Who's Afraid of Determinism?

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Abstract
Because of the idealizations involved in the ideas of a total state of the world and of all the laws of nature, the thesis of all-encompassing determinism is unverifiable. Our everyday non-scientific talk of causation does not imply determinism; nor is it needed for the Kantian argument for a general causal framework as a condition for experience of an objective world. Determinism is at best a regulative ideal for science, something to be approached but never reached.

1. The status of determinism

Determinism is standardly understood as the thesis that the laws of nature together with the state of the world at any particular time necessitate the state of the world that must come next. Since the same applies to every future instant, the whole subsequent history of the universe would be predetermined. In the early nineteenth century the French mathematician Laplace expressed this metaphysical claim in epistemological form: if a super-intelligence or demon knew the total state of the universe at a given time and all the laws of nature, then the demon (or these days, a super-computer) could do the calculations and predict every state of the world with mathematical certainty. (Legend has it that when the Emperor Napoleon asked him where God came in, Laplace replied 'Sire, I have no need of that hypothesis'.) Indeterminism is the negation of determinism – that there is at least *one* case in which the future is *not* necessitated by the present.

Over the last few centuries it has seemed to many people intellectually *compulsory* to believe in determinism, in light of the impressive progress of science and our continuing commitment to scientific method. Admittedly, the advent of quantum mechanics has shaken belief in universal determinism at all levels of nature, but the theory of chance events at the sub-atomic level has not done much to stop a widespread fear that determinism may still apply at the level of human behaviour. Yet the possibility cannot be ignored that random micro-events may result in some degree of indeterminism at the macro-level, as illustrated by the notorious thought-experiment

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of Schrödinger's cat, and (so I am told) by recent developments in quantum computing and cryptography. And there is a long-standing argument that even if there should be some indeterminism in the brain, that would not amount to free will, which surely involves some connection (which need not however be *determination*) between a person's decisions and the reasons for them in her thoughts, desires and feelings. A 'choice' that is determined by a sub-atomic chance event hardly seems like a choice at all. Indeterminism might be a necessary condition of free will (though that has long been denied by compatibilists), but it is certainly not a sufficient condition. Thus philosophers have continued to debate the implications for free will *if* determinism is true, and to exercise their conceptual ingenuity on a variety of subtle positions about the compatibility or incompatibility of free will with determinism. This debate is predicated on a widespread assumption that determinism is a coherently-statable, extremely general, yet ultimately empirical claim about the overall character of our universe – and that science has provided strong evidence for its truth at any level above the atomic.

However I am going to argue that there are several fundamental difficulties in this apparently easily-stated but ambitiously world-encompassing conception. Even before we get to physical science, there is a purely mathematical obstacle in the way of a Laplacean demon or computer. Most of us, knowing little science (perhaps only the school textbook statements of Newton's laws of motion) tend to assume that the calculations can be straightforwardly performed. But that is to betray ignorance of the complexity of the mathematics that is involved. Even in the long-standing paradigm case of gravitation, whose mathematics is elementary by today's standards, there lies a problem. Newton's Second Law of Motion says that acceleration of a body, i.e. the double derivative of distance with respect to time, is equal to the force acting on it divided by its mass. So to know its velocity at any time we have to integrate the differential equation; and to predict its position we have to integrate again. If there were only two bodies in the universe, then given their masses and their relative distance we can readily calculate the gravitational force acting between them and thus their acceleration towards each other, and hence their velocities and positions at subsequent times after their initial positions and motions. If however we imagine *three* masses isolated from all other forces, the derivation of predictions about their relative motions and positions poses the classic 'three body problem' that is apparently still unsolved in principle, though there are methods of making approximate predictions for practical purposes (so that we were able to send men to the moon and back).

The moral of the story is that even in that very simple artificially isolated case, although we *believe* that the future states of the system are completely determined by the laws and its initial state, neither our best mathematicians nor our most powerful computers can derive predictions with *absolute* precision.

Recent developments in the mathematics of so-called 'chaotic' or nonlinear systems show that for some equations the predictions that can be computed from initial states can vary dramatically, depending on very small differences in the initial states (as in the 'butterfly-wing effect' on the weather on the other side of the world). 'Chaotic' is not really the best label for these systems, for the output values remain mathematically determined by the input values, it is just that tiny differences in the inputs can make huge differences to the outputs. This means that in practice, given that all of our actual measurements have limits of accuracy, some of our predictions are liable to large errors for complex systems such as the worldwide weather, and that most complex system in the universe, the human brain. But the point is also instantiated in simpler systems that we use to generate 'random' outcomes, such as tossing a coin, or dropping a ball to bounce down through an array of pins, or the more elaborate randomizing devices now used in national lotteries; in these cases, a human action starts a physical process whose result cannot be predicted. It is not just that we lack the technology to make sufficiently precise measurements of the relevant variables, those systems are designed to have so much multiplication of tiny differences that no measurement could ever make realistic predictions of outcomes. We here get indeterminateness arising from the limits of measurement, even where Newtonian mechanics is assumed to apply.[1]

That is the first difficulty in the Laplacean picture. Next I want to point out how much idealization is involved in the notion of the *total state of the universe* at any one time. There is no prospect of anyone (or any computer) ever *knowing* such a total state of this world, including the size and shape and fall of every leaf, the motion of every molecule in the air, the exact mixing of genes in every act of reproduction, the firing of every neurone in animal and human brains – let alone what happens on other planets and in the nuclear innards of billions of

[1] As Elizabeth Anscombe noted in her inaugural lecture 'Causality and Determination' (Cambridge: Cambridge University Press, 1971), reprinted in E. Sosa (ed.) *Causality and Conditionals* (Oxford: Oxford University Press, 1975). The point has also been made by the distinguished mathematician Roger Penrose, in *The Emperor's New Mind* (Oxford: Oxford University Press, 1989), 224–5, 559.

stars. Some philosophers are not impressed by mere epistemological difficulty however, and will insist that this does not disprove the *metaphysical* thesis that there *exists* a total state of the universe at each moment.[2]

Peter van Inwagen has provided one of the most careful formulations of metaphysical determinism.[3] He expresses it in terms of *propositions*, which makes it sound language-relative, but propositions as he defines them correspond to 'possible ways the word could be', and those 'ways' can outrun what can be expressed in any particular natural language. Thus his definition of determinism has as its first clause: 'For every instant of time, there is a proposition that expresses the state of the world at that instant'. Some philosophical hearts (including mine) will quail at the thought of a monstrously large proposition that expresses every instantaneous detail of the entire universe, but metaphysicians are made of stronger stuff and remain confident that their armchair formulations can encompass the whole of reality. It does not help if we try to think an enormous (perhaps infinite) number of propositions, each of which corresponds to a way that some determinate *part* of the world can be; for the conjunction of any set of propositions is itself a proposition, so if you are prepared to recognize some such complete set of smaller propositions, you can get the One great World-encompassing Proposition for free. The underlying intuition is robustly, indeed extremely, Realist: namely, that at any time there is such a thing – or fact, or state of affairs, or truth – as the way the whole world is, including every detail of everything. And the Metaphysical or Ontological definition of determinism is that, given the Laws of Nature, each complete instantaneous state of the world determines the state of the world at any other time (or at least, at any future time).[4]

However I am going to argue that universal determinism is not an empirical thesis at all, but rather an *idea* or *ideal* in Kant's sense. In support, I cite Nancy Cartwright (who knows vastly more science and philosophy of science than I ever will) who describes universal

[2] See John Earman, *A Primer of Determinism* (Dordrecht: Reidel, 1986), II.3–4.

[3] Peter van Inwagen, *An Essay on Free Will* (Oxford: Oxford University Press, 1983) Ch.3, reprinted in *Free Will*, 2nd edition, ed. Gary Watson (Oxford: Oxford University Press, 2003).

[4] At first sight it seems possible that the same total world-state could come about from two *different* preceding states – but I do not need to decide that question here. Earman offers an equivalent definition in terms of time-slices of all physically possible worlds, i.e. possible worlds that satisfy the laws of nature that hold in our actual world, op. cit. note 2, II.6.

determinism as a 'pseudo-rationalist idea',[5] and Robert Bishop, who says 'our best physical theories are terribly ambiguous regarding the status of physical determinism'.[6] But note that I am not taking the logical positivist hard line that the idea of determinism is cognitively meaningless – for it is an idea that we quite easily form and understand – but rather that we arrive at it by a process of abstraction or idealisation from the empirical realities that we actually deal with.[7] It can never be directly applicable to them, though it can serve as an ideal to be approached but never actually reached. As we have seen, the definition of determinism requires the conception of a total state-description of the universe at any one time. That contains two idealizations – to the ideal of describing *all* the states, and of describing *each particular state exactly as it is*. And there is a third idealization, to the idea of a complete set of laws of nature.

Let me first address the ideal of exact description. This surely implies measurement, for although there are plenty of everyday descriptions which do not involve numbers (e.g. 'purple', 'noisy', 'fragrant, 'annoying', 'celebrity', 'sexy'), most serious science involves assigning numerical values to empirical quantities, using instruments of various degrees of sophistication, from rulers and thermometers up to the likes of electron microscopes and Geiger counters. But how precise can measurement be? Technology is constantly improving, we are constantly told, but even the most skilled operator of the most up-to-date piece of kit has to admit, if pressed, that her observations are accurate only within a certain margin of error. The realist metaphysician may say in his lofty way that this is only a matter of gross human senses and gadgets, and that there remains a distinction between physical reality and our approximate measurements of it. His claim would presumably be that there is in principle an absolutely precise answer for every question of measurement, and he will have to allow that the numerical values will typically go into decimal points. But how far into that infinite range? There is no *theoretical* limit, so the conceivable answers stretch into the rational numbers, and perhaps the reals.

Realist-minded philosophers may still want to say that these practical limits on our knowledge of the present and predictions of the

[5] Nancy Cartwright, *The Dappled World* (Cambridge: Cambridge University Press, 1999), 6.

[6] Robert Bishop, Chapter 4 of *The Oxford Handbook of Free will*, 2nd edition, ed. Robert Kane (Oxford: Oxford University Press, 2011), 94.

[7] See the index references to abstraction and idealization in Cartwright, *How the Laws of Physics Lie* (Oxford: Oxford University Press, 1983).

future do not affect the underlying facts about how reality is 'in itself'. Some may say that for all we know, the world *may* be completely determinate in all respects; others may stoutly maintain that it *must* be so. On the other hand, Michael Dummett (who developed the notion of 'anti-realism') has described the assumption that every measurable quantity must have a precise value given by a real number as 'a realist fantasy which, though deeply embedded in our thinking, must be rejected'.[8] If so, it is a nice irony that realism, which is supposed to be in the business of acknowledging reality as it is, may become fantastic, i.e. out of touch with reality.[9] But there are at least two kinds of dissociation between thought and reality: we may *unde*restimate what there is, or we may *over*estimate it. (The thesis that a certain 'transcendental' kind of realism involves deep philosophical error is central to the thought of Kant, but we have yet to see if that has any relevance to our topic.) Dummett is bold enough to suggest that reality itself may be in certain respects indeterminate – and he was not thinking of causally undetermined events, but of intelligible questions to which there is no true or false answer.

I do not know any way of resolving this standoff between realist and anti-realist over exact measurement. The realist claim can hardly be classed as meaningless, for it seems intelligible (and philosophers' attempts to draw sharp limits around the meaningful do not have a promising track-record). The anti-realist will point out that the realist's claim can never be confirmed or disconfirmed by experience, but the realist will not be fazed by that, for it was part of his view from the start that the truth on some matters may forever outrun empirical test. Perhaps the best the anti-realist can do is to show that the idea of *absolutely* precise measurement plays no essential role in our actual dealing with the world, not even in the most theoretical parts of science. To be sure, science expresses laws in the form of mathematical formulas, and computations can be performed in idealized cases (in textbook examples and school homework) by feeding numbers into the equations. But when it comes to testing the empirical validity of those laws or using them to predict anything, we have to use *actually measured* values of gross physical stuff, and these can only

[8] Michael Dummett, *Thought and Reality* (Oxford: Oxford University Press, 2006), 87. (What a capacious title for a slim volume!)

[9] I am reminded of the Northern Irish story about a university student of engineering who got talking to the men digging up the road outside his department; when he remarked that in *his* work he had to be accurate to within the thousandth part of an inch, the fellow at the bottom of the hole replied: 'Youse is lucky! In our work we've gotta be *dead on*!'

be accurate only within a margin of error, and should not be strictly identified with numbers as abstractly conceived of.

It is tempting to suggest that the idea of exact measurement functions as a Kantian ideal, to be approximated to but never actually reached. But even that is open to question, for although it sounds like good advice to say that we should make our measurements as accurate as possible, our standards of precision will quite reasonably vary depending on what we are measuring and for what purpose: there will be no point in trying to measure the width of a road or the height of a growing child to hundredths of a centimetre. And even when it *is* important to micro-measure with the best available kit, in cosmology or atomic theory for example, new technology may increase our accuracy but we never get any nearer to coming up with an *infinite* row of decimals, for the distinguishing feature of an infinite set is that however many members of it you go through, there always remain infinitely many more. Thus the mathematical ideal of complete precision is not asymptotically approached, but constantly recedes over the horizon.

Let me now come back to the idea of a *total* state-description of the world at a time. The claim would be that there always *is* a monstrously large (yet presumably still finite) proposition, consisting of a conjunction of *all* the true propositions about the world at a time. Such propositions must outrun the conceptual resources of any human language. There were electrons and stars in the universe, and rocks and dinosaurs on the earth, long before humans developed concepts of them. And we have to allow that the sciences will probably develop new concepts in future, to identify aspects of reality that presently lie beyond our ken but are all around us now. Conceptual innovation is not confined to the sciences, either: consider the concepts of bassoon, A minor scale, symphony, cobalt blue, golden section, pointillism, cubism, tragedy, sonnet, novel, general election, prime minister, fascism, insurance contract, subprime mortgage, paedophilia, and soap opera. Each of these concepts has developed at some stage of human history, and if our history continues there will no doubt be new concepts, of which of course I cannot yet give examples. I submit that the notion of a stupendously large proposition conjoining *all* the truths about *everything*, involving *all* the concepts that are not just actual but *possible*, is a very great idealization indeed.

It may be suggested that we can cut down the imagined superset of *all* facts to a more manageable size by saying that the state-descriptions in any realistic thesis of determinism will have to prescind from any such riot of aesthetic, political and sociological concepts, and should be expressed austerely in terms of basic physical terms that apply universally to the matter and energy of which everything is composed. This raises a cluster of profound issues centring round reductionism and emergence, about which clouds of technical philosophy continue to be generated. Here I can only gesture to what seem to be the main issues. There is firstly a question whether we can ever be sure that we have identified the most basic level of physical reality, for the history of science show a series of steps down the levels, and though the much-hunted Higgs boson now seems to be making its presence felt in the large hadron collider, there can be no guarantee that our present Standard Model of sub-atomic physics is the end of the story.

Then there are deep and difficult questions about how the presumed basic level relates to the other levels of reality, from the chemical and the biological up to the psychological, social, historical, political, aesthetic – and whatever else goes into the untidy mix. If we accept the weakest possible form of materialism and say that everything is *composed* of the entities recognized by the basic level of physics, that excludes Platonic or Cartesian dualism of mind and matter, but leaves almost everything else open. Most of us find very plausible the weakest form of supervenience – namely that if there is any sort of difference between two things or events, there must be some difference between them at the *basic* material level, or conversely that if they are *exactly* similar at the bottom level they must be similar at all other levels of description. But this amounts to very little: all it implies, for example, is that if orchestra A give an exciting performance of Beethoven's 5th Symphony whereas orchestra B's account is underwhelming, there must be some difference at the acoustic level between those two sound-events – which is hardly news. If we imagine two possible states of the *whole universe* identical in every physical respect, then if we believe in supervenience we would have to say that there could not be any difference between them in any other respect. Yet it would not follow that their non-physical properties can be *deduced* from a complete description at the physical level, any more than the properties of a computer – such as storing philosophical insights, subversive politics or child pornography – could be deduced from a complete knowledge of the electronics of its innards.

When physicists and cosmologists talk with their sublime arrogance of 'a Theory of Everything', I make bold to suggest that they do not literally mean what they say. It is not part of the ambition of physics to explain why Mozart's early Quintet for Piano and Wind is such a great work, why there were economic recessions after 1929 and 2007, or why Edward VIII decided to abdicate the British throne. Physical theories are not about such humanly interesting stuff, but about boring measurable quantities of mass, length, time, charge, and radiation. And even in the realm of such physical facts, there are still deep problems in the notion of a Theory of Everything. A scientific theory, as Stephen Hawking himself admits,[10] is a *humanly-constructed model* which exists only in our minds, but tries to economically explain a large class of past observations in terms of a small number of assumptions and to accurately predict future observation. Up till now, all physical theories have been partial, they have only tried to explain a large but limited class of physical phenomena. Moreover, the computing of the observational implications of a physical theory involves approximations and simplifying assumptions, as does the setting up of experimental apparatus, as Hawking concedes[11] and Cartwright documents in detail.[12] Adjudicating the fit or lack of fit between a theory and reality is a messy business, both conceptually and technologically. So there seems to be no real prospect of a theory that is complete rather than partial, and fits observations exactly rather than approximately.

This is connected with the third idealization I identified, to the set of all the laws of nature. First of all, some epistemological modesty is again appropriate. Can we derive all the higher-level laws, for example that all men are mortal, that it hardly ever rains in the deserts of Peru, or that sugar dissolves in water, from a certain set of fundamental, basic-level laws – which these days would be at the sub-atomic quantum level? If 'derive' means 'mathematically deduce', that is an enormous task that so far as I know is in most cases nowhere near completed. Indeed it is often difficult to know where to *start*, because contingent empirical assumptions have to be brought in, for example about the ocean currents in the Pacific Ocean, and *which* such assumptions are we to make in each case? Moreover, can we ever be sure that even our best-confirmed scientific theory has identified *all* the fundamental laws of nature? Nancy Cartwright has vigorously argued that what we like to think of as the fundamental exceptionless laws of nature formulated by theoretical physics are not even literally *true* of the physical world, but are

[10] Stephen Hawking, *A Brief History of Time* (London: Bantam Press, 1998), 11.

[11] Hawking, op. cit. note 11, 187, 204.

[12] Cartwright, *How the Laws of Physics Lie* (Oxford: Oxford University Press, 1983), Chapters 1 and 6.

mere mathematical equations that can only be applied in imagined textbook examples where all interfering factors are imagined away by fiat, or in highly contrived experimental set-ups ('nomological machines') where all known interfering factors are shielded off or compensated for.[13]

Whether we like it or not, the universe seems to be irreducibly complex, and resistant to exact and complete capture in any one theory, even in our most prestigious and all-encompassing science. Nancy Cartwright's favourite phrase for it is 'the dappled world' (inspired by a famous poem of Gerard Manley Hopkins). The notions of a *total* state-description of the world and *all* the laws of nature are idealizations vastly inflated from anything we will ever have reason to believe in. This whole discussion confirms the theologian Austin Farrer's judgment back in the 1950s that determinism is not a hypothesis but '*a pious hope*' that under ideal conditions the complete causes of all human conduct could be 'plotted out'.[14] It is indeed an unverifiable faith.

2. Concepts of causation

So far I have not explicitly invoked the notion of cause. But determinism has often been expressed as the claim that every event has a cause, where a cause is usually understood as a preceding state of affairs upon which the event follows in accordance with a law or rule, hence with a certain kind of necessity. So let us scrutinize this well-worn saying 'every event has a cause'. It has often been taken in a determinist sense, to mean that for any event there is a preceding *total* state of the world which, given the laws of nature, implies that that event must happen. But there is a much weaker way of interpreting it. Take the example of an apple (that paradigm fruit of Newtonian Paradise!) and consider how it could be detached from its tree by at least three different kinds of cause – a gust of wind, the decay of the last strand of its stalk, or the tweak of a human hand. It is one thing to say that any particular apple-detachment must have some cause or other in the vicinity, where by 'cause' we just mean an event of a kind which *normally* results in an effect of the relevant type; but it is quite another thing to assert that for every apple-detachment there must have been some preceding total state of the universe

[13] Op. cit. note 12, Chapters 2 and 3.
[14] Austin Farrer, *The Freedom of the Will* (London: A. and C. Black, 1958), 297–8.

which made it inevitable. That is a speculative thesis that goes way beyond the homely generalizations of apple-gathering folk.

The usual generalization 'Every event has a cause' may seem very simple, but it is *deceptively* so, for it suffers from ambiguities in the notion of cause and the associated notions of law, rule, and necessity.[15] There is an everyday usage of the word 'cause' which amounts to *what made a certain event happen in the circumstances*, and what is usually meant is the *most distinctive* thing in that set of circumstances that made or allowed the event to happen, where what counts as 'most distinctive' often depends on our interests in apportioning praise or blame, e.g. was the plane crash caused by pilot error, extreme weather, or a design-fault in the aircraft? But this informal notion of what made something happen in the circumstances by no means implies that it absolutely *had* to happen, that nothing whatsoever could have stopped it. The possible causes of apple-detachment mentioned above could each be prevented from having their usual effect: the pressure of the wind could be stopped by a wind-shield, the decay of the stalk might be arrested by a chemical spray, and the apple-picker's grasp might be interrupted by something more urgent diverting her attention (the voice of Adam, perhaps?). In the case of the air disaster, the absence of any one of the above-mentioned factors might have been enough to avoid a crash. It is harder to see how it could have been prevented if all three factors combine, but it is not inconceivable, for perhaps another freak in the weather might allow a skilled pilot to stabilize the falling plane.[16]

I am thus backing up Elizabeth Anscombe's ground-breaking argument that our ordinary notion of causality does not imply determination or necessitation.[17] It seems to involve only the conception of what *usually* leads to the effect, *if no interfering factor prevents it,* where the vagueness of the word 'usually' matches the vagueness of our everyday notion of 'cause'. Perhaps even 'usually' is too strong, in the light of cases such as the well-known fact that people

[15] See Earman, op. cit. note 2, II.2, and Cartwright op. cit. note 5, 5.2.5.

[16] My informal examples receive support, I think, from Cartwright's discussion of the problems involved in the composition of causes in op. cit. note 12, Introduction and Essay 3; see also Robert Bishop's discussion of the failure of causal closure in physics in Chapters 4 and 5 of op. cit. note 6.

[17] Anscombe, op. cit. note 1. See also her paper 'The Causation of Action', in C. Ginet (ed.) *Knowledge and Mind* (Oxford: Oxford University Press, 1983), reprinted in *Human Life, Action and Ethics: Essays by G.E.M. Anscombe* (Exeter: Imprint Academic, 2005), 103–4.

sometimes, but not always, catch diseases when exposed to infection. If A develops the symptoms of flu after being in a room full of sneezes, we will say with great confidence that that was the cause of A's catching flu, even if we know that B was also there but did not get it. Even if a *majority* of those sneezed upon do not develop flu, we may still believe, not unreasonably, that for those who do catch it their exposure was the cause. Similarly, we may be quite certain that it was last night's storm that brought down our beloved oak tree, though previous storms of equal or greater ferocity did not. And we may ascribe Joanna's appreciation of the difference between Kantian and utilitarian ethics to her taking course 101 in Moral Philosophy, even if most of her less attentive class-mates fail to come away with any such understanding. So if 'usually' is taken to imply 'in a majority of cases', we will have to downgrade still further to the bathetic 'quite often'. No wonder that Bertrand Russell once mischievously described the law of causality as 'a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm'.[18]

Readers may be itching to protest that the lamentable imprecision of most of our talk of causes is due to our ignorance. They will say that if we get to know more about the operations of viruses and the human immune system, the strength of tree roots and their vulnerability to the wind, the intelligence and industry of particular students and perhaps even some detail of their brains, then we should be able to come up with more precise analyses of the causal factors that are relevant in each case, and thus make more confident explanations and predictions. Now I do not for a moment deny that we can make progress in identifying more causal factors and in understanding how they can affect outcomes; indeed, most of science consists of such inquiries. But I insist that many of the generalizations involved will still need to hedge their bets, and take the form: if A, B and C occur, then D will usually, or normally, or nearly always, happen (or: if A, B and C occur, then D will happen unless something intervenes to prevent it). For anything as complex as immune systems, human psychology, and perhaps even the growth of trees, there seems to be no prospect of achieving a complete and perfect understanding of *all* the factors involved in their behaviour. So any summary of the state of the science about such complex systems needs to acknowledge a fringe of ignorance, and make allowance for interfering factors that remain unknown

[18] Bertrand Russell, 'On the Notion of Cause', *Proceedings of the Aristotelian Society*, 1912–13, reprinted in his *Mysticism and Logic* (London: George Allen & Unwin, 1917).

or imperfectly understood. Scientific research increases our knowledge, but does not reduce our ignorance to zero. Science is never omniscience.

But though this point may be admitted for complex systems where complete understanding and predictability are humanly impossible, anyone who has learnt a bit of science may want to insist that at the micro-level of chemistry and physics we have discovered fundamental laws that are genuinely exceptionless, and need no hedging about with untidy reference to possible interfering factors. Our paradigms tend to remain Newton's laws of motion, Maxwell's equations for electro-magnetism, and the formulas for chemical reactions – though the need for catalysts may muddy the latter waters. However there is an important distinction between the general theories involving such laws and their application to real-life situations. The examples in the textbooks invite us to consider simple situations *in isolation,* as if nothing else existed in the world – or nothing else that is relevant, at least. Newton's first law says that a body *not acted upon by any forces* will continue in its state of rest or of motion in a straight line, but of course there is no such totally isolated body anywhere in the universe. Classical mechanics achieved striking success in explaining and predicting the motions of the solar system, and has thereby exerted a stranglehold over our imaginations, leading many people to assume that science has proved the truth of determinism. But that success with the heavenly bodies rests on the contingent facts that the sun is enormously massive compared to the planets, that they themselves are much more massive than the asteroids and comets, and that all the stuff in the rest of the universe is so distant that its gravitational effects can be safely ignored. The impressively accurate predictions of eclipses and comets for many years ahead are based on *approximations*, which work to the scale of accuracy that concerns us. But for smaller asteroids their motions cannot be computed with similar long-term accuracy, so future impacts on the earth can be neither predicted nor ruled out (except when it is too late). The solar system looked at in detail is quite complex after all, and not every smaller event is predictable. I conclude that there is plenty of application for our rough-and-ready everyday concept of causation, without commitment to determinism.

3. The need for a general causal framework

But is determinism a necessary condition of our having any conception of an objective material world? Kant has often been interpreted as proving (or at least as *taking* himself to have proved) just that, and it is true that some of his writing suggests as much.[19] I do not want to get involved here in eternally-debated matters of Kantian exegesis (his arguments in the Second Analogy seem especially repetitive and ambiguous), so I will just offer a summary view of what I think we should learn from what he had to say on these topics of causality, determinism and objectivity. Like every other 18th century thinker Kant was very strongly influenced by the Newtonian paradigm, and he sometimes seems to commit himself to the *a priori* truth of determinism, or at least to what we have seen to be the vaguer claim that every event has a cause. But unlike Hume, who treated the latter as an posteriori matter, Kant argues for its synthetic *a priori* status as a necessary condition of experience of an objective physical world. So his interpreters have naturally tended to assume that he carried forward this result to his statement of the free will problem in the opposing arguments of the Third Antinomy, and to his proposed solution, one side of which seems to be a clear affirmation of determinism as applying to the whole empirical world, including ourselves as physical beings in time.[20]

The headline of Kant's Second Analogy encourages us to read him as a determinist. In the first edition the thesis is: 'Everything that happens (begins to be) presupposes something which it follows in accordance with a rule' (A189), and in the second edition it is reworded as: 'All alterations occur in accordance with the law of the connection of cause and effect' (B232). It is tempting to read these sentences as asserting that every event has a cause, but we have seen that that is an ambiguous statement. In the very repetitious argument that follows, Kant makes central appeal to the fact that not every alteration in our perceptual experience, e.g. in successively walking around a large house, represents an alteration in the object perceived, for a house does not normally change as one inspects it, so one presumes that its parts and features remain in simultaneous existence as one moves around it. But in other cases our perceptions do represent changes in the objective world, such as when we see that a

[19] See the Second Analogy of Experience, and the arguments for the thesis and antithesis of the Third Antinomy in the *Critique of Pure Reason*.

[20] Henry Allison, doyen of Kant interpreters, has written: 'the Kantian project requires not merely the reconciliation of free agency with causal determinism … but rather the reconciliation of such determinism with an incompatibilist conception of freedom', *Kant's Theory of Freedom* (Cambridge: Cambridge University Press, 1990), 28.

ship has changed its position. The main 'transcendental' topic of inquiry in the Second Analogy is into the necessary condition of our being able to make such distinctions between changes in our perceptions and changes in the things we perceive.

But what exactly is this necessary condition that Kant claims to elucidate? That remains rather embarrassingly vague and disputable. Henry Allison says that it is 'merely that every event falls under the schema of causality rather than under particular causal laws'.[21] That might get us stuck in another notorious morass of Kantian-exegesis in the Schematism chapter, but perhaps we can steer round that if we take up Allison's other formulation, that Kant is concerned only to defend the 'every-event-some-cause' principle, rather than the 'same-event-same-cause' principle.[22] Graham Bird suggests we should understand Kant as arguing only that every event must be contained within 'a general causal network'.[23] On this interpretation, what the Second Analogy succeeds in showing is that our recognition of perceptible events in the world as objectively ordered in time and space requires that we locate all events within a web of spatial and temporal relations that involve a great deal of causal connection. The main idea is that to make the distinction between the time-order of our perceptual experiences and the time-order of events in the physical world we need to rely on the normal workings of our sense-organs, i.e. the causal dependence of our perceptual experiences on things perceived and on our spatio-temporal relationship to them, plus the known regularities in the persistence and changes of familiar sorts of thing. So we could not apply the concept of objective event unless (to put it vaguely) we also find plenty of application for causal conceptions.

But that need not imply that *every* single event must have a cause. Once a general causal framework is in place, can there not be conceptual room for some uncaused events? After all, the physicists now tell us that quantum mechanics has shown that undetermined events occur at the sub-atomic level, and there can be no hidden variables to explain them. And at one stage in twentieth century cosmology, before the advent of the Big Bang theory, it was suggested (by Fred Hoyle) that the observed expansion of the universe might be

[21] H.E. Allison, *Kant's Transcendental Idealism*, 2nd edition (Cambridge: Cambridge University Press, 2004), 256.

[22] H.E. Allison, *Idealism and Freedom* (Cambridge: Cambridge University Press, 1996), 80.

[23] Graham Bird, *The Revolutionary Kant* (Chicago and La Salle: Open Court, 2006), 19.2, 20.1, 27.1.

explained by the random creation *ex nihilo* of hydrogen atoms in interstellar space. That is not now believed, but the idea has, I take it, been rejected on empirical rather than *a priori* grounds. In olden times people believed that lower forms of life were spontaneously generated in dust and slime, and though we now know they were wrong, they surely had enough of a general causal framework to be able to distinguish their perceptions from objects perceived, so they satisfied the requirements of Kant's Second Analogy whilst perhaps believing that some events lacked causes. At present we lack a thorough understanding of what causes the incidence of cancer in individual people and its occasional remission (sometimes greeted as miraculous). We all hope that medical science will make progress on this, but if evidence were to emerge that the growth and remission of tumours depends on random events at the quantum level, the lack of causation for such cancers would not impugn their tragic reality.

Much depends here on what we mean by that very ambiguous little word 'cause'. If we see any of the above possibilities of 'uncaused' events as not ruled out *a priori*, it is surely because in those scenarios the relevant events are envisaged as *fairly frequently*, though unpredictably, occurring *in certain specifiable conditions*. Any report of a *one-off* uncaused event could reasonably be disputed on grounds like those Hume adduced against believing any report of a miracle: it would be said that the observer must have been mistaken, that the recording apparatus was not working properly, and so on. But if in a certain type of condition A, events of type B are quite often reliably observed to happen, though in ways that we cannot explain by any intervening factor C, then it seems we have a choice. We could continue to insist that there must *be* some such explanatory factors, however many times we have failed to find them, and thus maintain that every event has a cause as a matter of unfalsifiable faith. Or else, so my argument suggests, it is open to us to say that these B-events have no causes in the sense of something that *necessitates* their occurrence in the circumstances. Yet they could still be said to have a cause in the weakest possible meaning of the word, namely, a type of condition A in which Bs have been known to sometimes occur, perhaps with a quantifiable measure of probability. That usage would drop any connotation of A *making* Bs happen, but it could retain the notion of A being the *source* of Bs, that from which Bs typically derive, or in which Bs tend to come into being.

We would surely still believe that every event has an *effect*, or at least that it *could have* an effect on suitably-placed observers or instruments, but we would give up the belief that every single event has a cause in that sense of something involving a necessary connection between cause and effect. Kant obviously had that stronger sense in mind when he wrote: 'For this concept [of cause] always requires that something A be of such a kind that something else B follows from it *necessarily* and *in accordance with an absolutely universal rule*' (A91/B124, with his emphasis), and: 'there must therefore lie in that which in general precedes an occurrence the condition for a rule, in accordance with which this occurrence *always* and *necessarily* follows' (A193/B238-9, with my emphasis).[24] Just after the first of those sentences, Kant wrote that the concept of cause has a dignity and necessity which an empiricist like Hume fails to accord it – so perhaps he would accuse me of casting aspersions on its dignity! To be sure, Hume found necessary connexion to be part of our idea of cause, but the sort of necessity he offered was altogether too subjective and contingent for Kant. And although Hume talked of *constant* conjunction as the foundation of our causal beliefs, in later sections[25] he allowed that *probable* reasoning, which leads to uncertain conclusions, can be founded on chances (as in the fall of a die), and on causes where past evidence contains contrary instances in which similar states of affairs have produced different results. Hume thus recognized a probabilistic conception of cause. Both philosophers talk of *regularity*, and of things happening *in accordance with a rule*, but both could avail themselves of the ordinary language point that neither phrase need imply the total absence of exceptions, e.g. 'Snoggins attends our church regularly – though not when he's ill or on holiday'; 'As a rule, heavy smoking leads to lung cancer – but for reasons that we do not understand, it does not always do so'. Kant had a notoriously rigorist cast of mind, and his main concern was to analyse the *a priori* elements in causation and the *necessity* of causal connections as he understood them, but he knew perfectly well that there is such a thing as probable empirical reasoning, so he need not have cavilled at the idea of probabilistic causation.[26]

The upshot of this section is that although Kant may have thought he had proved the need for scientific-style exceptionless laws as a prerequisite for experience of an objective world, it seems that all that he succeeded in showing is that we need a general causal framework as part of our conception of an objective physical world, and that

[24] Quotations are from the English translation of Kant's *Critique of Pure Reason* by Guyer and Wood (Cambridge: Cambridge University Press, 1998).

[25] *Treatise of Human Nature* I.III.xi–xii.

[26] A728-9/B756-7; A775/B803; A820-2/B848-50.

within such a framework every event has a cause, if only in the weakest possible sense of a probabilistic cause or typical originating condition.

4. A regulative principle

As we have repeatedly seen, to say of any given event that it is predetermined is to say that it is necessitated by the laws of nature plus preceding total state-description of the world; and to say of an event that it is *un*determined is to say that the laws of nature plus the preceding total state-description do *not* necessitate it. So both determinism and indeterminism (Kant's 'transcendental freedom') presuppose that there *is* such a thing as a total description of the world at any given time – but we have found that such a notion is an idealization way beyond whatever progress we may make in science and technology. Determinism and indeterminism are precisely what Kant called' transcendental' ideas or concepts:

> Thus the pure concepts of reason we have just examined are *transcendental ideas*. They are concepts of pure reason; for they consider all experiential cognition as determined through an absolute totality of conditions. They are not arbitrarily invented, but given as problems by the nature of reason itself, and hence they relate necessarily to the entire use of the understanding. Finally, they are transcendental concepts, and exceed the bounds of all experience, in which no object adequate to the transcendental idea can occur. (A327/B383-4, with Kant's emphasis)

I suggest that determinism is an ideal that many scientific theories quite reasonably try to live up to (though not it seems in quantum mechanics, or arguably in individual psychology or in economics), but it is not an empirical assertion, let alone a true one, about the physical world as a whole. Consider how much of the surface of the earth is littered with material stuff that is the intentional result of human activity.[27] The successes of much physical science have encouraged the speculation that the whole universe is deterministic, but that will always remain beyond complete verification. This conclusion fits with the distinction between constitutive claims and

[27] Anscombe wrote of 'an itch for determinism' in the human mind ('The Causality of Action', op. cit. note 17). This consideration suggests there are limits to how much we should scratch it.

regulative principles that Kant made so much of in the Dialectic of the *Critique of Pure Reason*. Here is a typical statement:

> Thus the principle of reason is only a *rule*, prescribing a regress in the series of conditions for given appearances, in which regress it is never allowed to stop with an absolutely unconditioned. Thus it is not a principle of the possibility of experience and of the empirical cognition of objects of sense … nor is it a *constitutive principle* of reason for extending the world of sense beyond all possible experience; rather it is a principle of the greatest possible continuation and extension of experience … thus it is a principle of reason which, as a *rule,* postulates what should be effected by us in the regress, but *does not anticipate* what is given in itself *in the object* prior to any regress. Hence I call it a *regulative* principle of reason … (A508-9/B536-7, with Kant's emphasis)

At the end of his solution to the Third Antinomy, Kant says that he has not been trying to establish the *reality* of freedom (by which he meant transcendental freedom, i.e. indeterminism), and not even its *possibility*; he rests his case on treating freedom as a *transcendental idea* which does not conflict with natural causality (A558/B586). I fear he was not so clear about the status of determinism; he seems prone to overestimate what he has shown in the Second Analogy, indeed in one place he suggests it is a conception of the *understanding*, whereas it would be more consistent with the main lines of his thought to say that whereas causality is a category of the understanding, determinism is an idea of *reason*.[28]

So we can follow the regulative injunction to keep on researching into the causes of things as far as we can, without having to believe in determinism either as an *a priori* or an *a posteriori* truth about the ultimate structure of the universe. So for the human issues that concern us so deeply, our commitment to science need not threaten free will in the way that so many people have feared. Determinism, where is thy sting?[29]

[28] Reason for Kant being the faculty of making inferences and seeking explanations. In the third Critique, he explicitly recommended a *regulative* interpretation of the maxim that 'all production of material things and their forms must be judged to be possible in terms of merely mechanical laws' (*Critique of Judgment*, Section 70, 5:386–8).

[29] This article is a substantially revised version of the last essay 'A Kantian Defense of Free will' in my book *Inspirations from Kant* (New York: Oxford University Press, 2011), 139–161.

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