

# NEURAL DETERMINISM AND THE METAPHYSICAL PERSON:

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**Abstract:** Modern neurobiology, indeed biology as a whole, is guided largely by a strictly deterministic view of causality and natural law, seen as applying at all times and all places without exception. This view of natural law was not held by the pioneer physicists in the early years after the scientific Renaissance, nor is it typical of twentieth century physics, although it did hold sway in physics during the nineteenth century. The determinism of modern biology is incompatible with the metaphysical concept of a person, which is fundamental to our lives as social beings. There are many parallels between the relation of physics to the concept of God, at the time of the Enlightenment and the relation of neuroscience to the concept of a person in modern times. If neurobiology were based on a view of causality deriving from twentieth rather than nineteenth century physics, the concept of a person could more readily be defended.

## 1. Synopsis

The main thrust of this article can be summarized in three propositions, plus a fourth one, which is the conclusion derived from the first three. These (not in the order in which they will be expounded below) are as follows: (i) As social animals, we have an absolute need for the concept of a 'person', who is, in some curious metaphysical sense, a free agent. (ii) The premises driving modern neurobiology (and indeed biology as a whole) in present times are fundamentally incompatible with such a concept of a person. (iii) This incompatibility arises largely because modern biology, and specifically neurobiology, rest on a view of causation and natural law deriving from nineteenth century physics. (iv) It would be easier to reconcile the metaphysical concept of a person (which is so necessary to us as social beings) with biological science, if biology could be founded on a view of causality and natural law more in tune with modern physics.

To expound this thesis I want to cover scientific history over the last two-and-a-half millennia, not once, but twice: The first account gives the usual (or 'authorized') version that is given of scientific history, from the time of the ancient Greeks to modern brain science. The second account is a radical revision of this history, pointing out some of the social pressures underlying the development of science, and pinpointing one or two key assumptions which crept in about two hundred years ago, almost unnoticed. This leads us to the nub of the present argument, that is, the situation at the end of the twentieth century when modern biology (and especially modern neurobiology) is implicitly abandoning a concept which is older and (arguably) far more fundamental to human existence than the scientific enterprise - the metaphysical concept of a person.

## 2. What is 'Why'?

As a teacher in anatomy, one is frequently asked questions beginning with the word 'why?'. For instance: 'Why do bone ends need to fit together so well in the hip joint?'; 'Why is cartilage lining the ends of bone able to survive without any blood vessels

running through it?'; 'Why are ellipsoid joints (such as the human wrist joint) unable to rotate, but can carry out all other movements?' In these three questions, the simple interrogative word 'why?' is posing three quite different sorts of question. The first of these questions asks for a 'purpose' (that is the goal or objective for which the hip joint is designed). The second question asks for a 'mechanism' (such as the adequacy of diffusion alone to supply necessary nutriment, for tissue types which have a very low metabolic rate). The third asks for a 'reason', that is, it asks what is logically inherent in the term 'ellipsoid'.

This source of confusion is such a common aspect of English usage that we may hardly notice it in everyday parlance. Similar confusion also appears to exist in other languages: The German interrogative 'Warum?' or the French 'Pourquoi?' are attended by the same ambiguity as is 'Why?' in English. However, as soon as the ambiguity is pointed out, it opens up a very large philosophical issue. This issue was fundamental to the rise of scientific thinking at the time of the Renaissance. It has been a live issue at many times in later years, especially in the rise of biology as a science. It is still a live issue in modern times, especially in neurobiology. In my view, this issue is one which is incapable of a definite answer, as provable fact, but rather is (and will always remain) a matter of faith or belief. What is this issue? It is about our concepts of causality.

### **3. History of Concepts of Causality: I. The Authorised Version.**

In the time of the ancient Greeks there were scientists, but science was very different from what it is now. In particular, 'time' as a definite scientific variable was rather ill-defined. Therefore, Greek science tended to be static, with its greatest triumphs in fields like hydrostatics, leverage, or the geometry of the Pythagorean school (Farrington, 1953, pp. 45-52). The concept of natural law - that is the principles of change over time, in the natural world - were scarcely recognized, except to some extent by occasional scholars in the 'atomist' school, such as Democritus (Russell, 1969, pp. 82-90). Instead, philosophers (and others) thought in terms of 'final causes'. In other words, things in the natural world behaved the way they did in order to fulfill some purpose or destiny intrinsic to them. Such an idea probably started in the biological realm rather than with inanimate matter, since living organisms, to the innocent observer, do seem to be intrinsically purposeful. The organic perspective of the 'final cause' concept was probably also influenced by the fact that Aristotle, one of its chief proponents, had a medical background. Bernal (1965, p. 202) gives as an example: 'It is in the nature of a bird to fly in the air . . . That, in fact, is what birds . . . are for'. The origin of the idea of final cause may also have resulted, in part, from philosophers looking inward at their own mental processes, in which could be discerned, at the subjective level, complex purposes, which, once conceived, could be given objective expression and realization by the subject's voluntary actions or speech.

By extension of thinking derived from biology and psychology, a similar interpretation in organic terms was imposed on the inanimate world. Thus, a heavy body falls towards the ground 'to rejoin its native earth' (Bernal, 1965, p. 202). Planets fulfill their destiny by moving in circular orbits (as proposed by Plato's disciples Eudoxus and Callippus), circular orbits being regarded as perfect shapes (Farrington, 1953, p. 98). Farrington (1953, pp 146-148) argues that the concept of final cause was applied to the inanimate world by analogy with the relation between the master and slave classes in ancient Greece. Inanimate matter, like the slaves, was inherently refractory and disorderly, and could only come to fulfill a definite end if an external 'masterly' Mind imposed its will.

For many centuries, any idea that there could be natural laws which generalized across the universe, rather than final causes intrinsic to each entity within it, was scarcely recognized. Further away yet, was the idea that purposeful behaviour observed in living

things could arise at a more fundamental level by the operation of mechanisms governed by such natural laws. (To give such an explanation, of course, is one of the pursuits of modern brain science.) Even further from the grasp of philosophers of those days was the idea that the subjective conception of purposeful enterprises in the minds of human beings, and their expression and realization as acts and speech, could be reduced to the operation of those same natural laws, which generalized across the universe.

We come to the Renaissance. Galileo (1564-1642), the pioneer of experimental method in natural philosophy, initiated this revolution by doing quite fundamental experiments, such as rolling metal balls down inclined planes, timing them, and thus studying empirically the acceleration due to gravity. This experiment required some technical ingenuity on the part of Galileo (Stillman Drake, 1990), since there were no accurate time-pieces in those days. Galileo was thus responsible, more than any other scientist, for introducing into science the idea that 'time' could be treated as a precise quantitative variable; and this was an essential step in the later development of the concept of natural law.

In the same era, astronomers, such as Tycho Brahe (1546-1601), had been collecting data about the movement of heavenly bodies (Thoren, 1990). Although Brahe had neither telescope nor accurate time-piece, he was the first to make systematic observations of planetary motion, over a period of many years. Since heavenly bodies moved more slowly in the sky than metal balls rolling down an inclined plane, relatively accurate timing could be achieved even without accurate time-pieces. He, and his calculator collaborator, Johannes Kepler, were able to show that the planetary orbits were not exact circles, although the discrepancies from circularity were quite small.

The culmination of this chapter of history came with Isaac Newton (1642-1727), in the late seventeenth century. By defining the concept of gravitational attraction, he managed to explain many things - the falling of apples from trees, the motion of pendulums, the steady acceleration of falling bodies previously analyzed by Galileo, the tides, and (of course) the movement of the planets. Newton had to invent a new form of mathematics - infinitesimal calculus - in order to achieve this. It was a stupendous achievement. It changed the way people thought about causality. It laid the foundation for all subsequent attempts to reveal other sorts of natural law, for the physical universe. It was the start of the replacement of the concept of 'final causes' by that of 'antecedent causes', that is causality as we usually understand the term today.

However, in his scheme of planetary motion, Newton was well aware of a number of facts, known empirically, which did not fit exactly the predictions of his gravitational theory. He was aware of certain discrepancies between the observed course of the planets, and their predicted course according to gravitational theory. He was particularly aware that the continual passage of comets through the solar system would gradually perturb the stable and regular circulation of the planets through the skies; and he was also concerned that the stable circulation of the planets was not possible unless they were set going 'at the start' with exactly the correct position, velocity and direction. In Newton's system, there was always the search for additional factors which could explain discrepancies:

'In experimental physics we are to look upon propositions collected by general induction from phenomena as accurately or very nearly true, notwithstanding any contrary hypothesis that may be imagined, till such time as other phenomena occur, by which they may be either made more accurate, or liable to exception' (*Principia Mathematica, Book III*, quoted in Heisenberg, 1955/62, p 118)

Nevertheless Newton could also conceive that all these problems were solved by the active intervention of God - usually referred to in Newton's writings as 'the divine arm' -

as in the following quotation:

‘The transverse impulse must be a just quantity; for if it be too big or too little, it will cause the earth to move in some other line. . . I do not know any power in nature which would cause this transverse motion without the divine arm.’ (Thayer, 1953, p. 52)

Many of Newton's appeals to the divine arm concern the initial conditions necessary to set the heavenly bodies in motion; but he also invokes the divine arm in the later history of the universe:

‘God made and governs the world invisibly . . . and by the same power with which he gave life at first to every living species of animals, he is able to revive the dead, and has revived Jesus Christ our Redeemer.’ (Thayer, 1953, p. 66)

Thus, in Newton's thinking there was a complex combination of natural law as we understand it today and pre-Renaissance reliance on the concept of a final cause (the concept of God - the divine arm - being of course pre-Renaissance, heavily dependent on the idea of final cause, giving purpose to the universe).

About one hundred years after Newton, in the late eighteenth century, the French mathematician, Simon Pierre de Laplace (1749-1827) re-examined Newton's planetary system, informed by more recent astronomical measurements and observations. His mathematical reasoning led him to the conclusion that the planetary orbits were self-stabilizing in the face of minor perturbations, such as those produced by the comets. One day, Monsieur Laplace was introduced to Napoleon Bonaparte, to whom he presented his recent book on planetary motion. The following account of the conversation was given by Rouse Ball:

‘Someone had told Napoleon that the book contained no mention of the name of God. Napoleon, who was fond of putting embarrassing questions, received it with the following remark: “M.Laplace, they tell me you have written this large book on the system of the universe and have never even mentioned its Creator.” Laplace, who, though the most supple of politicians, was as stiff as a martyr on every point of his philosophy, drew himself up and answered bluntly “Je n’aurais pas besoin de cet hypothese là”’ (Dampier, 1929).

Laplace's famous remark (‘I have no need of that hypothesis’) will be referred to later in the present paper.

How has the debate about the status of natural law fared since then? In 1846, the planetary system of Newton, as revised by Laplace, achieved a further notable success: Discrepancies from gravitational theory were seen in the orbit of the planet Uranus, from which it was possible to predict the existence and exact position of a new planet, which was soon found exactly as predicted, and was named Neptune (Dampier, 1929, pp. 193-194).

In addition, the nineteenth century was the time when biology as a science started to develop. One of the key issues was whether natural law as discovered in the physical sciences applied to living things. In earlier times there had been scientists who had explored whether fundamental physical principles applied to living things. One of these, Sanctorius (1561-1636) designed a large scale balance, on which he frequently ate, worked and slept, and could thus investigate the weight changes associated with everyday bodily functions. ‘After thirty years of continuous experimentation he found that the sum total of visible excreta was less than the amount of substance ingested’ (Britannica,

1974). He thus confirmed empirically the suggestion, made originally by Galen, that there was 'insensible perspiration'. Despite the efforts of such pioneers, in the nineteenth century, many people still preferred to believe that there be some special 'vital force' underlying the phenomenon of life. This is, of course, another manifestation of the pre-Renaissance concepts of 'final cause'. In the late eighteenth century, Lavoisier and Laplace had hinted that the Law of Conservation of Energy might apply to living things (although it was not until a century later that empirical demonstrations of this were published)(Klieber, 1944). In the early nineteenth century another important step was to show that the simple molecule urea, isolated from urine, was exactly the same substance as ammonium carbonate, recently synthesized by early chemists (Singer, 1959, p. 428). This was the start of organic chemistry.

Later in the century there was of course the enormous debate about evolution. One aspect of that debate was about the significance of 'design', so evident in the structure of living things. People with traditional religious beliefs thought that living things were so elegantly designed that there must be a Designer - otherwise known as God the Creator. Such arguments are still in wide currency today. Against this view Darwin proposed that the elegant design actually arose as a result of purposeless variation, combined with natural selection. Such variation was later defined as mutation, again assumed to be random and purposeless.

In the past, and at the present time, there have been many other areas where, implicitly, there is uncertainty about whether one should think in terms of final causes or antecedent causes. In brain research into higher nervous functions, there has been (and often still is) a tendency to lump together all the higher faculties which go to make up a 'person', as something which might be metaphysically different from the rest of the brain, and whose intrinsic mechanisms are therefore beyond investigation. This way of thinking tends to draw researcher's attention away from that mysterious central complex of functions which underlie personal wholeness. The main foci of such brain research which then remain are the sensory and motor functions. To avoid analyzing the mechanisms of the mysterious entity lying between the 'way in' and the 'way out', a number of forms of words have been used over the last hundred years, to refer to the 'ghost' in the machine. These serve to reify this entity, and at the same time hinder attempts at its scientific analysis. For instance, it may be called a 'homunculus'. Few neuroscientists would say that they really believe that there is a homunculus, but nevertheless the homunculus rears its shadowy head in other formulations of higher nervous functions. In the theory of attention and working memory it may be called a 'central executive' (Baddeley, 1986), or it may be confined to a limbo of uninvestigable processes by referring to it vaguely as 'cognitive' (Rosenbaum et al, 1997), or one may identify the functions of this ghostly entity as 'controlled' to distinguish it from other processes designated as 'automatic' (Shiffrin and Schneider, 1977). Indeed the older distinction between the somatic motor system (concerned with 'voluntary control' and the autonomic nervous system (concerned with 'automatic' control) has many of the same implications, and is generally discussed without reference to the thorny philosophical questions of the differences between 'automatic' and 'voluntary'. Whatever the nature of these mysterious central agents, it is implicit that they are inherently purposive. Use of such concepts holds researchers back from actually unraveling the mechanism of these central processes, although there is no real scientific reason why we should not tackle such questions as fascinating and fundamental research goals.

The dichotomy between final causes and antecedent causes also arises in common everyday attitudes to health. When I have a minor ailment, I sometimes consult a doctor, who usually prescribes something, and then I recover from the ailment. Sometimes I decide not to consult the doctor, believing 'it will get better anyway', and usually it does; but occasionally it does not, and I make a bad mistake. Underlying the initial decision

about whether to consult the doctor is a mixture of attitudes: on the one hand, blind faith in the body's powers of natural healing (that is, in the innate purposeful nature of the body), and on the other a belief that the body is a mechanism which can malfunction, and can then, in equally mechanistic fashion, be put right. The latter requires no belief in the innate purposefulness of the body, though it may require faith in innate purposefulness of the doctor!

The debate between final causes and biological mechanisms dependent upon antecedent causes arises with particular vividness in psychiatry. Sigmund Freud was a psychiatrist who was in vogue a generation ago, though not so much nowadays. In scientific terms there are many aspects of his approach to psychiatry which deserve strong questioning. Aside from this, one central part of his work was his advocacy of the concept of the 'unconscious mind'. According to Freud, many aspects of human behaviour and neurotic symptoms reflect the workings of the unconscious mind. This way of thinking assumes that there are entities within a person, of which the person has no explicit awareness, which, in a quite purposeful way, can control behaviour. For instance, in describing the 'sense' of a psychical process, he writes:

'We mean nothing other by it than the intention it serves and its position in a psychical continuity. In most of our researches we can replace "sense" by "intention" or "purpose"'. (Freud, 1917/1973, vol 1., p. 66)

Freud started his working life as a physiologist, and, in his early years was involved in the investigation of reflex action. However, he never tried to reduce the idea of unconscious motives to a similar biological mechanism. He explicitly rejected such an idea, in the following words:

'...psychoanalysis must keep itself free from any hypothesis that is alien to it, whether of an anatomical, chemical or physiological kind and must operate entirely with purely psychological auxiliary ideas.' (Freud, 1917/1973, vol 1., p. 45)

Thus, for Freud, in his later work, it seems that final causes took precedence over antecedent causes or biological mechanisms.

Quite apart from Freud's ideas, in some parts of the world it is widely believed that major mental illness arises from demon possession. This common attitude is probably less malevolent than some of the folk beliefs about mental illness which are currently entrenched in Western culture. However, it is another example of the use of the concept of final causes, quite similar in principle to the concepts of Freud. Understanding major mental illness in terms of *antecedent* causes is a topic with which scientists and psychiatrists around the world are struggling in the present generation.

#### **4. Reduction of Purposive Behaviour to Mechanisms Determined by Antecedent Causes.**

It is clear from the previous section that the debate between (or ambivalence about) final causes versus antecedent causes, though very old, is still with us today. However, there is a line of scientific thinking which greatly enlarges the reach of antecedent causes, and at the same time undermines attempts to retain beliefs based on final cause. This aspect shows that the apparently purposeful behaviour of some entities (living or non-living) can be explained quite rigorously in terms of an underlying mechanism.

Consider some simple negative-feedback control systems, or servo mechanisms. Probably the first engineering device which relied on negative feedback was the

'regulator' in steam engines. This consisted of a rotating spindle, to which was attached an arm, which could swing towards or away from the axis of the spindle. A weight was attached to the end of the arm. As the spindle rotated faster, the arm swung away from the spindle, and the weight was spun out further from the axis. This increased the angular inertia of the whole system, and thus slowed down the speed of rotation. This, then, was a self-stabilizing device controlling angular velocity. Overall, the position of the weight on the arm could determine the velocity at which the system would stabilize. Such devices were capable of quite precise control of angular velocity, and were in use in wind-up gramophones even into the 1950s.

In biology there are innumerable examples of negative feedback, including most reflexes, and a host of homeostatic mechanisms, which ensure the stability of the body's own 'internal environment'. As a broad generalization, one can view the stability of living things as the result of a complex set of interlocking negative feedback control systems, with, of course, some positive feedback processes, such as those involved in the generation of action potentials. Evolution by natural selection can also be regarded as a form of negative feedback, since it involves preservation of stable types and elimination of types unfitted to survive (but see comments on evolutionary theory in the final section of this paper). Reproduction on the other hand is a potential positive feedback process. Negative feedback systems *appear* overall to be purposive. However, clearly they are no more than a mechanism. Thus, purpose is reduced to a mechanism. Final causes give way to antecedent causes.

Let us also consider these issues in the context of learning, which will bring us into contact with contemporary research. In the 1890s E.L.Thorndike formulated, as a psychological principle, what he called the 'Law of Effect':

'Of the several responses made to the same situation, those which are accompanied by, or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that when it recurs, they will be more likely to occur' (Thorndike, 1898)

In one reading, this is little more than commonsense, providing a way of ensuring that favourable, purposeful patterns of behaviour are acquired by an animal, just as evolution proposes that favourable variants of animals survive and proliferate. However, the Law of Effect is a principle of learning, and therefore can be interpreted in terms of biological mechanisms as well as in psychological terms. In neuroscience, there has been a long-standing belief that learning is mediated by functional strengthening of selected synaptic connections. In 1949 Donald Hebb (Hebb, 1949) proposed a principle by which synapses could be selected for strengthening; and this principle has been the subject of very many experimental studies in the last 35 years, largely supporting Hebb's ideas. However, Hebb's proposal was not concerned with the sort of learning defined by E.L.Thorndike. I became aware of this in the 1970s, and in 1981 (Miller, 1981) put forward some proposals, basically modifications of Hebb's ideas, for the sort of synaptic modification which might be involved in the acquisition of purposeful behaviour, according to the Law of Effect. In recent years, Wickens and coworkers (Wickens et al, 1996) have investigated the biological basis of these ideas, and have given them empirical support.

Thus, those mysterious inner confines of the central nervous system, where is supposed to reside an inherently purposeful entity, the source of purposeful behaviour, is gradually coming within the scope of mechanistic science. Functions that might have been attributed to a homunculus, or some other entity which implicitly is metaphysically different from the brain, are now no longer metaphysically different, but are subsumed under the concept of natural law. Once again, final causes are yielding to antecedent causes.

## 5. The Authorized Version: Synopsis

Overall, one can sum up the history since the time of Galileo as a repeated pattern, that the concept of final cause has been gradually giving way, often very reluctantly, to the rise of scientific thinking, associated with the concepts of natural law and antecedent causes. Two quotations from the twentieth century sum up this view of scientific history. Bertrand Russell discusses the subject of causal necessity versus final cause as governing events in the natural world, in the following terms:

‘I do not see how it could be known in advance which of these two questions science ought to ask, or whether it ought to ask both. But experience has shown that the mechanistic question leads to scientific knowledge, while the teleological one does not. The atomists asked the mechanistic question, and gave a mechanistic answer. Their successors, until the Renaissance, were more interested in the teleological question, and thus led science up a blind alley.’ (Russell, 1969, pp. 84-85)

Jacques Monod, pioneer of molecular biology writes, with Gallic conciseness, along the same lines:

‘The cornerstone of the scientific method is the postulate that nature is objective . . . in other words the systematic denial that true knowledge can be reached by interpreting phenomena in terms of final causes - that is to say, of purpose’. (Monod, 1972, p. 30)

(Here Monod is contrasting the word ‘objective’ not with the word ‘subjective’, but with the word ‘projective’.)

Is this the last word to be said on this subject? Perhaps not. After all, history is generally written by the winners, and the philosophical perspective summarized in the above two quotations has definitely been in the ascendancy in recent times. By ‘winners’ and ‘in the ascendancy’ I mean that the view of causality described above has won the allegiance of most educated people in Western-style countries. This does not necessarily mean that this viewpoint has really won the argument. Therefore, in the next section, we retrace the history of science since the Renaissance from a different perspective, attempting to reconstruct a revised version of that history. This is, in part, a history of the relation between science and religion, especially in the time between Galileo and Laplace.

## 6. History of Concepts of Causality: II. A Revised Version.

It is well known that Galileo fell foul of the Catholic church in his day. As a result it is rather difficult to find what Galileo’s exact beliefs on religious questions were, as distinct from his views on the church as a powerful authority, although it is clear he was a devout believer.

Between the times of Galileo and Newton, the mathematician and philosopher Rene Descartes (1596-1650) lived and worked. He is best known for his phrase ‘*Cogito ergo sum*’ - (“I think therefore I am”). For Descartes, thinking was proof of his own existence, when every other statement could be doubted. As one who espoused dualism between mind and brain (as two separate substances, capable of causal interaction with one another), he regarded the processes of thought as something metaphysically quite different from mechanisms in the brain or the body. He simply could not conceive that

human thought was the product of a comprehensible mechanism.

Newton himself is widely regarded as the person who presented natural laws as a challenge to medieval ways of thinking based on final cause. However, as already explained, this was far from the case. Newton was also a deeply religious man, and the divine arm was incorporated into his system in many ways. At this time the radical split between science and religion had not yet taken place (at least in England). Newton considered that he was investigating God's design of the universe, and that included God's continual governance of the universe, if necessary in flagrant defiance of natural law, which, after all, God himself had created. Unlike Galileo, who worked at a time of religious warfare in Europe, Newton, though a Dissenter, managed to escape from the religious conflicts of his time, to work in relative freedom. After 1689, it was a time of relative religious tolerance. Newton actually belonged to a sect, nowadays known as the Unitarian church. This sect was rather free-thinking, and has attracted a number of scientists to its ranks, including (later) Joseph Priestley, discoverer of oxygen. The sect was however, rather heretical, in so far as it denied the doctrine of the Trinity. Such beliefs were not exactly tolerated, but were not actively suppressed in Cambridge in the late seventeenth century.

Seventy years after Newton's birth the Scottish philosopher David Hume (1711-1776) was born. He gave a lot of thought to the newly emerging concept of natural law. He pointed out that predictions derived from natural law could never have the force of a logical statement. For instance:

‘ ’Tis evident that Adam with all his science, would never have been able to demonstrate that the course of nature must continue uniformly the same, and that the future must be conformable to the past. . . This, therefore, is a point which can admit of no proof at all, and which we take for granted without any proof. . . ’Tis not therefore reason which is the guide of life, but custom. That alone determines the mind in all instances to suppose the future conformable to the past. However easy this step may seem, reason would never, to all eternity, be able to make it.’  
(Hume, 1740/1965)

Put more simply, the fact that the sun has risen in the east every day in one's experience, has, in purely logical terms, nothing to do at all with whether it will rise there tomorrow.

These developments took place in the British isles. On the continent of Europe things were different. Unlike Newton's times it was an environment of religious intolerance. In France in the eighteenth century Voltaire (1694-1778) was railing against the corrupt influence of the church. Voltaire seems not to have been very great as an original thinker, but he was very influential in popularizing recent British philosophy, as well as a newly-translated version of Newtonian physics. The translation by Émilie du Châtelet was faithful to the original, but, in due course, the view which came to be accepted (see below) was a distortion of Newton's own views. In this environment, a philosophy became prominent, espoused especially by Voltaire, and commonly known as deism.

According to ‘A Dictionary of Philosophy’, deism . . .

‘ . . . has appeared in various forms in various periods of history, but its best known manifestations are found in the thought of the 18th century Enlightenment, and especially, of Voltaire. It is usually taken to involve God's leaving the universe to its own lawful devices, without any particular interventions, once the process of creation had been completed. . . Deism is sometimes seen as exemplifying the vast confidence in reason of the post-Newtonian era; the human intellect, now at

last come of age, and aware of its own powers, no longer needs any assistance in demonstrating the existence of an originator of the whole scheme of things . . .'  
(Flew, 1984)

Thus, if God had any role at all, it was only at the time of Creation, and, after that, Newtonian physics was all that was required to keep things going for ever. So, Voltaire used Newton's name to advocate a simple-minded determinism which was actually very far from what Newton himself believed. This, then, was the time - almost 100 years after Newton - when the radical split between science and religion took root. This was the intellectual environment in which Laplace was able to make his provocative comments to Napoleon Bonaparte; and this was the era in which the seeds were sown for biological determinism as we know it today.

Laplace was influential just after the French revolution, which was set to change everything. People generally became more aware of historical change, and the idea of 'Progress' became more important. One could not object to 'Progress' any more than one could object to mother love or apple pie. As part of the same environment, scientists started to do something they had never had the confidence to do before: They made attempts to explain history. One of the earliest such attempts was in the work of Thomas Malthus, who, in 1796, tried to account for the rise and fall of human populations as a cyclical product of excessive reproduction on the one hand, and starvation on the other. Another prominent attempt was Marxism, which tried to account for development of human societies, largely in economic terms. This credo has been defended in the twentieth century by many people, who have regarded it as a science as rigorous as Newtonian physics. Two other theories in the same class are Darwinism, on which further comments will be offered below; and (in physics) the third law of thermodynamics (the law of increasing entropy), which is also, in part, a theory of universal history.

These historical theories went beyond Newtonian physics in a crucial, but little recognized way, which speaks of the supreme confidence scientists now had in natural law. In general these historical theories implied that natural laws applied not just in the here-and-now, in the scientist's laboratory, that tiny span of events which they could experience directly; they applied universally, at all places, and at all times. In other words, in contrast to what David Hume asserted, but in agreement with the deists, they assumed that natural law was valid far beyond the empirical evidence for it, and in fact had the force of rigorous logic behind it. Newton of course also believed that the laws of motion and the principle of gravity applied 'everywhere and always', but for him the assumption derived from theological reasoning, and, God willing, there could be exceptions. For the deists, it was part of a completely determinist, materialist world view.

As an example of this, take the Law of Increasing Entropy - the proposition that throughout history, and in all parts of the universe, disorder will inevitably increase. In empirical terms, this principle arose in the nineteenth century from small-scale experiments on heat engines, carried out by Carnod, Clausius and Joule. These were found never to be 100% efficient, and the departure from 100% efficiency was taken as an indication of the inevitable tendency to increasing disorder over time (Sharlin, 1979, pp. 112-115). In due course, such small-scale demonstrations were transformed into a principle applying throughout history and throughout the universe. Indeed the Law of Increasing Entropy is seen by some as the most important advance in physics in the nineteenth century. I recently asked a theoretical physicist 'What is the empirical evidence that this law applies on a universal scale?' After some puzzled looks, I received the response: 'Empirical evidence? But it is a mathematical law!' In other words, on a universal scale (if not in the laboratory) it is to be justified by the force of mathematical logic, not in empirical terms.

We reach the end of the nineteenth century in our revised version of scientific history. Physicists thought they had the universe more-or-less completely accounted for. All that was required was remorseless operation of neat causal laws, all completely objective and deterministic. Everything was reduced to processes analogous to the mechanical devices which the Victorian age produced in such profusion. As an example, take the following two quotations from Lord Kelvin (William Thomson), the Scottish physicist of 100 years ago:

‘All physical knowledge which could not be embodied in a mechanical model was meagre and unsatisfactory’ (Singer, 1959, p. 428)

‘It seems to be that the test of “Do we understand a particular point in physics?” is “Can we make a mechanical model of it?”’ (Thomson, 1910, p. 830)

Within a decade, at the start of the twentieth century, this confident view started to fall apart. On the level of large scale events Einstein’s theory of relativity showed that observation of mass, length and time are not objective, but depend on the velocity of the observer relative to what is observed. On the level of subatomic particles, the quantum theory of Neils Bohr and other physicists similarly showed the impossibility of true objectivity. Observation, in which the observer is uninfluenced by the process of observation is an idealization which holds in classical physics, but in the world of subatomic physics manifestly does not hold. Following such an insight came Heisenberg's Uncertainty Principle, based on the deduction that it is impossible simultaneously to have accurate knowledge of a particle’s position and momentum. These new perspectives also undermined the classical concept of causality. As Bohr put it ‘It should not be forgotten that the concept of causality underlines the very interpretation of each result of experiment’. However, if the act of observation, and the definition of objects as having precise positions and momentums are idealizations which manifestly do not hold in practice, the ‘claim of causality’ (Bohr’s phrase) can no longer be maintained. The view of Kelvin, that all events could be understood as analogies of the mechanical devices we see demonstrated on the everyday scale, seemed to emanate from a distant world. In particular, from Einstein, writing at the end of his life, we have the words:

‘As far as the propositions of mathematics relate to reality, they are not certain; and as far as they are certain they do not relate to reality’ (Einstein, 1954)

(The original German reads as follows: “Insofern sich Sätze der Mathematik auf die Wirklichkeit beziehen, sind sie nicht sicher, und insofern sie sicher sind, beziehen sie nicht auf die Wirklichkeit”)

So much for the idea that a principle such as the Law of Increasing Entropy, as it applies on the universal scale, can be justified as a mathematical law. In this quotation, Einstein is voicing exactly the same thought as David Hume, though expressed in the language of a theoretical physicist, rather than that of a philosopher.

## **7. Causality and Modern-Day Biology**

Let us now jump forward almost 100 years to the present time, when biology is the dominant science. There are many parallels with physics at the time of Kelvin. Contemporary biologists think they have everything to do with life neatly explained and unified. Natural law, as the deists conceived it, rules supreme, and is all we need. Neat mechanical models are in vogue - for genetics, cell biology, membrane biology, all very

similar in tone and underlying assumptions to Kelvin's statements quoted above. Molecular biology and molecular genetics present a highly deterministic view of living organisms. No elements of mystery seem to be left, even for human beings.

How about neurobiology? Neural determinism is of course in full swing at the cellular level. However, the key issue is whether the whole organism - somewhat equivalent to the 'person' in everyday parlance - can be given a deterministic account. Few people venture into this area, at least in Western science. They seem to actively avoid this issue, perhaps because it threatens the idea of the metaphysical freedom of the individual, which is part of the spirit of the contemporary world view, encompassing also their own freedom of enquiry. However, for researchers attempting to understand major mental illness (amongst whom I would like to be included) this issue cannot be dodged. A fully mechanistic account of the higher nervous functions of human beings, and the disorders of such functions seems to be a requisite, if we are to understand the causes of these major human problems. Although commonly avoided, such a mechanistic and deterministic account of the human person is clearly implicit in modern brain research. The first two steps of the argument go somewhat as follows:

(i) The behaviour of single nerve cells is currently being explained in increasing detail as an electrochemical machine, with ever more complete accounts of transmitters actions, ion channels and related intracellular messengers.

(ii) At a higher level, these same neurones become elements in a body of theory (which has increasing experimental support, albeit always indirect) showing how constellations of vast numbers of cells can function in a fully mechanistic fashion. This is cell assembly theory (Hebb, 1949; Braitenberg, 1978). At the same time, these constellations of nerve cells achieve the complex information processing which psychologists tell is performed by the brain.

As originally conceived, cell assembly theory was concerned mainly with the cerebral cortex, taken as a uniform network structure. However in more recent versions, this body of theory has been developed to account for interactions between the different cell layers within the cortex (Miller, 1996a), and has been extended to incorporate groups of neurones in other structures of the brain, such as the striatum (Miller and Wickens, 1991), the thalamus (Miller, 1996b) and the hippocampus (Miller, 1991). An account has also been given of how cell assemblies in right and left hemispheres in humans may function in different ways (Miller, 1996c). With these theoretical advances, the subtlety and complexity of the information represented by assemblies is vastly enhanced. It is becoming plausible to think of the overall unity of brain function (which we might be tempted to identify with the 'person') as a 'grand cell assembly' involving many regions and macrostructures of the brain in the span of its connectedness.

What about 'thought', which was the sticking point for Rene Descartes? A perspective has grown up during the present century, amongst both psychologists and neurologist, which identifies the strategies of information processing in our cognitive processes (that is our 'thoughts') as being formally similar to those also occurring in outwardly-displayed sensori-motor processing. Thus, in the work of Jean Piaget (Piaget and Inhelder, 1966) it was postulated that schemata for explicit sensori-motor processing, elaborated early in infancy, come to be developed at a later stage of psychological development into the hidden processes which we, as adults, are subjectively aware of as our 'thoughts'. Another strong reason for drawing the analogy between sensori-motor processing and thought comes from neurologists and neuroanatomists: Several of the major structures of the forebrain - including both the cortex and striatum - have one segment dealing with sensori-motor processing, and another equally large part dealing with cognitive operations. In each macrostructure, the different segments have similar, if

not identical, cellular architecture, and presumably accomplish similar computations, via similar mechanisms (Joel and Weiner, 1999). Sensori-motor processing, being actually observable, can be studied more easily than thought. However, the close analogies in cybernetics and cytology between the two suggest that the underlying mechanisms can be generalized between the two. If so, thought becomes a mechanical function, something that was not even dreamt of in the philosophy of Rene Descartes. So, the third step of our argument is:

(iii) Consequently, according to this line of argument, determinism applies to our highest functions and our most carefully-considered decisions.

## 8. The Concept of a Person

What becomes of the concept of a person in all this? For that matter, what is a person? In everyday parlance, this word 'person' is used in a totally confused manner. Sometimes we use the word to refer to an entity that is metaphysically free, purposeful, responsible, rational and moral. At other times, we are able to excuse the misdemeanors or crimes a person has committed by reference to mechanisms supposedly at work in the person. (These may be either environmental or hereditary; it matters little for the purposes of this argument.) Seldom, in analogous fashion, do we attempt to 'explain away' the highest of human achievements (artistic, scientific, or political). We would not dismiss the work of the latest Nobel laureate with the words: 'Well, he was not responsible for his actions, of course'. In such cases we prefer to cling to the view of a person as metaphysically free and responsible. When we think of a person in one of the above ways, and when in the other seems to be haphazard and undisciplined. Thus, where persons are concerned, we think in terms of an unruly mixture of pre-Renaissance final causes and post-Renaissance natural law, in a manner somewhat akin to Newton's mixture of natural law and the divine arm, though not with such explicit recognition of the fact.

However, consider some of the really important events in human life: We fall in love, we fill in our tax returns, we may be tried in a court of law, we teach and examine our students, we submit research papers, and may be asked to referee the papers of other researchers. In all these examples, persons in these important social interactions are assumed *not* to be biological machines, that is deterministic 'grand assemblies' of neurones, but to be in some sense metaphysically free agents. In most of our day-to-day interactions with other people, we certainly have an absolute need for this concept of a person. As the nineteenth unitarian century hymn writer F. L. Hosmer puts it:

Thought answereth alone to thought,  
And Soul with Soul hath kin  
The outward God he findeth not  
Who finds not God within.

We simply cannot live our lives without the metaphysical concept of a person. It is a concept far older than the scientific enterprise, and fundamental to any stable human society. Despite the vast impact of science on the lives of most people in the late twentieth century, the concept of a person may yet be more important, and enduring than science itself.

However, by teaching us that our higher functions are the product of a mechanism (rather than the person being metaphysically free) modern neuroscience appears implicitly to be undermining the concept of a person. Hence the final step of the argument is as follows:-

(iv) Descartes wrote ‘I think therefore I am’. However, if my thoughts are determined mechanistically by the dynamics of neuronal interactions, it might follow that ‘I, as a person do *not* exist’; what *really* exists is just those collections of neurones.

This syllogism derives the conclusion that ‘persons do not exist’ by using an erudite and abstract argument. However, many people who have suffered major mental illness have had the *direct experience* that their minds function in a mechanical fashion, and consequently have to some extent lost their sense of personhood. They may then never fully recover that sense of personhood. Frith (1987) has commented that such patients are the ones who are no longer deluded; and that for people without such experiences, the sense of freewill though normal is nevertheless a ‘normal delusion’. This of course begs the crucial question.

Laplace, on the basis of astronomical work which was contemporary in his day could say, with respect to God ‘I have no need of that hypothesis’. The arguments presented above are of exactly the same form as Laplace’s, using the concept of natural law (taken as having no possible exception) to challenge a pre-scientific concept of deep and personal significance to us all. Thus, on the basis of current neuroscience, we might be tempted also to say, about the concept of a person ‘I have no need of that hypothesis’.

One can therefore conclude that modern neurobiology is essentially dehumanizing; and implicitly, so is biology as a whole, because it shares the same assumptions. Perhaps, at the end of the twentieth century, debates about the existence of God are a bit old-fashioned, a trifle passé. However, we cannot shrug off so easily questions about whether or not persons exist.

## 9. How Do We Escape From An Absurd Conclusion?

How do we escape from this bleak conclusion? The argument I have presented above is of the form ‘*reductio ad absurdum*’. We start with certain premises, follow the argument wherever it leads, and it leads to absurdity. When this happens, we are challenged to re-examine the premises of the argument.

Remember the quotations from David Hume and Einstein (above). Determinism, the rule of natural law without exception, is neither provable nor disprovable. Neils Bohr regarded the events described by quantum mechanics as indeterministic even at the semantic level, in the sense that the very concept of ‘simultaneous knowledge of position and momentum’ cannot be defined. Thus, ‘discussion about an ultimate determinism or indeterminism of physical events’ is futile, according to Bohr.

Determinism is thus a faith, not espoused by Newton, nor by Einstein, and questioned by Hume. It has however been held very widely since the time just before the French revolution when deism flourished, and is held especially today by biologists, and those who develop so-called scientific theories of history. Where there is nothing empirically to choose between faiths, there might be alternative faiths. Decisions about whether or not the universe as a whole is purposeful is likewise an unanswerable question - either way a matter of one’s faith. It is not antiscientific to believe in a purposeful universe, nor is it necessary to science to believe (as does Jacques Monod) in a purposeless one.

If we as neuroscientists are to be able to defend the concept of a person, I believe that we should be able to relax a little the idea of the untrammelled rule of natural law. We should be able to allow exceptions. These need not be the large-scale exceptions which Newton attributed to the divine arm, and used to explain the known discrepancies from the predictions of his gravitational theory of planetary motion. In terms of modern physical theory, there is plenty of room within the realm of quantum theory for myriad

tiny departures from the infinitely-accurate causality required by the determinist creed. These could be empirically quite undetectable; nevertheless, they could tip the balance in critical and decisive ways, one way or another, at points of 'bifurcation' in the complex state-space of brain dynamics. The same statement could also be made about the critical points of bifurcation in evolution when new species form. Neither of these critical points of bifurcation can actually be examined empirically, as individual events. These then could be the tiny 'miracles' by which an inherently purposeful world, or inherently purposeful people could sometimes work out their destiny.

This may seem strange territory for most modern biologists; but it is actually by no means strange in contemporary physics. For instance, it has been noted that the exact quantitative values for certain fundamental physical constants represent some sort of carefully poised balance. Thus, if the ratio of mass of proton to electron were changed ever-so-slightly, atomic nuclei would not be stable. If the ratio of the universal constants describing gravitational attraction and electromagnetic forces were changed by as little as 1 part in  $10^{40}$ , stable, life-supporting solar systems could not exist (Davies, 1983).

How are these curious coincidences to be explained? Are they evidence of design in the universe?; or are they a reflection of the fact that the only possible universe in which intelligent observers could evolve to ponder the significance of these coincidences is one where the relative magnitude of fundamental physical constants is such that they do lead to a stable universe? Many physicists realize that these questions are unanswerable in terms of empirical evidence. There is no objective way to decide between the alternatives. Any choice which might be made is thus to a substantial degree a step of faith on our part, rather than one totally constrained by empirical evidence. Where there is no empirical basis whatsoever on which to make a decision, no-one can be criticized for making a decision which renders their lives more meaningful and livable.

This debate is actually very similar in form to that which took place in the nineteenth century concerning the significance of design, for instance in the morphology of living things. Did it reflect the operations of a Grand Designer? or was it the product of random mutation and natural selection? Although it is unpopular to suggest it in present times, in biology (as in physics) this question appears to be unanswerable. Any answer we might offer is based as much on faith as on evidence.

The concept of randomness is of critical importance in the biological debate, where variance in any measurement is vastly greater than in most situations in physics. As an illustration of this, consider the thinking of a traffic-flow engineer: In working out the best way to control peak rush-hour traffic flow, he probably has a working model in which traffic flow along various thoroughfares has various probabilities, the direction taken by any one vehicle being assumed to be random, given these probabilities. However, from a different perspective the direction of each vehicle is far from random, but is highly purposeful: The drivers of most of these vehicles are actually going home for an evening meal. The point of this example is that randomness is a necessary assumption in certain models; but with no model to bias our thinking, it is actually impossible to prove that any set of events is truly random in an absolute sense. Nevertheless, models which assume randomness are employed almost universally in biology. They are an essential component of the framework for evolutionary theory. The concept of randomness is also used in most statistical treatments of results. When there is significant variance across subjects, biologists are much more interested in the values of mean and variance than in individual values. However, the individual values may represent processes that are quite different from those controlling the mean values (as in the example of traffic flow at rush-hour). They could even be metaphysically different, the expression of purpose in the universe, rather than assumed randomness. A similar argument has been developed by McKay (1978a), although his emphasis was on defending the concept of Divine Providence, rather than that of the metaphysical person.

If biologists were able to relax a little the commonly-held idea of unmitigated rule of natural law, there would be some significant changes in the way we view biology. Explanatory arguments starting from the molecular level and leading up to the molar level might become non-sequiturs. Remember that there are  $10^{23}$  molecules in a mole, and millions of possible interactions for each molecule in each second (for instance, in a fluid environment). Who can say that there is no single exception to causal laws when the number of interactions is as large as that? Who can say that such exceptions, if and when they occur, are random in an absolute sense? This argument has direct relevance to interpretations of human behaviour in terms of psychiatric genetics.

In addition, arguments starting with events in the here-and-now, or the experimenter's own laboratory, and extending to all remote spans of historical time, and throughout the universe may also become non-sequiturs. As a result, historical theories become questionable. These include not only the theories of Freud and Marx (which have now mainly been discarded), but also Darwin's theory, and the Law of Increasing Entropy, as these theories might apply on a universal scale. In some of these historical theories, there is of course considerable evidence on the small scale for the causal processes invoked; but the extension from this scale to the universal scale appears to be a non-sequitur. It is also worth pointing out that none of these historical theories is validated by technological spin-off, as occurred in other areas, such as the discovery of electricity, or the structure of atomic nuclei. Their real impact has been at an entirely different level, namely the way in which we, as human beings, view our own situation in the universe. This perhaps gives the game away: These historical theories are not true scientific theories at all, but aspects of faith, appropriate to the spirit of their times, but actually not at all objective.

The words of Werner Heisenberg (1955/62, p. 180), written in 1955, are very apt at the conclusion of this section:

‘Modern science, in its beginnings, was characterized by a conscious modesty; it made statements about strictly limited relations that are only valid within the framework of these limitations. This modesty was largely lost during the nineteenth century. Physical knowledge was considered to make assertions about nature as a whole. Physics wished to turn philosopher, and the demand was voiced from many quarters that all true philosophers must be scientific. Today physics is undergoing a basic change, the most characteristic trait of which is a return to its original self-limitation. The philosophic content of science is only preserved if science is conscious of its limits.’

Perhaps a basic change is also needed in biology, similar in some ways to that which overran physics earlier in the twentieth century. This might be spearheaded by systems neuroscientists, because they are closest to the interface between neural mechanisms and the concept of the metaphysical person. If this does happen, it is perhaps preferable that the necessary changes be led by scientists themselves, rather than by others. It could be led by public pressure, since large sections of the public also have a growing skepticism of trends in modern biology, in many areas, ranging from psychopharmacology, to genetic engineering. However, if public pressure comes to lead such a revolution, we might not have such an intelligently thought-out solution.

## **10. Concluding Comments:**

The idea of indeterminacy at the quantum level has been used by other neuroscientists as a part of their philosophical arguments. D.M. McKay (1978b) did so in a manner very similar to its use in the present article, except that this idea was used in defense of the idea of Divine Providence, rather than the inherent purposefulness of persons. Neither

McKay's view, nor the view advocated here requires a wholesale retreat to the version of final causes adopted by Aristotle (which, when employed in quite undisciplined fashion, held up scientific progress for many centuries). Even in the times of the ancient Greeks there were philosophers who sought a compromise between this view and the idea of natural law as we know it today (for example, Theophrastus, a contemporary of Aristotle (Farrington, 1953, p. 159-169). Obviously on the large scale, and even on the scale of cellular processes, such as the biophysics of nerve cells, natural law can hold with considerable precision. However, at the quantum level, we cannot exclude the possibility that there be totally different and inscrutable determinants of natural processes, which permit a component of purposefulness to be combined with the overall rule of natural law; and this can in turn influence macroscopic events, albeit ever-so-slightly.

One point of clarification is needed here, which touches on another area of philosophical debate, the relationship of 'mind' to the physical brain. Thirty years ago, this issue was hotly debated by brain scientist (Bunge, 1977; MacKay, 1978b; Sperry, 1980) following the publication of Popper and Eccles' book '*The self and its brain*' (Popper and Eccles, 1977). The present author's philosophical position with respect to 'mind' is one of psychophysical parallelism, rather than the interactionist dualism of Popper and Eccles. However, as argued elsewhere (Miller, 1995) there is nothing incompatible between this parallelist view of mind, and the quite relentless operation of natural law in the brain. Thus, in principle, such a view of the relation between mind and brain is entirely compatible with strict determinism. However parallelism does not *require* absolute determinism. It could admit the modest relaxation of strict determinism advocated in the preceding paragraph.

The emphasis of this paper is however mainly on the philosophy of causality and natural law. The aspect of neural determinism discussed above is one which has its theoretical derivation from concepts of natural law as they apply in science more generally, and particularly in the core discipline for the scientific enterprise, namely physics. As such, the focus is on 'determinism in principle', rather than 'in practice'. Brain science cannot now predict (and probably never will be able to predict) the exact form of human behaviour in practice. Nonetheless, although the article has been about 'determinism in principle' the shift of emphasis from theory of mind to the concept of causality may have brought to light some issues which have a sharp bite in practice: Our views about the principle of determinism as it applies to people (even if *only* 'in principle') colour all our social interactions, and this is a practical matter.

In developing the argument here, it has also been necessary to venture into the territory of the 'myths' (the word being used without pejorative intentions), which are needed for a viable human society. Central to these is the myth of a 'person'. An argument has been presented (for reasons which go way beyond science) that in areas where there is absolutely no empirical data to prove whether or not determinism operates in infinite and relentless detail, we should adopt a version of causality which allows us to preserve this vital concept, not as final truth, but as a necessary and defensible myth.

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