of Frayn's repeated suggestion that the order of the physical Universe is largely a mental construction. The uncertainty principle never could have been reached by thought alone because it requires the concept of the quantum, which is absent from the classical understanding of position and velocity. The quantum was thrust upon the human mind at the beginning of the twentieth century by the need to explain experimental results, namely the observed black-body radiation from hot, dark containers.

Likewise, Frayn says that Einstein's theory of gravity would have remained unassailable even if its predictions had not been fulfilled, because it too was derived from first principles. The only conclusion of a negative experimental result, Frayn says, would have been that those principles were deemed not applicable to those particular situations. However, the equivalence principle, on which Einstein's general theory of relativity is based, could have been proven wrong by experiment, just as the concept of parity conservation was proven wrong in the 1950s and subsequently abandoned. First principles in science, no matter how beautiful and alluring, are eventually discarded if they repeatedly disagree with experimental results.

If Frayn is right that the logic and order of the external Universe are only products of the human mind, how can we separate the physical theories we conceive, such as quantum chromodynamics or the general theory of relativity, from ourselves, the conceivers? Don't the laws of nature, Frayn argues, simply reflect our human way of understanding? I don't think so. Suppose an intelligent civilization emerges somewhere in the Universe, produces scientists, conceives laws of nature describing such things as electricity and relativity, and then self-destructs. Before annihilation, the forward-thinking beings bury their physics books. Eons pass without any life forms in the universe. Then, ten billion years later, a new civilization emerges and develops its own equations for the laws of nature. One day, they accidentally uncover the physics books left behind by the previous society. They spend years deciphering the unfamiliar language but finally succeed, as modern humans did with the Rosetta Stone, and compare their theories of nature. What is the result? Every scientist I know would bet a roomful of pocket calculators that the separate descriptions of nature, composed billions of years apart, would have substantial agreement. The order and logic of nature, by whatever name you call it, seems to exist outside our heads.

If Frayn truly believes that the Universe has no logic beyond what we give it, then why does he repeatedly board aeroplanes for trans-Atlantic trips? Each time he flies, whether consciously or not, he is trusting his life to the logic and repeatability of nature, to the predicted relationships between air pressure, density, velocity, wing area and gravity.

I find Frayn to be at his most convincing when describing the ambiguities and complexities of the human mind and heart. Here, his experience as a novelist and playwright, his insights into human psychology, and his good sense serve him well.

"Like me, I know, you are an endlessly flowing and shifting river of perceptions and feelings, and ever-springing source of decisions and initiatives. How can I ever lay hold of this subjectiveness?… We are like fetishists, who simplify the objects of their desire by reducing the intolerably complex whole to a pair of shoes or a piece of underwear."

In the end, I was moved by this book not because of its science, or even its philosophy, but because of its poetry. *The Human Touch* is an extended ode to our humanity, to what it means to be a thinking being in this strange cosmos we find ourselves in. I was taken on a journey by a thoughtful companion. I was entertained. I was provoked. And I was left asking afresh some ancient questions. What is thinking? What is feeling? What is that intense sense of self that we have? What does it all mean? ■

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The beginning of wisdom

Is Pluto a Planet? A Historical Journey Through the Solar System
by David A. Weintraub
Princeton University Press: 2006. 248 pp. $27.95, £17.95

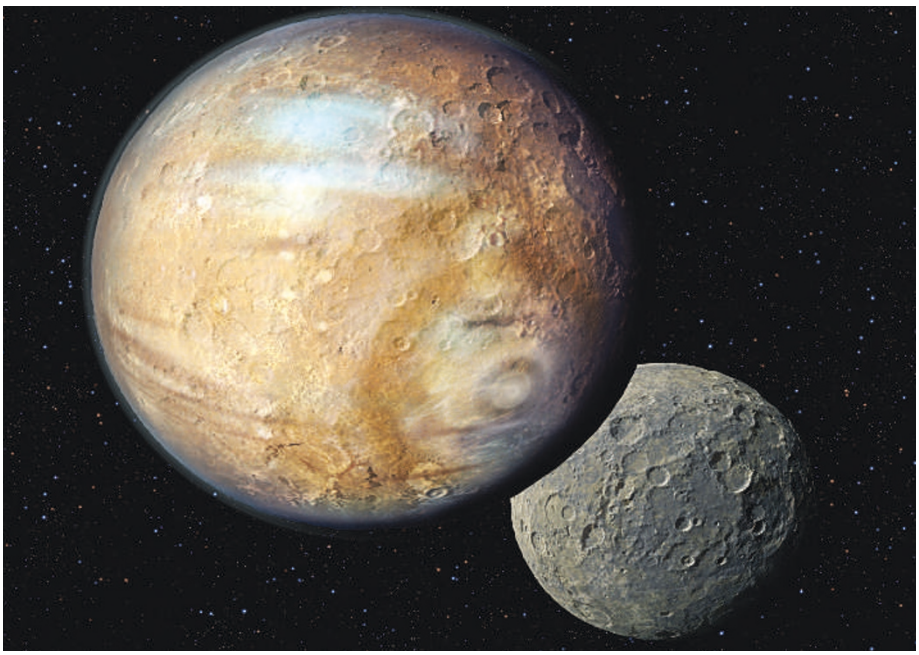
Stuart Ross Taylor

Pluto carries much the same sentimental, emotional and historical overload as Father Christmas. Even the name for this frozen dwarf, suggested in 1930 by 11-year-old Venetia Burney in Oxford, UK, is evocative, having mythological connections. And one of man's best friends appears as Disney's Pluto of the same vintage. It all makes for a heady cocktail.

Discovered by accident by Clyde Tombaugh, Pluto is a legacy of the obsession of Percival Lowell (he of the martian canals). It might otherwise not have been discovered for another 50 or 60 years, in which case the question of whether Pluto is a planet might never have arisen.

The discovery of Pluto's relatives, the trans-Neptunian objects (TNOs), or Kuiper Belt objects as they are also known, is reminiscent of the history of the asteroid belt. Ceres, located in 1801, was hailed as the missing planet between Mars and Jupiter that was long predicted by the Titius–Bode law. But its trivial size and the rapid discovery of Pallas, Juno and Vesta in the vicinity suggested that the true situation might be more complex. It was not until 1845 that other bodies were discovered, and better telescopes led to a deluge, relegating the four new planets to the status of minor planets or asteroids. As they did not display a common origin point, even the notion that they were remnants of a shattered planet vanished.

Why, then, did it take so long to discover the predicted swarm of TNOs beyond Neptune? Probably because Pluto has such an eccentric and inclined orbit that no one was dedicated enough, or had sufficient funding or energy, to repeat Tombaugh's arduous search technique. Although Pluto's moon, Charon, was found in



D. VAN RAVENSWAAY/SPL

After 76 years, astronomers still argue over the status of Pluto (represented here with its moon Charon).

1978, it took David Jewitt and Jane Luu until 1992, searching with modern instruments, to discover the next body in the Kuiper Belt — a classic case of finding a needle in a haystack. Now we are overwhelmed with TNOs.

The story is well told in *Is Pluto a Planet?* by David Weintraub, which provides a readable historical account of our knowledge of the Solar System and the concept of what has been considered to be a planet. Fashions have changed with time, and the number of planets has ranged from 6 to 24. Specialists will note that the author passes over the questionable acquisition by Johannes Kepler of Tycho Brahe's data, which Kepler himself admitted to "usurping". And Uranus was discovered after a careful search of the heavens by William Herschel, arguably not by accident, but it was probably inevitable. I also found no mention of Burney, who now forms part of the mythology.

A concluding appendix gives a useful discussion of the properties of Pluto and Charon, preceded by the views of various astronomers and planetary specialists on what should constitute a planet. As always, these reveal as much about the commentator as the problem. I found the most perceptive was from Brian Marsden: "It has rarely been scientifically useful to use the word [planet] without some qualification."

Towards the end of this interesting book, Weintraub surprisingly concludes, despite the close analogy between the discovery of the asteroid and Kuiper belts, that we should retain Pluto as a planet by using the three physical parameters of orbital characteristics, mass and roundness. Although he admits that "we know that Pluto earned its status as a planet by accident", this suggestion accords Pluto a kind of royal status. The application of his criteria leads him to a total of 24 planets. This number is bound to grow and the classification is too broad to be scientifically or even culturally useful. As *The New York Times* has remarked, "too many planets numbs the mind".

Trying to define a planet runs into the philosophical difficulty of attempting to classify any set of randomly assembled items. A bewildering array of objects formed in the early solar nebula, including dust, asteroids, Trojans, centaurs, comets, TNOs and our eight planets, ranging from tiny Mercury to mighty Jupiter. All differ from one another in some salient manner, as do the 160 satellites. The key question is how did they form and evolve, not what pigeonhole can they be forced into. So the decision of the International Astronomical Union that there are eight major planets and a host of minor planets seems an appropriate compromise. But even so, qualifying terms, such as ice giants and Earth-like planets, will always be needed. We need, then, to recall the wise words of Confucius: "The beginning of wisdom is to call things by their right names." ■

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The next pandemic

R. STEVENSON/AP/EMPICS

Is this your Christmas dinner? Farmed flocks of poultry could become infected with H5N1 flu.

Bird Flu: A Virus of Our Own Hatching
by Michael Greger
Lantern Books: 2006. 416 pp. $30, £21.99

John Oxford

I am often kicked around by American authors in books about influenza. How dare a Limey suggest that the Spanish influenza A H1N1 virus arose in a gas-infected, pig-ridden and bird-infected army camp of 100,000 people in France in 1916, when the whole world knows it started in Dorothy's home state, Kansas? But I felt less bruised than usual. Perhaps I am getting used to it.

Bird Flu by Michael Greger pulls and pushes the reader along, and every virologist under the Sun is thrown into the mix. We are projected back to pandemics in 1918, 1957 and 1968. But mostly the searchlight illuminates the current and worrying spread of H5N1, the recent theories of pathogenesis, mutation and spread. Greger covers the science rather well, and his descriptions of the polymerase chain reaction, innate immunity, cytokine storms and virus evolution are as clear as crystal. He also provides hundreds of references to burrow into.

But does the book really deliver on its title? It certainly goes to town on the subtitle, burning the bridges that link us to the great international avian reservoir. With the exception of virologists Graeme Laver and Robert Webster, we have only recently realized that influenza A is an avian virus securely seated in the 50 billion ducks, geese and swans that migrate across our planet. Periodically the virus makes the leap to infect humans. But not many of us stroke the feathers of a banded goose, so the virus first moves laterally to domesticated birds and then to their keepers.

The bridge leads to the industrialized chicken industry. I sympathize here. Unbeknown to the UK Department for Environment, Food and Rural Affairs, my wife keeps seven precious chickens at the bottom of the garden. Every autumn they are covered up to avoid the virus-spewing migratory geese who pass overhead. I have slowly cottoned on to why we pour grain into their hungry mouths. We don't like seeing chickens used as fodder, being scalded to death, chopped up alive or, worse, dying of H5N1. There can be no more unpleasant death than a neurological disease that kills a bird in 72 hours. The book is a hydrid, and the trick is to balance a scientific exposition about influenza with a cry from the heart about industrialized farming and how it demeans us. The author notes that "it may take a pandemic with a virus like H5N1 before the world realises the true cost of cheap chicken".

Greger is a clever writer. The book is a zinger, not deep like John Barry's *The Great Influenza* (Viking, 2004; see *Nature* **429,** 345; 2004), but more worldly, broader and more scientific. It is also more global in its approach than most US books, but I suppose it has to be as the United