had been separated after their birth, concluded that intelligence is primarily determined genetically. Whether Burt was right or wrong, two of his 'co-authors' did not exist. Recently eleven papers written by scientists at Stanford University were officially withdrawn because the published results had been obtained fraudulently (Norman 1988). McBride (1988) describes a researcher found guilty of deliberately falsifying the results of an experiment. A recent case of fraud in geological science was disclosed by Talent (1989). We can refer to Maddox (1988) on fraud in a study of the regulation of the immune responses. More such instances are described in a few recent books, such as those by Broad & Wade (1983) and Kohn (1986). These saddening experiences naturally have led some people to consider ways of warranting integrity in the biomedical sciences (Culliton 1988a), as well as in general scientific practice (Shamoo 1988; Culliton 1988b).

4 PSEUDO-SCIENCE AND FRINGE SCIENCE

"Pseudoscience uses the scientific terminology but not the scientific criteria" is perhaps the simplest definition. There is "no well defined demarcation line between science and pseudo-science, but one of the features is the lack of an independent testable framework of theory, capable of supporting, connecting and explaining the claims" (Grove, 1986). In pseudo-science it is often hard to falsify a statement, which means it is difficult to prove it is not true. "The virtue of science as a system is that it can and does sort out its errors. Pseudoscience does not" (Gould, 1986). But more is needed to describe pseudo-science adequately. The 'seven sins of pseudo-science' were recently described by Derksen (1989). The three most important sins in his opinion are: speculation based on insufficient observational evidence; unfounded immunizing; unfounded abduction (abduction = drawing conclusions from coincidences; as a first step this is not wrong and is common practice in science).

Many cases of pseudo-science, bad science or non-science are around. The catastrophe theories of Velikovski and his followers try to explain certain properties and regularities of the planetary system by fantastic and

unfounded assumptions involving collisions of celestial bodies. The various recurrent hypotheses on Atlantis also fall into this category.

A large group of pseudo-scientific theories is based on the mistake of taking correlation for causation. An instructive example is: the levels of street illumination in many countries have increased since 1950 and so have the levels of criminality. A plot of criminality against the level of street illumination (for the USA, but the same would perhaps have been found for other countries too) shows a remarkably straight line with correlation coefficient of about 0.9. Does street illumination therefore create conditions for crime? And would crime subside as a result of switching off street lights?

Correlations between sunspot numbers and terrestrial phenomena are incredibly popular since a correlation was found, in the twenties of this century, between the water level in Lake Victoria and the sunspot number. The course of time sometimes cures such mistakes: continued observations showed that the correlation, in fact, does not exist. Sunspots have been correlated with the quality of harvests, of wine, of numbers of suicides, etc. A further example from the years '50-'60 is the so-called Piccardi tests, in which the behaviour of colloids in laboratory experiments seemed to be correlated with the sunspot number (Piccardi 1960). In all cases studied the correlation is weak or absent, while tests at different institutes yielded different results. The experiments are continuing, with improved techniques, but results remain meagre and although theories have been advanced, a satisfactory physico-chemical explanation for the correlations is still absent. If the period over which correlation is sought is short enough there is always correlation – positive or negative. But even if a perfect correlation were found over a long period of time, the case can be considered solved only when the causal relation is also found (see the example of the street illumination). This is what is lacking in most pseudo-scientific correlation analyses.

An example of pseudo-scientific reasoning is provided by the following account of an experiment performed in the Netherlands in the mid-fifties, of which I was an eye-witness. To check the reactions of a certain Mr A., interested in flying saucers, some of his friends filled a little children's balloon with gas and let it go. When it had acquired a height of some 25 m Mr A. was alerted. He observed the little roundish object, first with the naked eye, and thereafter with binoculars, until it gradually had disappeared into the blue sky. After that he first carefully measured the angle with the horizon at which it had disappeared. He then declared: "My first observations are these: (a) this is a material object; (b) it disappeared from Earth into space at an angle of 28 degrees with the horizon, hence the important conclusion: it did not disappear behind the horizon, and (c) it moved into a southern direction and no motor noise was heard".

Thereupon he inquired at the Meteorological Office about the wind direction at 5 km altitude. Being asked by others from what source he got the assumed height of 5 km, and not, say 20 m or 20 km he answered, that this was indeed a problem. But as a working hypothesis and no more than that he wanted to examine the consequences of this first assumption; when the consequences would fit into a coherent picture he would consider this assumption as correct. One of the reasons to begin trying 5 km was that he

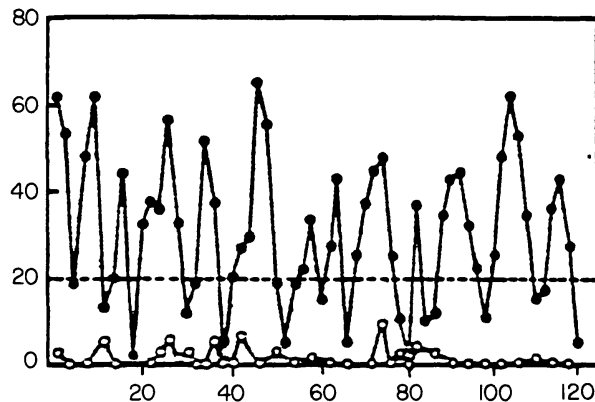


FIG. 2. Plot of the results of Benveniste's experiment. Ordinate: activity of the IgE molecule. Abscissa: log to the base 10 of the dilution.

had not heard any motor noise. Anyway, the Meteorological Office replied that at 5 km the wind was blowing north (opposite to the direction at ground level). Mr A. then concluded: "working hypothesis confirmed. I assumed 5 km because I could not hear any motor noise. The object was moving against wind direction. Hence it must have had a motor. And, since I did not hear it, it should indeed ..." etc. I describe this experience in so much detail because it has so many elements in common with 'well proven UFO reports' of the kind we see so often in newspapers and in UFO journals. But, how many of the 'working hypotheses' that appear in the scientific literature may have run into similar, or perhaps somewhat more complicated pitfalls?

5 DOUBTFUL SCIENCE AND NON-SCIENCE: HOMOEOPATHY

Much rumour was caused by a paper by Davenas *et al.* (1988) who showed that a certain biologically active substance kept its properties even when diluted to the fraction 10^{-120} . Fig. 2 shows how, as a function of the log to the base 10 of the dilution, the activity of the molecule does not decrease, but rather shows a kind of alternating behaviour. A critical examination (Maddox *et al.* 1988) of the way of experimenting, by a team consisting of John Maddox, editor of *Nature*, the scientist Walter W. Stewart and a famous magician (James Randi) experienced in debunking fraudulent scientific practice, failed to confirm the results and brought to light that the data were suspiciously lacking the statistically expected sampling errors. This case was not really one of fraud, certainly not by the leader of the group, Jaques Benveniste, who had already openly declared the results as 'absurd' and who had expressed his surprise that the results never appeared when the experiments were done by himself! He was, however, too careless in not checking the work of his co-workers who, apparently, assumed that if experimental results disagreed with expectation they might be wrong and had to be rejected. It was a case of immunizing the data. His results were used though to support the basic principle of homoeopathy.

Homoeopathic medicine is widely used in the Netherlands as well as in many other countries. Homoeopathy was introduced by Hahnemann

(1755–1843) who, somewhat in the line of ideas put forward by Hippocrates (fourth century BC) and Paracelsus (1493–1541), introduced the principle of curing an illness by letting the patient take a diluted extract of the substance that causes the illness: “*similia similibus curenter*” – like cures like. Homoeopathic drugs, if taken in large enough doses, would cause the illness, but in actual practice they are served to the patient in extreme dilutions. The procedure for producing these medicines is to dilute them (mostly in water) by a factor of 10 or 100 (these are called D1 and C1 respectively) and to repeat this procedure N times yielding dilutions DN and CN. Each time, the bottle containing the dissolvance is shaken. Shaking is said to be necessary to commute the properties of the dissolvance to the water. Dilutions of D30 or C30 (meaning 10^{-60}) are normal, and Benveniste (Davenas *et al.* 1988) even went up to D60, i.e. 10^{-120} .

Many non-physicists are unaware what these strong dilutions mean. The Earth’s oceans contain about 10^{46} molecules of water. This means that with a dilution of C60, 10^{74} oceans like those of the Earth would be needed to contain only one molecule of the original substance. Or: the mass of our Universe is estimated at about 10^{56} g. If completely composed of water it would contain 10^{78} molecules of water. Hence 10^{42} universes filled with water would be needed to contain one molecule of the original substance. In 1987, I presented this little calculation in a lecture at the Technical University Twente. A professor of Science Policy then smilingly counter-remarked: “That may be true, but you neglect the effects of shaking the bottle, during which the properties of the substance are communicated to the water”. He was not sensitive to my remark that the changed properties of the water had never been shown, not even by the most delicate spectrochemical analyses, and that exceedingly strong forces, more than those exercised in manual shaking, would be needed to overcome the associated intermolecular forces.

In spite of the fact that homoeopathic drugs are just water with an alleged memory, these drugs are very popular. This may be so because they are associated with adjectives like pure, natural, non-industrial. Indeed, the substance is pure enough: few things are purer than plain water. But there does exist a large and growing homoeopathic industry that makes large profits.

There are two reasons why these drugs help, in spite of the fact that they do not work. First, many of the usually reported common illnesses are fictitious; the patient wants attention and when this is given, in whatever way, he/she may already feel better. The other reason is that in many cases a placebo appears to work. The reasons are not yet fully clear but recent pharmacological research seems to indicate that a patient, believing in the physician and his treatment, produces endorphines, which act as a kind of drug, and thus have a healing or in any case some pain-relieving effect – but only for slight illnesses from which they might have recovered anyway. Recent research seems to show that acupuncture works in the same way.

6 ASTROLOGY

The second example that I want to discuss is astrology. The popular ‘natal effect’ – the relation between the sign of the Zodiac under which one is born and his/her character – has been checked variously by double-blind methods and is found not to exist, as could be expected (Carlson 1985; Dean *et al.* 1985).

The same applies to the forecasting value of horoscopes. In 1988 January I was confronted in a TV interview with the forecasts of Mr Gielis, perhaps the most renowned Dutch astrologer. Most of his various forecasts were of the usual style, and were nothing more than intelligent guesses, so well known from astrology predictions (such as an earthquake in South America, floods in Asia, and the death of a well-known politician – in that connection I forecast on another occasion that Khomeiny would die in 1988 or 1989 and I was right!). There was however one specific forecast: an aircraft crash on 1988 April 10. When asked for further details he added that the uncertainty in the astrological data yielded a spread of plus or minus ten days in the expected date. From the statistics of aircraft crashes in the months thereafter I learned that there is about one incident mentioned over TV or radio every three weeks. So, statistically, Gielis was right: there might be an aircraft crash in the 20 days around 10 April 1988. Actually, as statistics also teaches, there need not be one, and it so happened that there was no accident in the six weeks around that day. Neither did Gielis foresee the dramatic collision of two Italian military planes at an air show in Germany, 1988 late August, in which, in addition to the pilots, about 70 spectators were killed; nor did he forecast the tragic accident involving a US Boeing that crashed over Scotland, later that year. This all confirms current scientific ideas on the value of horoscopes and astrological predictions.

There is, however, one finding of birthday statistics that needs more attention. The French statisticians M. and F. Gauquelin (1955, 1979) investigated the positions of the planets at the moments of birth of eminent sportsmen. To that end the apparent orbit of a planet at any particular day is divided into 12 sectors, of which six equal sectors are above and six equal sectors below the horizon. The sectors below and above the horizon therefore usually do not have the same length. They took care only to include natural births, not those that were accelerated by medical operation. They found, from the study of a sample of 2088 sportsmen from France and Belgium, that more of them were born when Mars was in the first or fourth sectors after its rising above the horizon than one would expect experimentally. The difference was 3.7 per cent, which is statistically significant for such a large sample. In addition, they found some indications that the effect is stronger, the more eminent the sportsmen. But there are a few questions: first, Mars does not stay in each sector during the same period of time and how do non-sportsmen respond to the statistical analysis; and next: what are the criteria for selecting top sportsmen. The first problem could be cured by the suggestion of the statistician Marvin Zelen of working differentially, by making the same statistical analysis for non-sportsmen born at the same time and in the same region as the sportsmen examined: for the two kinds of

persons Mars has the same apparent orbit. A comparison of the number of births of the two categories should then yield more reliable results.

When Gauquelin applied this new procedure to his own material he again found a deviation that was statistically significant because, surprisingly enough, non-sportsmen did not show the 'Mars effect'. This result needs independent checking, which has since been carried out by various researchers. In the following I will only describe two of these checks. The first was an investigation by Kurtz, Zelen & Abell (1979a), who repeated the study for 408 US sportsmen, for which they found no significant result. An analysis of the same data by Rawlins (1979) who also included the other planets up to Saturn, as well as the Sun and the Moon, yielded a distribution of births over the 7 (celestial bodies) times 12 (sectors) = 84 bins that just fitted to a Gaussian with the expected sigma-value. Rawlins found that the distribution over the Mars sectors showed a maximum in sector 10, not in 1 and 4 as it should be according to Gauquelin. An immediate criticism of this study is that the Mars effect could never have been found from the data available to Rawlins because the number of data points per bin is too small and hence the resulting standard deviation too large to unveil the small effect found by the Gauquelins.

The result of Kurtz *et al.* (1979a) was thereupon attacked by Gauquelin (1979) who questioned the U.S. result on two counts: first, that only births from before 1950 should be included, because for these births it is more certain that they were natural births. The second remark is that the U.S. study did not deal with real top sportsmen, for instance there were basketball players in the U.S. sample. The following is a quotation from Gauquelin & Gauquelin (1979): "I recommended that basketball players not be included because they have given the most disappointing results in the European sample". The word 'disappointing' suggests that Gauquelin excluded unsuitable groups from his sample in order to get 'better' statistics. In my opinion this weakens the reliability of his results.

The remainder of the discussion (Gauquelin & Gauquelin 1979; Kurtz, Zelen & Abell 1979b) was a quarrel on the definition of top sportsmen that did not advance the solution of the problem. For me, this debate may still be classified as inconclusive. I will not describe the many heated discussions that took place during the few years thereafter, some of which were not at the required scientific level. However, important progress was made in a thorough statistical study by Ertel (1988) who investigated 4391 sportsmen, including the samples of the Gauquelins and of Kurtz *et al.* With this larger data set a finer subdivision of sectors appeared possible. Criteria were established to define in an objective way the degree of eminence of sportsmen: five classes were defined. The Zelen test was thoroughly applied. The result was that the Mars effect appeared clearly and beyond any reasonable doubt (Fig. 3). In addition the 'eminence effect', already suspected by Gauquelin (1955), came out clearly (Fig. 4).

To call this result surprising is perhaps an understatement. But one has to note that what has been found is a correlation. It should not be confused with a causal relation. It has not yet appeared possible to find an explanation for the Mars effect. It seems most difficult to assume that the position of Mars in the sky might have any effect whatsoever on the bodily qualities of newly-

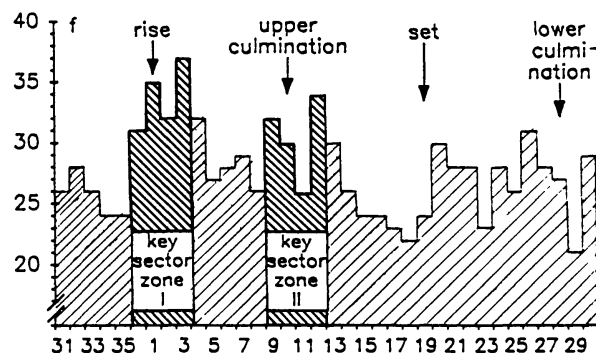


FIG. 3. The Mars effect from Ertel's (1988) study. The apparent Mars orbit is divided into 36 sectors. The zero point is at the rise of the planet. The sample contains 4391 sportsmen. There are significantly more sportsmen born when Mars is in its first sectors.

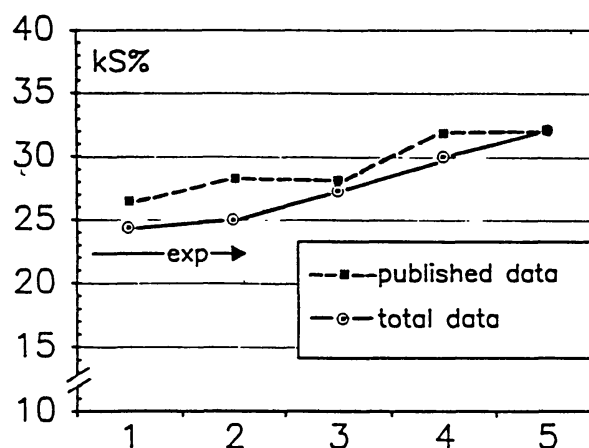


FIG. 4. The eminence effect. The higher the degree of eminence, the clearer the effect. The solid line refers to the total amount of data ($N = 4391$) studied by Ertel (1988); the dashed line is for data published earlier ($N = 2888$).

born children. I therefore suggest instead that a relation may be sought in the following direction: it is known that biological species have favourable periods of birth; individuals born outside the 'best' period have less chance of surviving. It may be that remnants of this effect do still exist in some way in *Homo sapiens* and that these show up most clearly in the bodily best developed subjects – the sportsmen. Such an effect may appear in the results in the observed way because the years of birth of the subjects investigated cover a finite number of Mars revolutions. That may give rise to spurious frequencies in what is essentially a Fourier analysis. Such frequencies could only be filtered out by studying births over a very long period, but those data are not available. It is clear that this remark can only be verified by a thorough analysis of the data set studied by Ertel. Until an explanation is found, a remarkable correlation remains.

7 A FEW CONCLUDING REMARKS

In this paper I have not dealt with the following paranormal phenomena *per se*: paragnosis, telekinesis, psychic surgery, spiritism, reincarnation. We can say about each of these curious and often interesting experiences: they invariably boil down to credulity and superstition; they tell of deceit or just pure misunderstanding or merely of the wish to be interesting. But in all those cases in which alleged paranormal phenomena have been really thoroughly examined, with tight scientific criteria, the result has been nil. "Parascience has so far failed to produce a single repeatable finding, and, until it does, will continue to be viewed as an incoherent collection of belief systems, steeped in fantasy, illusion and error" (Marks 1986).

The question may then be asked, why should one bother about the widely spread belief in paranormal phenomena, or dispute the value of pseudo-scientific studies? Why care about homoeopathy? If people are happy with their superstition, why not leave them in their quasi-religion?

One answer is that public mental health is indeed important, particularly when (e.g.) people suffering from real illness approach a quack, herb or witch doctor, rather than to go to a physician; or when they ask for the help of a psychic rather than thinking themselves. In The Netherlands the matter is presently being debated of whether costs of so-called alternative medical treatment should be included in the official health insurance regulations. It is of importance that it be generally realized that in this way the government would be financially supporting an illusion with money that could be better used for other purposes. One of the top civil servants in the Dutch Ministry for Welfare, Public Health and Culture (a Dr Z.) has connections with someone who Dr Z. claims is able to distinguish clean from filthy water in a paranormal way, even in a closed and opaque bottle. Teaching people to think clearly may be of general interest, particularly when the managers of society are involved.

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