The concept of physical law

Second edition

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For Sylvia, Diane, Efrem, Steve, Manjeet, Ruby, Paul, and Lorna (Theresa).

And in loving memory of my parents, Martin and Eva.

Contents

Preface to the first edition (1985)

I remember reading years ago about a young boy who complained about a book entitled *All about Whales*. He was aggrieved because the book did not deliver on what he took to be its promise, namely, relating everything there was to be said about whales. The child's parents had to explain to him that the title was ambiguous and should be read as meaning only that everything in the book was about whales.

Having taken the lesson to heart, let me warn that this is not a book that endeavors to say everything that can be said about physical laws. It aspires only to be a book in which everything said (this preface excepted of course) is about physical laws. And that is quite a difference.

Indeed, as you read this book you will doubtless be struck by how much I have chosen to omit altogether. In the following pages, you will find nothing, or nearly nothing, about the taxonomy of laws, for example, the distinctions between causal laws, laws of concomitance, laws of dynamics, and functional laws. Similarly, you will find nothing about empirical laws and theoretical laws; nothing about the difference between low-level and high-level laws; and nothing about basic laws and derived laws. You will find nothing about the difference between those laws whose nonlogical and nonmathematical terms refer only to observables and those laws that contain some descriptive terms that refer to unobservable (or theoretical) entities. And you will find nothing about whether time and space are discrete or continuous, and little about the analysis of "state of the world," "occasion," "natural kinds," and so forth. I have, in short, ignored – and, in some instances perhaps, run roughshod over – some traditional distinctions. I have done much of this knowingly and with design, for my purpose has been to "get back to basics," to try to analyze the *generic* concept of physical law, and in particular to examine the modal, as opposed to the epistemological, status of physical laws. As will become clear in due course, I think that elucidating this point has important consequences for how we view the world.

I would hardly be honest if I said that I have a great conviction that the thesis of this book is true. I have no such conviction. And indeed, the fact that I have disagreed so profoundly with so much of what is taken to be received wisdom about these matters, far from exhilarating me (as it might easily someone else of a different temperament), has caused me considerable worry. What prompts me to publish is the hope that I might not be wrong.

I have lived for many years with the problems I discuss in this book. I have, over those years, wrestled with and vacillated between two competing theories, Necessitarianism and Regularity. But, during the last few years, I have finally settled on the latter. In what follows, I try to defend Regularity against Necessity.

Jonathan Bennett, Raymond Bradley, and Terrance Tomkow were generous, unstinting really, in offering criticism of some early drafts of chapters. More recently, Philip Hanson and Hannah Gay read nearly completed versions of the manuscript and offered detailed comments. Their notes were enormously helpful and quite beyond my ability to repay. Two exceptionally helpful critics are unknown to me by name. , These latter philosophers, whom the editor, Richard Ziemacki of Cambridge University Press, enlisted to comment on the manuscript, provided a wealth of detailed criticism, challenges, encouragement, and suggestions. I have chosen to follow their advice in many places; but I have also been bold, or foolhardy, enough to decline some as well. Certainly, this book is much better for their careful thought. Steven Davis, E. Wyn Roberts, and David Zimmerman offered encouragement when my enthusiasm and stamina flagged.

The bulk of the manuscript was typed by Merrily Allanson, whose skills at her keyboard are to be compared to Franz Liszt's at his.

Cambridge University Press called on Alfred Imhoff to do the considerable job of copyediting this book. He managed to impose a uniform, integral style on an eclectic hodgepodge.

Sylvia, Diane, and Efrem graciously accorded me solitude when I became so immersed in these arcane studies that I scarcely could make conversation. Unlike other spouses and children who temporarily lose their mates and parents to the lure of golf or gambling, my wife and children had to endure my succumbing to the call of ratiocination. Their forbearance was inspiring.

Of the many books I consulted in the course of writing this essay, one proved invaluable: Tom Beauchamp's anthology, *Philosophical Problems of Causation* (1974). It was this collection of papers that provoked me to begin writing on this topic; and it was again this collection to which I most often turned in the course of working out my own thoughts.

Finally, a little piece of philosophy just for this preface.

One thing that surprised me as I reread what I had written in this book was how remarkably little I have said about the concept of causal laws and of causality in general. I did not set out consciously to avoid the latter subject; it is just that it did not naturally, of its own, come up very much. That, I think, is a pretty interesting philosophical discovery. If this book had not evolved in the way it did, I probably would not have believed that one could say as much as I have without also talking at length about causality. It seems to me, now, in judging this book, that the two notions – that of physical law and that of causal law (a specialization of the former) – can, profitably, be discussed apart. But, clearly, this claim is contentious, and I alert you to it so that you might judge for yourself.

Preface to the second edition (2003)

All known typographical errors in the first edition (Cambridge University Press), 1985, have been corrected. To improve readability, the body of the text has been reformatted. In particular, all quotations are now indented, and the size of the type has been set uniform (12 points) in the text, the quotations, and the footnotes. There are, in addition, other small changes throughout.

I would like to thank the university and college instructors who adopted the first edition for use in their philosophy courses. Thanks, too, to all those who have written to me with comments, questions, and suggestions.

By making this book available, both as a single file and as multiple files (chapter-by-chapter), I hope instructors who wish to use selected chapters as parts of their course materials will now find it easy to do so.

Since the original version of this book was written before I owned a word-processor, that edition did not exist as computer files. I have had to run every page in the book through an optical character reader (OCR) to produce this e-text version. Thanks to Scansoft Inc. for creating *TextBridge Pro*© software.

Most important, I must extend my especial thanks to Burke Brown, a singularly dear friend, who found that (some at least of) the theses of this book dovetailed with ideas of his that he has been developing for years. It was at his repeated urging that I have prepared this second edition.

PART I

Theory

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1

'Near' laws and 'real' laws

Physical laws[1] are propositions,[2] that is, they are the sorts of things that bear truth-values.

There is no such thing as a false physical law. In saying that physical laws are the sorts of things that are true or false, I mean that they form a subset of those things that are true or false or, more specifically, of those things that are *true.*

"Physical law" is a success term: If something we have taken (assumed, believed, etc.) to be a law is subsequently learned to be false, that proposition is not a false law, but no law at all. In this regard, that is, in implying the truth of its subject, "is a physical law" belongs to a class of predicates including such others as "is known" and "is logically necessary." But to say this is

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1 I prefer the term "physical law" to either "law of nature" or "natural law" so as to avoid any seeming connection with the doctrine of "natural law" in ethics. (Here I follow the practice of Wollheim 1967.) Unfortunately, where the term "natural law" has unwanted connections with concepts of natural rights and the like, the term "physical law" has unwanted connections with theories of physicalism. So let me say explicitly that I will be using "physical law" in a broad sense. The term is to be understood to include those laws of living, as well as inanimate, matter; individual human, as well as social, behavior; and overt or public as well as private, human behavior. In using "physical law" to encompass all the latter, I am fairly sure that I am not begging any questions to be examined in this essay, nor do I think I am surreptitiously introducing materialism (although I am a materialist). Of the two terms, "physical" and "natural," the former seems to have fewer problems associated with it. Neither term is wholly satisfactory; choosing between them is much a matter of taste.

2 Bradley and I have argued elsewhere (Bradley and Swartz 1979, pp. 65-86) that propositions are sui generis abstract entities, not to be identified with, e.g., indicative sentence-types or sentence-meanings. However, that particular theory of the ontology of propositions is not presupposed in this book. Here, my concern is with such matters as the modality of propositions that are physical laws. One need not have settled views, still less the same views as this author, about the ontology of propositions to pursue the kinds of issues that will be raised shortly.

not, however, remotely to suggest that physical laws need be known, still less that they are necessary.

Twenty-five years ago, Scriven began an essay by writing, "The most interesting fact about laws of nature is that they are virtually all known to be in error" (1961, p. 91). I still find his arguments persuasive, but with one important rider: By "laws of nature," he does not refer to what I am here calling "physical laws"; that is, the difference between us is not just terminological. Scriven's point is about the pronouncements of science, about what scientists call "laws"; what they invoke in their explanations of physical phenomena; what they advance in textbooks and teach to their students (see also Cartwright 1980a). In this essay, when I refer to "laws" I am talking about a certain class of truths about this world, a class wholly independent of whether or not anyone successfully discovers, formulates, announces, believes, or promotes those truths. If Boyle's (so-called) Law is – as it certainly is – false, so be it. When I hereinafter talk about laws, I do not mean Boyle's Law, or Bernoulli's Theorem, or Fermat's Principle, or Maxwell's Rule, etc. I mean those (for the most part, unknown) true propositions that lie at the heart of the matter (no pun) and account for the verisimilitude of the pronouncements of science.

Scientific laws are conceptually distinct from physical laws. Only the barest handful of scientific laws are physical laws. I am unprepared to venture a guess as to how many these might actually be; I don't know their absolute number, only that their relative number is very small.

The claim that few scientific laws are physical laws may at first appear implausible, for what then is science doing, if not producing physical laws?

> The scientific enterprise consists in observing, experimenting on, and of course hypothesizing about the world in order to explain, predict, control, and in a broad sense come to understand the world. The way these latter activities – explanation, prediction, control, and understanding – succeed is by bringing ever-greater parcels of the phenomena of the world under the umbrella of accepted scientific laws. Since science works, and works so exceptionally well, the laws it invokes that allow it to get on with its business must *be* the laws of the world.

This argument seems so self-evidently sound that few would question it. Nonetheless, there is good reason to challenge its conclusion.

Both Popper and Kuhn, for quite different reasons, have urged us not to believe that scientific laws are true. Kuhn has done so because he promotes the theory that there is no objective truth, and hence scientific laws are truth-valueless instruments. According to his account, scientific laws are not true, but this is because they are neither true nor false (1970, pp. 205-7). Popper, in contrast, allows that scientific laws do bear truth-values. However, in light of the frequency with which assumed laws of previous generations have been falsified, he cautions us not to believe that the current stock are true. But he does not counsel us to believe that scientific laws are false; instead, he recommends that we adopt an agnostic attitude, that we hold scientific laws only gingerly, tentatively, as conjectures and not as commitments. (1962a, pp. 50-2).

I agree with both Kuhn and Popper that we should not believe that scientific laws are true. But unlike Kuhn, I believe that scientific laws do bear truth-values; and unlike Popper, I think we ought to have beliefs about the truth-values of scientific laws. We ought to believe that virtually all of them are false.

In any event, the particular views of Popper and of Kuhn concerning the nature of scientific law have not dislodged the common view. The eighteenth-century conception of the nature of scientific law still prevails. This stock theory has it that science progresses, steadily most of the time and by a leap on occasion; but it moves nearly always forward, with the steady accumulation of more and more truths and with regular additions to the stockpile of known scientific laws.

The material progress of science cannot be doubted, even if its moral direction is a source of constant dispute. The information-explosion of the twentieth century and the dramatic increase in knowledge in the preceding three centuries both lend credence to the claim that the growth of scientific knowledge is exponential over time.

It is in explaining *how* this knowledge is possible that the common theory fails. The standard account is to the effect that scientific explanations are *valid inferences* from *true* statements of universal or statistical laws conjoined with appropriately chosen statements of relevant antecedent conditions.

This theory about the means by which science generates its multitude of successful explanations and predictions is untenable, and it should eventually atrophy like any other theory at such variance with empirical fact. To the extent that philosophers of science have believed, and contributed to, this common theory, the philosophy of science has perpetuated and promoted a mythic, normic model of explanation.

In the philosophy of science, as in every branch of philosophy, there are strong a prioristic tendencies.[3] These tendencies must be kept in check by empirical facts. Philosophy must beware not to promote models that depart substantially from the actual practice of scientists, whether these models concern, for example, the generation of hypotheses, the technique of explanation, or the dynamics of the acceptance or rejection of a theory. Normic models are relatively easy to construct: They do not have to pass the test of conformity to actual practice; but, by the same token, they may badly misrepresent actual practice and, indeed, even stultify that practice if an attempt is made to implement them.[4] The usual justification given for such philosophical theories, namely, that they endeavor to describe 'ideal' rather than actual practice, must not exempt them from critical probing. Quite the contrary. If a model is promoted as describing ideal practice, it must be subjected to heightened scrutiny because it would suggest the revising of actual, usually successful, practice.

One has only to begin actually to read scientific journals and to speak to scientists themselves to find that many of what casual observers of science take to be laws are little better than mere calculating algorithms. Many of these 'laws' are produced simply by curve fitting to empirical data and have no particular theoretical backing; that is, they are not derived from theory. Many others are 'derived' from theory, but not directly as we might suppose. Here, the paradigmatic models of derivation we have inherited from Hilbert's geometry and Peano's arithmetic do not aptly apply. To get from theories to working laws, scientists regularly, daily, advance simplifying assumptions.

Beginning students in science are from the outset introduced to simplifying assumptions in their homework assignments and laboratory experiments. They are told that they may assume

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[3] There are many examples: Mill in his writing as if he had adduced recipes for a logic of discovery; Poincaré in his arguing that Euclidean geometry would always be conventionally adopted above all other competitors; and Carnap, at one period in his thinking, in his believing that Probability_1 (degree of confirmation) was a guide in life.

[4] Bridgman's Operationalism is a case in point. In thrall to a bad philosophical theory, operationalist physicists and psychologists produced some of the most sterile research of the twentieth century. Fortunately, the episode was a temporary aberration (even if its effects have not quite disappeared). In 1953, 24 years after having written *The Logic of Modern Physics* (1929), Bridgman was to declare publicly (in an allusion that confused Mary Shelley's fictional doctor with that doctor's abominable monster): "I … have created a Frankenstein" (1961, p. 76).

that the expansion of the gas is adiabatic; that the rise in temperature is negligible; that the coefficient of friction is constant for the range of velocities; that the internal resistance of the power supply remains constant; that the light source is monochromatic; that the sample is uncontaminated; that the walls are perfectly reflecting; that the period of oscillation is a constant; that the heat sink is infinite in capacity; that the combustion chamber exhausts completely and that the outside air in the vicinity of the vent is at the same temperature as the air at remote distances, that is, that diffusion is complete and instantaneous; etc. This informal aspect of the training of scientists, although universal, is virtually invisible to the person who is not deliberately looking for it. There are no chapters in textbooks detailing what simplifying assumptions one may make, just as there are no chapters suggesting which areas of research are likely to prove rewarding. What it is reasonable to assume, what one may hypothesize it is permissible to ignore, and what mathematical techniques might be used to yield a solution are insights to be gained by practice, apprenticeship, and intuition.

In the scientific journals, the degree of sophistication increases and the vocabulary broadens, but the essential point remains the same: The scientific laws derived are not *deduced* from fundamental theories, but are arrived at through layers of simplifying assumptions and approximations.[5] We turn, for example, to but one recent issue of the *Physical Review A,* Volume 27, Number 1 (January 1983). In article after article, we find the authors laying out their assumptions and approximations Only physicists will be familiar with the specialized technical terms of the field, but the layperson can read these articles and attend profitably to the nontechnical terms, such as "approximation," "estimate," "corrections," "calculations of varying sophistication," "uncertain," and "spurious results."

- Assuming certain specified conditions hold, the new complementary functional will have a local maximum at each local minimum of the old energy functional and the value of the functionals will be identical at these extrema. (Berk 1983, p. 1)

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5 Virtually nothing published in the professional journals in physics and chemistry concerns individual matters of fact. Physicists and chemists are intent to explain *classes* of facts, or *kinds* of events, not – as historians often are – singular events, e.g., why this particular photographic plate shows the peculiar tracks it does. The 'events' explained bear no calendrical dates or geographical coordinates. Laboratory results are credited only to the extent that they are thought to be representative of a kind of event or behavior. The aim in doing basic research, in making inferences from fundamental theory, and in publishing findings, is geared to the general case. Thus when various researchers, cited immediately below, write of electron scattering, resonance, capture, etc., they may be taken as advancing scientific *laws* of, respectively, electron scattering, resonance, capture, etc.

- In the Born-Oppenheimer approximation, the wave functions of molecules are expressed as the product of electronic and vibrational wave functions. This quasiseparability is conventionally attributed to the fact that the mass m of the electron is much less than the mass M of the nucleus with the result that the vibrational motion of the nuclei is adiabatic in comparison with the faster electronic motion. Such an explanation is not substantially supported by the actual size of the nonadiabatic coupling terms. ... there are other underlying dynamical factors for the validity of adiabatic approximations in molecular physics. (Lin 1983, p. 22)

- When relativistic and exchange corrections are omitted and the Born approximation is used for the scattering of an electron by an N-electron target system, the differential cross section can be defined in terms of the Compton profile. (Gasser and Tavard 1983, p. 117)

- There are, to our knowledge, no experimental determinations of the position and width of the lowest ^2P resonance in electron-beryllium scattering available at present. A number of theoretical calculations of varying sophistication have been performed on this resonance, which are largely in disagreement with one another. For this reason we have undertaken complex-basis-function calculations using configuration-interaction techniques to provide an accurate estimate of the resonance position and width. The lowest ^2P resonance state of Be^- can be thought of, to a first approximation, as a p-wave shape resonance ... (McNutt and McCurdy 1983, p. 132)

- Experiments in which fast negative muons are slowed and captured by atoms or molecules typically yield information on the capture times, final capture ratios for different atoms, and muonic x-ray cascades, but no detail on the slowing-down and capture processes. Nevertheless, knowledge of the energies of the muons just before capture and the characteristics of the capture orbitals is important for interpretation and must generally be supplied by theory. In view of this need, the theory of negative muon slowing down and capture is surprisingly uncertain even for hydrogen atoms. Estimates of the average muon energy for capture have varied from near thermal to several keV… Stopping powers and capture cross sections are required over a wide energy range and no single quantum-mechanical method is practical over the entire range. The Born approximation is valid at high energy and has been calculated. Some of the spurious results for muon capture are no doubt due to use of the Born approximation at low collision energies, as well as to use of inconsistent theories for the slowing down and capture processes. For low-to-intermediate energies there have also been several quantum-mechanical calculations, the results of which differ significantly. These calculations all make serious approximations, e.g., two states, straight-line trajectories, approximate wave-functions, etc., whose effects are difficult to evaluate. They also neglect inelastic scattering, which, according to the Born approximation, may contribute about 25% of the stopping power.

In the present work a quite different approach [the classical-trajectory Monte Carlo method] is taken… Except for classical mechanics and the use of a microcanonical ensemble for the ground-state hydrogen atom, there are no other approximations… The only additional source of error is statistical which can be reduced slowly by running more trajectories[6] (Cohen 1983, p. 167)

- This corrected $\Delta\nu$ must be treated with caution because the fitted line centers depend somewhat on the range over which the fit is made. It is to be hoped that the data of future measurements will be interpreted directly in terms of the more correct line shape discussed here. Finally, it is important to emphasize that a complete understanding of the positronium Zeeman resonance at the 1-ppm level needs a calculation of the α^2 corrections to the $\Delta\nu$ and at least a good estimate of the quadratic magnetic field contributions to the four-level effective Hamiltonian. (Mills 1983, p. 267)

The semiofficial 'standard' view of science[7] hardly reveals what we see above in the sampling of quotations. The route from basic theory, for example the capture of negative muons by hydrogen (see penultimate quotation above, Cohen 1983), is not simply a matter of *deducing* laws from basic theory, but of guessing, estimating, and selecting simplifying assumptions. When a physicist declares at the outset of his paper that he will assume that Newtonian mechanics applies, or that the trajectories are straight-line, or that temperature may be disregarded, etc., he rarely is using the term "assume" to mean "assume to be *true*." Quite the contrary, these particular assumptions are often made with the full knowledge that they are probably false, and more often with the knowledge that they are certainly false. The trouble is that Truth is often intractable and Deduction (of specialized laws from fundamental ones) beyond our powers of inference – beyond, that is, our own human mental powers and those of our computers.

It does not follow simply from the fact that there were false simplifying assumptions made in deriving them that most derived scientific laws are false. We know that it is logically possible for

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6 The Monte Carlo method is a technique for solving mathematical problems by averaging the results of trials using random numbers for the values of the variables. For a popular account and various illustrations of the method, see Millikan 1983.

7 See, e.g., Carnap 1966, ch. 25, "How New Empirical Laws Are Derived from Theoretical Laws."

a true proposition to be validly inferred from a set of propositions one or more of which is false. But although the falsity of the vast number of these derived laws is not guaranteed by the falsity of the simplifying assumptions used in inferring them, it is at least made probable by such assumptions. For the deriving of a false proposition from a set of propositions containing a false proposition is more probable than deriving a truth. Even so, the attribution of falsity does not rest solely on a priori probabilities. The falsity of the majority of derived laws is further attested to by the fact that they virtually all have limited application and, as a practical consequence of this, cluster into numerous sets each containing a few mutually inconsistent laws all treating of the same subject. Indeed, it is virtually de rigueur among physicists to begin their professional articles by reviewing others' work in their own field showing in what ways their commonly held stock-in-trade of specialized scientific laws is false.

Being false is hardly a sufficient condition for robbing a proposition of explanatory (or predictive, etc.) value. But being false is not a privileged state, either. Whether a proposition can function successfully in an explanation must depend on something other than its being true or false; probably on something akin to its being close-to-the-truth. However, closeness-to-the-truth cannot be exactly the special feature. For sometimes the truth is so complex that a proposition that approximated closely to it would be so unwieldy as to be useless.[8] The imperfectly understood property that confers suitability for use in explanation must be some complex property involving a weighted mixture of closeness-to-the-truth along with tractability and human comprehensibility.

Insofar as scientific laws are approximations or proxies, they must be approximations of, or proxies for, *something.* Of course, from a strictly logical point of view, scientific laws might be nothing more than approximations for still other approximations, and these in their turn, but approximations for still further approximations, and so on without end. In short, "*x*'s being an approximation" does not logically entail that there is some **true** proposition, *y*, whose approximation *x* is. Nonetheless, although the existence of a law of Nature as the endpoint of the series of approximations hardly logically follows from a scientific law's being an approximation,

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8 It follows from this, of course, that *truth* itself is not a sufficient condition for bestowing explanatory power on a lawlike proposition. For where truth exceeds human comprehension, it cannot be used to explain anything. Indeed truth – if complicated enough – can prove an obstacle to serviceability.

the existence of determinate laws of Nature is virtually axiomatic in the contemporary world view. If one is not going to allow that scientific laws are themselves physical laws, then there must be physical laws to which scientific laws approximate.

Is the World (i.e., Nature) governed by law? *If* it is – and this is a question to which I will devote considerable attention in Chapters l0, 11, and 12 – these ‘governing’ laws must be real laws, not scientists’ workaday proxies or approximations. Lying behind the false, but consummately useful, laws of the laboratory and scientific journal are, we may suppose, the real laws of Nature itself, laws not subject to the vicissitudes of changing fashion, human idiosyncrasy, fortune, or genius; laws whose number does not increase with the growth of human knowledge; laws not subject to revision and that never suffer the indignity of being falsified. It is because of the existence of *these* laws that the world is the way it is. It is because of the existence of these laws – common wisdom has it – that science itself has an objective focus and a court of appeal beyond mere consensual favor among learned practitioners.

Nowhere is this belief in the existence of ‘real’ laws more strongly underlined than in the debates concerning miracles, free will, and determinism. In these debates when persons wonder, for example, whether there ever has been a supernatural intervention in the course of history, or whether the existence of physical laws is compatible with there being free will, or whether the future course of the world is causally predetermined, they clearly are taking “physical laws” in the fundamental, not in the scientific or epistemological, sense. If the existence of physical laws is seen to be a threat to the exercise of a free will, or if the existence of physical laws is thought to entail that the future of the world is necessitated by physical laws and antecedent conditions, or if miracles are regarded as the temporary suspension of the laws of Nature, then the physical laws so presupposed cannot be the fallible approximations and estimates of scientific journals. What threat there is, what necessitation there is, what temporary suspension there is, concern not the instrumental laws of science, but the real laws – known or unknown – that scientific laws imperfectly reproduce.

Each of these two kinds of law – scientific law (the surrogate laws of scientific practice), and physical law (the laws of Nature itself) – related though they are, poses its own unique problems for philosophical inquiry. I will endeavor to keep the two apart. I shall not here be especially concerned with the former class, with scientific law. Thus I shall not be examining such standard issues as inductive support, genesis of hypotheses, underdetermination among competing hypotheses, incommensurability of paradigms, theory-ladenness of observations, research programs, etc. What follows is not an essay in the philosophy of science insofar as the latter is usually regarded as a branch of epistemology. Instead, what follows is an examination of the concept of physical law.

Three main questions will interweave in this study. The answer I offer to each will have important implications for the answers to the others. This is to say that the issues are interconnected in important logical ways.

1. What are the truth-conditions for physical laws?

    What *‘facts’* or states-of-affairs ‘make’ a physical law true? Can an *un*instanced physical law be true? If its instances are not what ‘make’ it true, then what *are* its truth-conditions?

2. What is the modal status of physical laws?

    Physical laws are logically contingent, that is, each of them is true in the actual world and each of them is false in some other possible world. No physical law is true in every possible world. But are physical laws **merely** contingent, contingent – for example – in the way in which my liking the music of Charles Alkan is contingent? Or do physical laws have some special law-bestowing ‘natural necessity,’ intermediate between mere (or bare) contingency and logical necessity?

3. What is the number of physical laws?

    Are they finite and few, as many have supposed and speculated [9] or are they finite and many, or even, perhaps, infinite?

The answers to these questions are important, so much so that we must not rest content adopting standard accounts, however much those accounts may predominate and appear self-commending. What answers we give to these questions will determine much of how we view the world:

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[9] “Physics originally began as a descriptive macrophysics, containing an enormous number of empirical laws with no apparent connections. In the beginning of a science, scientists may be very proud to have discovered hundreds of laws. But, as the laws proliferate, they become unhappy with this state of affairs; they begin to search for underlying unifying principles.” (Carnap 1966, p. 244)

“In a significant sense, the ideal of science is a single set of principles, or perhaps a set of mathematical equations, from which all the vast processes and structure of nature could be deduced.” (Schlegel 1967, p. 18) whether events are necessitated; whether human beings can truly choose among alternative courses of action, or whether we are bound to do what we do in the way in which water will solidify when its temperature drops; and whether there is a limit in principle on human empirical knowledge.

A very great deal is known of this world. But what does this knowledge require us to think about the world's fundamental structure? How shall we conceive of the underlying reality of the world – its physical laws – in order that it should enjoy its epistemological character, its seeming toleration of free, deliberative, morally responsible actions, and its plenitude of variety and novelty? Questions such as these are transcendental questions, which is to say that what follows is an essay in – not the epistemology, but – the metaphysics of science.

2

Falling under a physical law

FIVE NECESSARY CONDITIONS FOR PHYSICAL LAWFULNESS

Physical laws comprise a proper subset of the class of general propositions.[1] More specifically, physical laws occur among only two classes of general propositions: universal propositions and statistical propositions.

Some writers (e.g., Kemeny 1959, p. 37) have considered physical laws to be found only among those propositions that are mathematical formulas. But I shall regard those physical laws that are mathematical in form to be but a special case, albeit an exceptionally remarkable special case, of universal and statistical generalizations. For example, the mathematical formula that states the connection between the force impressed on a mass and its acceleration, $f = ma$, may be read in an explicit, universal form: "For any f, m, and a: If the magnitude of the mass of an object is m, and the magnitude of its acceleration is a, then the magnitude of the impressed force, f, is m times a." Similarly, the mathematical formulas (too complex and lengthy to be reproduced here) that describe the 'allowable' (better, most probable) electron orbits of an atom may be regarded as statistical propositions.

Although a physical law may in fact apply to no or few items or events in the world, physical laws are not to be thought of as descriptions of specific items or events. Such generality is

1 Physical laws, however, are not empirical generalizations, i.e., propositions inductively generated from empirical data (although, of course, some few of them might come to be entertained by such means). "Generalization" here is to be understood in its *logical* sense, in which it contrasts with "singular"; and not in its epistemic sense, in which it often contrasts with "hypothesis," "conjecture," etc.

Generalizations are propositions about *classes* of things. They are *quantified* propositions, propositions beginning, e.g., with such *quantifiers* as: "for all...", "there is some...", "most...", "many...", "22 percent of all ...", etc.

secured by requiring that the only terms (other than logical and mathematical ones) that may properly figure in a physical law are ones that are purely descriptive.

The concept of *being a purely descriptive term* bears careful examination. For it turns out that being purely descriptive is not the same thing as being ‘unrestricted’; and that certain ‘restricted’ predicates may be regarded – for our purposes – as being purely descriptive and suitable for inclusion within physical laws.

There are two ways that a descriptive term, or predicate, may be restricted: in being analytically restricted to applying to a certain number of things; or in making reference, implicitly or explicitly, to some particular item or event.

The class of predicates that are analytically restricted in their range of application includes such members as: “is the last commercial whaling ship”; “is the largest supernova”; and “is the third longest war.” Although such predicates may fail to apply altogether, they cannot apply to an unrestrictedly large number of things. They may be contrasted with such unrestricted predicates as “is blue,” “is square,” and “conducts electricity,” all of which may – theoretically – apply to any finite or infinite number of various things.

Quinton calls the properties referred to by these former terms “ordinal properties” (1973, pp. 15–16), and the name is apt. I will adopt his nomenclature here, speaking of ‘ordinal properties’ and of the terms that refer to them as ‘ordinal predicates.’

The class of ordinal predicates, however, does not exhaust the class of analytically restricted predicates. The predicate “is the only barred spiral galaxy,” unlike “is the largest barred spiral galaxy,” does not place its subject at any particular position in an ordering. But “only” does share with “largest” the feature of applying to a restricted number of things. Thus “is the only barred spiral galaxy,” and others such as “occurred in the second quarter of the nineteenth century,” must obviously also count as being analytically restricted. Ordinal predicates, then, are but one, but perhaps the most populated, species of the genus “restricted predicate.” For convenience, we will examine ordinal predicates as representative of the latter class.

Do any physical laws include ordinal predicates? Probably the most common use of ordinal predicates is found in statements whose subjects refer to particulars, for example, “Truman was the thirty-third U.S. president” and “Jupiter is the largest planet in the solar system.” Nonetheless, ordinal predicates do often figure in statements not about particular things but about classes of things, for example, "The element with atomic number 35 is the third heaviest of the Halogen group."[2] Or, again, "In a sealed container that is a perfect heat insulator, the final temperature of several things that are initially at different temperatures will eventually stabilize between that of the hottest and that of the coldest."

There seems to be no good reason, then, to regard ordinal predicates as essentially inappropriate for inclusion in physical laws. Indeed, some of the paradigm examples of physical laws are often cast in a form that explicitly invokes ordinal properties: "The coldest temperature any physical state can attain is –273.15° C"; "The greatest velocity to which any object having mass can be accelerated is less than 299,792 km/sec."

Quinton has argued (1973, p. 16) that ordinal predicates can apply only in finite universes. If he were right about this, then there would be a powerful incentive to regard ordinal predicates as excluded from figuring within physical laws. For clearly the question of whether or not a given proposition is a *candidate* for lawfulness ought not to depend on the contingent fact of whether the universe is finite or infinite. Or, to put this a slightly different way: What sorts of propositions are candidates for lawfulness (as opposed to which of these are in fact laws) ought to be a conceptual matter, not an empirical one. If, then, ordinal predicates could apply only in finite universes, we should want to disallow their use in physical laws, for to allow them would require that we had antecedently and empirically determined that the universe is finite.

But I am quite sure that Quinton is mistaken in his contention. Ordinal predicates are as much applicable in infinite universes as in finite ones. Even if there were an infinite number, let's say, of stars, it might still be true that there is some one of them that is the largest, some one that is the smallest, and some one that is the 10,457th largest. After all, there are an infinite number of ordinals, just as there are an infinite number of cardinals. And our use of cardinals is not restricted to finite universes. Of course, though, if there were a very great number of stars, there would be the practical problem of our being incapable of *identifying* the 10,457th largest

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2 It may be to the point to remark that the proposition under examination is contingent inasmuch as being the *third* heaviest member of the Halogen group is not an analytic property of Bromine. It takes a very considerable amount of contingent theory to link these two conceptually distinct properties ("having atomic number 35" and "being a member of the Halogen group").

star. But this practical inability to identify the particular star that bears the ordinal property in question would have nothing whatever to do with there *being* such a star.

I conclude, then, that ordinal predicates – and indeed other members as well of the larger class of which they are merely the most conspicuous members, namely, the class of analytically restricted predicates – need not be disallowed from figuring within physical laws. Analytic restrictedness per se is not an insuperable impediment to physical lawfulness.

However, some analytically restricted predicates offend conceptually in ways having nothing to do with their being limited in application. For example, we should not want to allow Strawson's predicate, "is the first dog to be born at sea" (1964, p. 26), if by "sea" we understand a term tacitly restricted to a watery expanse on one named planet, namely, the Earth. It is only on the proviso that an analytically restricted predicate does not violate any other strictures on acceptability that it may be regarded as sanctioned for use.

The second class of problematic predicates, however – those that make tacit or explicit reference to particular items, places, or times (a class that includes, of course, certain analytically restricted predicates, e.g., the just-mentioned narrow construal of "is the first dog to be born at sea") – cannot so easily be accommodated.

"Copper has a greater specific gravity than aluminum" is perfectly general or, to be more precise, all its nonlogical and nonmathematical terms apply in principle to any number of things in the world. "Copper has a greater specific gravity than the specific gravity of this coin in my hand" is not perfectly general. "This coin in my hand" refers not to a *kind* of thing or to a property but to a specific particular. (And the predicate "the specific gravity of this coin in my hand" may be thought to refer to a property-token rather than to a property-type.)

We should want to lay it down as a requirement that the terms in a physical law should not refer to specific items in the world. Proper names of individuals, for example, "Truman," would be barred; and likewise would "is Truman" or (from Quine's class of neologisms) "Trumanizes," when this latter is used as a predicate necessarily applicable only to Truman. ("Trumanizes" is perfectly alright if taken to be equivalent to some set of properties that in fact, but not of necessity, uniquely applies to Truman, e.g., "completed his predecessor's fourth term in office and approved the expenditures of vast sums of money in aid to his country's vanquished enemy at the end of a global war.") More generally, no physical law may include a term such as

"= *a*" where *a* is the name of any particular item. But a predicate can fail to be purely descriptive without explicitly referring to specific particulars.

Spatial and temporal *coordinates,* singly, as opposed to spatial and temporal *relations*, are not purely descriptive terms. The predicate "is at 46° W longitude and 19° S latitude" clearly makes a tacit reference to the planet Earth.

Insofar as we regard physical laws as holding for all places and times, it would be contrary to our notion of lawfulness to allow that a law should make explicit or tacit reference to some particular place or time. (Kepler's laws seemingly present a historical counterexample. We will examine them in just a moment.) Our conception of physical law doesn't allow that one law should apply to the Northern Hemisphere of the Earth and another to the Southern Hemisphere of Venus; that one law should apply to the eighteenth century and another to the nineteenth.

Differences between spatial coordinates and *differences* between temporal events *do* figure in physical (and scientific) laws. But differences between spatial coordinates, as opposed to the coordinates themselves, are purely descriptive predicates. There are no physical laws pertaining to 46° W longitude and 19° S latitude, although there well may be to things separated from one another by the distance *between* 46° W longitude and 19° S latitude and 50° W longitude and 28° N latitude. Cities *A*, *B*, *C*, and *D*, all of which have different spatial coordinates, may pairwise stand in identical spatial relations free of any reference to any particular place (e.g., to the location of 0° longitude, i.e., Greenwich, England): *A* may be 103.5 km from *B*; and *C*, 103.5 km from *D.* Physical laws may invoke mathematical functions – differences (e.g., lengths, "is 50.552 m"), products (e.g., areas, "is 2.3 km^2"), quotients (e.g., "is 1,045 km/hr."), etc. – of pairs, triples, etc., of spatial and temporal coordinates, but never spatial or temporal coordinates *neat.*

Until recently, the predicate "is 50 m long" could not have been regarded as purely descriptive, for it tacitly referred to the standard meter bar maintained in Paris. But in 1960, the International Bureau of Weights and Measures changed the standard from that of the distance between the two lines drawn on the platinum-iridium bar to 1,650,763.73 wavelengths of the orange-red line from the isotope krypton-86, measured in a vacuum. With this change, the predicate "is *x* meters in length" became purely descriptive. Similarly, the unit of time is not defined by the pulsing of any particular clock, but by the oscillation of *any* atom of cesium (1 sec. = 9,192,631,770 oscillations of a cesium atom).

Clearly, then, I am rejecting Pap's contention that laws *can* make tacit reference to specific items (1962, pp. 292–5, 301–5). Pap cited the case of Kepler's laws, which do, certainly, refer to a specific item, the sun. Given the choice between saying that Kepler's laws are genuine laws and saying that laws cannot refer to specific items, he chose the former.

There is a way, though, to avoid having Pap's choice forced on us. By adopting the distinction made in Chapter 1, between physical laws and scientific laws, we can capture the intuitions of scores of philosophers who have argued that laws should be regarded as having only purely descriptive terms. We accommodate these intuitions by insisting that the descriptive terms of *physical laws* are always purely general; the descriptive terms of *scientific laws* may refer – implicitly or explicitly – to specific times, places, things, events, etc. It would follow, then, that Kepler's laws are scientific laws, not physical ones. Kepler's laws may be derived as a special case of Newton's Laws;[3] but Newton's laws *do not* make reference to any particular items in the world.

Goodman's notorious hypothesis "All emeralds are grue" poses certain problems parallel to those of Kepler's laws. Where Kepler's predicates made reference to a certain position in space (the center of the sun), Goodman's "grue," it would seem, makes reference to a specific time.

> The predicate ''grue''... applies to all things examined before *t* just in case they are green but to other things just in case they are blue. (1965, p. 74)

In reconstructing Goodman's definition, other philosophers have departed from his original version in at least two ways. For example, Kyburg drops the qualification "examined," so that "grue" applies to all things that are green before *t* (whether or not they are examined) and that are blue after *t*. This sort of revision makes no difference for our purposes. The predicates "is green" and "is examined and found to be green" are both purely descriptive, and both may properly

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3 "Special case" in this instance, as in so many others, means "using certain *false*, simplifying assumptions", e.g., that the planets do not affect one another's orbits, i.e., that the 'three-body problem' can be solved by two applications of the 'two-body' solution. Indeed, Newton's laws themselves are false (i.e., not quite true) as learned from developments in twentieth-century physics.

figure in a physical law. Far more troubling, however, is the term *t*. How is this to be understood? As a constant, that is, as some particular time? Or as a variable, that is, as merely some time or other? Goodman's own discussion is somewhat vague on this matter, but perhaps favors the former reading, for he does begin his preceding paragraph by writing "Suppose that all emeralds examined before a certain time *t* are green" (p. 73). Kyburg takes *t* to be a constant; indeed, he lets *t* be the year 2000 (1970, p. 132). Scheffler, however, allows that *t* should take on a successive series of values and thus treats *t* like a variable (1966, p. 455).

In any event, we can define two senses of "grue," a stronger and a weaker. The stronger sense mentions a specific time, the weaker only an indefinite time.

> A thing is (strongly) grue if there is some specific time *t* [e.g., the year 2000] before which it is green and after which it is blue.
>
> A thing is weakly grue if there is some time (or other) *t* before which it is green and after which it is blue.

The predicate "is grue" (i.e., "is strongly grue") refers to a specific time. It cannot, then, figure in a physical law. But "weakly grue" is purely descriptive. To say of something that it is weakly grue is formally analogous to saying, for example, that in the history of a certain sample of polymer resin there is a time (or some interval) before which it is a liquid and after which it is a solid. Such changes do occur and must be reckoned to fall under physical laws.

Certain items in the world *are* weakly grue, for example, the water in a vase in which a watercolor artist dips her brushes as she paints. But even if certain specific *items* in the world are weakly grue (some may even be strongly grue for that matter), are there any *kinds* of things which are weakly grue? More specifically, are there any physical laws in which "is weakly grue" figures? Might emeralds, for example, fall under a law of the sort, "All emeralds are weakly grue"?

This latter proposition clearly meets all the criteria for lawfulness so far laid down, but for one. We are unsure whether "All emeralds are weakly grue" satisfies the condition of being true. To date, it seems not to be true. What should our expectations (predictions, projections) be? Should we bet on this proposition being true? Like Goodman, I am confident that we should not. It is reasonable to believe that emeralds are neither weakly grue nor strongly grue, but are green.

Goodman's problem remains to try to find a rational basis for selecting one of two inconsistent *scientific* hypotheses ["Emeralds are green" vs. "Emeralds are grue" (we will read "weakly grue")], each of which is (allegedly) consistent with the same body of available evidence. His is far removed from our problem. "Emeralds are green" and "Emeralds are weakly grue" on the present account are equal candidates for being a physical law. Since these two propositions are logically inconsistent with one another, at most one can be a physical law, because at most one can be *true*. Finding out which is true, even elucidating conditions under which it would be reasonable to believe that one rather than the other is a safer hypothesis, is no part of the job of elucidating what the concept of a *physical* law is. Whether something is to be reckoned a *scientific* law does intimately concern the evidential basis for belief in that proposition and may well concern such matters as the history (or projectability) of the predicates figuring in that proposition. But such epistemological and historico-linguistic considerations are totally irrelevant in the conditions for being a physical law. After all, there is a logical possibility that emeralds *are* weakly grue. We should hardly, then, want to lay it down that there could be no physical law to that effect. In the end, it must be a contingent matter, and possibly an empirical one, but not a conceptual one, whether emeralds are weakly grue. Although "is grue" itself (i.e., "is green prior to the year 2000 and blue thereafter") must be excluded from physical laws, "is weakly grue" (i.e., "is green at some time or other and blue thereafter") is purely descriptive and must be permitted.[4]

By disallowing that unique spatial positions (e.g., "focused on the sun") and unique temporal positions (e.g., "is grue") should figure in physical laws, we thereby avoid the question of whether a jointly held position in space *and* time allows for several instances (occupants) or at most one. Quinton has argued for the latter thesis (1973, pp. 17-20), saying that, although any number of things can successively occupy one and the same location, and although any number of things can (and typically enormous numbers do) all exist at different places at any given moment of time, no more than one thing can occupy a joint position in space *and* time, for example, "is at P_1 at T_1" admits of no more than one instantiation. In this latter regard, "is at P_1 at T_1" is to be likened to the ordinal predicate "is the tallest man." On the other side, Waismann, for one, presupposed the logical possibility of there being multiple occupants of unique spatiotemporal positions (1965, pp. 201-2). He produced a counterfactual example of two

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[4] In a passing remark, Goodman expressed some worries about the very concept of a proposition being purely general, being free of reference to particular times and places. He cites the example "All grass is green," which he points out is logically equivalent to "All grass in London or elsewhere is green" (1965, p. 78). Does this pose a problem for our analysis? I am inclined to think not. "All grass in London or elsewhere is green" is merely an idiomatic paraphrase of "All grass in London or not in London is green." In this proposition, the predicate "in London" refers to a specific place; however, the expression occurs vacuously, or inessentially, inasmuch as *any other* spatial predicate whatever could be substituted for both occurrences and the resulting proposition would retain its original truth-value. In short, "in London or not in London" is not playing an informative role; it does nothing to change the extension of the term to which it is conjoined and may be thought to be a logical curiosity but no special problem.

physical chairs, which, on a collision course, merge into the same place. For Waismann, joint positions in space and time – in principle, if not in actual fact – clearly permit multiple instances. Even though I think Waismann is certainly right in this dispute, we need not become entangled in the controversy. For we have already rejected individual positions in space, as well as individual positions in time, as suitable properties for inclusion within a physical law. A fortiori, individual positions in space *and* time are also rejected. If there are no physical laws referring to the geographical center of Vancouver, and if there are no physical laws pertaining exclusively to December 11, 1968, then there are no physical laws restricted to the center of Vancouver on December 11, 1968.

In proscribing predicates that make tacit references to individual items and to specific places and times, we disbar from use in physical laws more than just (i) spatial and temporal coordinates, (ii) identity predicates that refer explicitly to individuals, for example, “is Truman” (“ = *a*”), and (iii) the neologistic equivalents of the latter, such as “Trumanizes.” We also disbar (iv) all indexicals, such terms as “here,” “now,” “his,” “hers,” and “yesterday”; and (v) demonstratives such as “over there,” “in this immediate vicinity,” “there, where I’m pointing,” “this” (accompanied by a gesture), and the like. In short, we also exclude all those predicates whose referents are determined, in part, by the circumstances or context of their use. What remains from this winnowing is the class of predicates that may be regarded as purely descriptive and hence that may be regarded as suitable for inclusion within physical laws.

What exactly does it mean for something to ‘fall under’ a physical law? What *sorts* of ‘things’ fall under physical laws?

For a start, neither individual properties, nor a bundle of properties, nor single events, etc. (see next section of this chapter), fall under physical laws. Although they do fall under necessary universal conditionals of the sort “if any thing (/event) has the property *P*, then that thing (/event) has the property *P*,” necessary truths are not to be reckoned among the class of physical laws.

Only contingently connected properties, contingently connected events, etc., fall under physical laws. That some given object is blue is not the right *sort* of thing (/fact) to fall under a physical law. Nor for that matter is the *conjunctive* property of being blue, cubical, weighing 2.1 kg, and having a temperature of 4.5° C. Similarly, the single event of a child dropping her toy is not the right sort of thing to fall under a physical law. Nor is the conjunctive event that consists of Able, Baker, and Charlie all falling ill together with food poisoning.

Single properties and conjunctions of properties do not fall under physical laws. But *pairs* of properties and states, where the members of these pairs are either single properties and states, or conjunctions of properties and states, may well fall under a physical law. The opacity (tout court) of the steel object on my desk falls under no contingent generalization. Neither does its being steel. And neither does its being both steel and opaque (where “being steel and opaque” is construed as a conjunctive property). But the ordered pair that consists of being steel and being opaque *does* fall under a contingent generalization: “Steel things are opaque” or “If anything is steel, then it is opaque.” We will have to, then, distinguish between, on the one hand, properties and conjunctions of properties; and on the other hand, pairs of properties, and pairs of conjunctive properties. Only the latter among these things distinguished may fall under a physical law.

Ordinary speech is not especially sensitive to the distinction between conjunctive (or conjoined) properties and paired (or connected) properties. We are likely to say that a metal's *conducting heat and conducting electricity* falls under a physical law. And this manner of speaking might – uncritically – be taken as evidence that conjunctive properties *can* fall under a physical law. But the grammatical form is misleading. It is rather the *pair* of properties – (i) conducting heat; and (ii) conducting electricity – that falls under a physical law. In exactly parallel fashion, it is only *sequences* of events (e.g., exposure to the measles virus and the subsequent developing of the disease), but not single events (e.g., either the exposure itself, or the outbreak of the disease itself), that may fall under physical law.[5]

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5 *Sequences* of events are of course events ordered in time. Why is science so little concerned with events ordered in space? If the concepts of space and time have the kind of formal parallelism often claimed for them (see, e.g., Taylor 1964 and Swartz 1973, 1975), it is surprising that there are few if any scientific laws concerning events separated by space and not time. Is this because of some contingent fact about this particular world, or does it have to do with some essential feature of the very concept of causal relation itself? Many philosophers have tried to describe hypothetical situations in which we would want to say that causal relations worked backward, from later to earlier. The verdict on these attempts is not yet in. But few philosophers have been equally concerned to see whether they could describe situations (possible worlds) in which spatial differences played the analogous role to that of temporal differences in the actual world. I have no a priori grounds for excluding the possibility of there being such worlds. And thus I do not want to make it a requirement of falling under a physical law that the events connected must be at different times. What connections there are, and whether in time, space, or time and space, seems to me (pending a good argument to the contrary) to be an empirical question; hence, I leave it as open whether the lawful connections that obtain between events might be other than temporal, e.g., whether there might be lawful connections between contemporaneous (i.e., simultaneous) events that are spatially noncontiguous. Newton thought there were, in his belief that gravity propagated instantaneously across space.

Physical laws state connections. Formally, this means that physical laws must be conditional propositions, not categorical ones.[6] Physical laws do not state that the world *is* thus and so; only that *if* it is thus, *then* it is so.[7] In ordinary speech, the conditional form of physical laws is, more often than not, masked. Physical laws often tend to be presented in categorical form: "Aluminum

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[6] Throughout this book. "$\supset$" will be used to symbolize the truth-functional relation of material conditionality; and "$\rightarrow$" to symbolize the stronger, modal relation of entailment or logical implication.

[7] We may want to allow for a few exceptions. The late N. R. Hanson was fond of invoking in his lectures the case of the centaurs, arguing that their existence was a 'biological impossibility'. A centaur would have to have two sets of lungs, an esophagus passing through its upper bowels, etc. If *C* is the predicate "is a centaur," is it a physical law that nothing is a centaur, i.e., $(x)(\sim Cx)$? Such a proposition, note, is categorical, not conditional. My inclination is to refine the example, taking "is a centaur" as a defined predicate, which in fact abbreviates "is half-human and is half-horse." If so, then that there are no centaurs may be thought to be a consequence of (because equivalent to) the *conditional* universal truth that, if anything is half-human, then it is not half-horse. Alternatively, if we want to allow that categorical universals of the sort "nothing is a centaur" [i.e. $(x)(\sim Cx)$] can be physical laws, then we can incorporate these peculiar cases by a minor logical sleight-of-hand, by regarding them as 'degenerate' conditionals of this sort: $(x)(Cx \supset \sim Cx)$. (This latter conditional is, of course, logically equivalent to the preceding categorical proposition.) I will continue, then, to regard physical laws as conditional propositions, but will allow for the possibility that some of these conditionals may be 'degenerate'.

melts at 660.37° C"; "The half-life of lead-214 (Pb^{214}) is 26.8 min."; and "$E = mc^2$." But each of these apparently categorical propositions properly ought to be understood as fundamentally conditional: "If anything is aluminum, then its melting point is 660.37° C" (a universal conditional); "If anything is a 'large sample' of lead-214, then (just about) one-half of the total number of lead-214 atoms will spontaneously decay in any period of 26.8 min." (a statistical conditional); and "If the magnitude of the mass of an item is *m*, then the magnitude of the energy 'contained in' it is equal to *m* times the constant *c* squared" (a numerical conditional).

For there to be connections of the kinds just spoken of, there must be at least two items to be connected. Connectedness, in the sense required for physical laws to apply, is a nonreflexive relation. The relation "has the same electrical conductivity as" is a relation that holds contingently between any two pieces of copper and necessarily between any one piece of copper and itself. If *x* denotes a piece of copper, and if *y* denotes a piece of copper, then *x*'s having the same electrical conductivity as *y* 'falls under' a contingent conditional if $x \neq y$; *but under a necessarily true conditional if* $x = y$.[8] To fall under a physical law requires, at a minimum, that the relevant conditional proposition be contingent and that the things 'connected' be at least two.[9]

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8 If we let *C* stand for "is copper" and *S* stand for "has the same electrical conductivity as," then the true universal conditional

$$(x)(y)(Cx \,\&\, Cy \supset Sxy)$$

has a specialization that is always contingent, viz.:

$$(x)(y)(Cx \,\&\, Cy \,\&\, [x \neq y] \supset Sxy)$$

and a specialization that is logically necessary, viz.:

$$(x)(y)(Cx \,\&\, Cy \,\&\, [x = y] \supset Sxy)$$

The latter is, of course, equivalent to:

$$(x)(Cx \supset Sxx)$$

9 Putnam (1975) has argued that on one theory, "Water is H_2O" (or, as I would rephrase this statement to make the parallel explicit with our form for lawfulness, "Whatever is water is H_2O") turns out to be contingent, and on another theory to be necessarily true. Putnam opts for the latter theory. He argues that if it is true that water is H_2O (and this he says can be learned only a *posteriori*, i.e., empirically), then it is a necessary truth that water is H_2O. That a necessary truth should be knowable only a posteriori causes me no particular worry. (See Bradley and Swartz 1979, pp. 168-9). Nor need I pause for fear that his conclusion jeopardizes my insistence that physical laws are contingent. For, if Putnam is right, if "Water is H_2O" can best be understood to be a necessary truth, *[footnote 9 continued on page 26]*

'Falling under' may be conceived in either of two equivalent ways. Consider the physical law $(x)(Px \supset Qx)$. Then, Pa and Qa may be said to fall under this law because either

Pa and $(x)(Px \supset Qx)$ together entail Qa,

or, equivalently,

$(Pa \supset Qa)$ is a substitution-instance of $(x)(Px \supset Qx)$.

This notion of 'falling under' bears further examination. We focus on the case of universal generalizations.

Clearly, the overwhelming majority – but not quite all – of the sequences of events, and the pairs of properties, states, etc., in the world do **not** fall under universally true, contingent conditionals. The whiteness of the sheet of paper on which this chapter began and the rectangularity of that sheet do not fall under such a true universal conditional. For there are countless things that are white and not rectangular. Similarly, my driving to work and later that day receiving an unwanted solicitation in the mail to buy a lottery ticket do not fall under a true universal conditional. Driving to work is not always followed by the receipt of unwelcome mail. (Of course, these cases do fall under some statistical generalizations.)

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9 *[cont.]* then, according to the account given here of physical lawfulness, this statement simply is not a physical law, no more so than the statement that all triangles have three sides. (This is not to say that there are not, in other regards, profound disanalogies between these two statements.) Provided other conditional, general statements with purely descriptive terms remain logically contingent – and I see nothing in Putnam's analysis to deny this – then one can proceed to ask of these latter statements which ones are physical laws.

Putnam argues, in effect, that the statement "*A* is *MNO*" – where *A* is a natural kind term and *MNO* a description of its 'hidden' (or micro) structure – is necessarily true. Putnam offers little, except by example, of what a 'hidden' structure might be, e.g., H_2O in the case of water. I am presuming that in Putnam's account, such statements as "Water has a vapor pressure of 41.8 Torr at 35° C and a vapor pressure of 233.3 Torr at 70° C" do not turn out to be necessarily true, that having a vapor pressure of 41.8 Torr at 35° C is not part of the 'hidden structure' of water. Clearly, in the example above, concerning the electrical conductivity of copper, I am assuming that, at the most, Putnam's theory – if true – would have it that the necessary truth about copper that corresponds to that about water would be something of this sort: "Copper is that element (/stuff) that has an atomic nucleus of 29 protons" and would not imply that copper's having some *one* specific value of electrical conductivity at some particular temperature was likewise a necessary truth. If these presumptions are not correct, then it would seem that Putnam's account would render every physical law a necessary truth, and the dream of the seventeenth-century Rationalists would have been realized. Were this conclusion to be warranted by Putnam's theory, I would regard this as a *reductio* of that theory.

But, as we continue our examples, we begin to feel a bit uneasy. What about my turning up the thermostat and the subsequent start of the furnace? Isn't there concealed in this sequence a pair of events that do fall under a universal conditional, even if not *all* settings of thermostats higher are succeeded by furnaces starting? Surely – we'd be inclined to say – there is some more detailed description of what I did such that, given *that* description, the starting of the furnace does logically follow from it, taken in conjunction with some true, purely general universal proposition.

This objection must be granted; indeed, the presupposition involved in it must be made explicit and underscored. The essential point is that which generalizations, if any, a sequence of events falls under will depend on the description of those events. My setting the thermostat higher – that is, my performing action *A* – is an occasion on which *B, C, D, E* ... *J* are also all true. (Some of these latter may include various facts about the thermostat, its manner of being wired to the furnace, the condition of the furnace itself, the quantity and flow of fuel, etc.) Describe my action not simply as *A,* but as *A* and *B* and *C* in circumstances *D* and ... and *J*, and it may well be true, indeed certainly will be true, that this more specifically described event does fall under – not a statistical but – a universal conditional whose consequent describes the starting of a furnace.[10]

Clearly, our familiar, unreconstructed ontology presupposes events. But we must take care to recognize that there is no empirical science of events *as such.* Empirical science can deal only with *kinds* of events. Only events under descriptions fall under physical laws. Hempel made this point in a classic paper when he wrote:

> The object of description and explanation in every branch of empirical science is always the occurrence of an event of a certain *kind*.... (1949, p. 460)

Although Hempel was theorizing about how we explain events, the point is equally valid as regards the strictly logical relation of an event's falling under a generalization. Only inasmuch as an event is *characterized* is it even meaningful to conceive of it as falling under a physical law.

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10 There may well be superfluity in these additional conditions. But remember, if "(L & M) $\supset$ Q" is true, then so too is "(L & M & N) $\supset$ Q." I.e., once a sufficient number of conditions has been specified so as to make the description fall under a true universal generalization, then to specify further conditions also obtaining will result in a description that also falls under a true universal generalization.

And just as there is no science of events per se, there is, equally, no science of 'individual events.' This follows, of course, from my insisting a moment ago that physical laws must be purely descriptive in their terms. Mount Saint Helens's eruption on May 18, 1980, falls under physical law inasmuch as it was an eruption (of a certain kind *Q*), occurring under circumstances (of a certain kind *R*) of a volcano (of a kind *S*), etc. But there is no physical law pertaining analytically to Mount Saint Helens exclusively. This is not to say, however, that there might not be one or more physical laws such that the circumstances leading up to the eruption and the eruption itself were those generalizations' *only* instance. Generality does not require that there be more than one instance; nor does it require, even, that there be at least one instance. But generality does require that the proposition not be analytically restricted to specific individuals (or events).

One must be careful, then, when speaking of some particular event *E* as falling under a physical law. Descriptions that are often sufficient to *individuate* an event ("the first eruption of Mount Saint Helens in the twentieth century," "Ford's pardoning of Richard Nixon," etc.) are often very meager, often contain proper names and other restricted terms, and often fail to specify – as is required for 'falling under' a law – a sequence of events. Thus Ford's pardoning Nixon is an event that falls under a physical law only to the extent that it has some general description and is identified as a member of a pair (or sequence) of similarly generally described events.

A somewhat odd consequence of this analysis is that 'one' sequence of events might be either physically possible or physically impossible, depending upon what description one gives of the events involved. (In saying this, I am, of course, talking about nonactual events, since any and every actual happening in the world, under *any* true description, must be physically possible. My point here concerns failed attempts, imagined or counterfactual circumstances, etc.) We will see (in Chapter 4) that a proposition (and derivatively the circumstances of states of affairs it describes) is physically possible if and only if it is not inconsistent with a physical law. Let us assume that it is a physical law that no mass is accelerated to a speed in excess of 299,792 km/sec. If, then, we were to describe some attempt to propel electrons in an accelerator as an attempt to accelerate them to a speed in excess of 200,000 km/sec., we should want to say that this kind of sequence – introducing the electrons into the machine; pumping energy into the machine; and the electrons' eventually attaining a velocity in excess of 200,000 km/sec. – is physically possible. But suppose our attempt to propel the electrons to this high speed admits of a more precise description, for example, it was in fact an attempt to propel the electrons to a speed of 410,000 km/sec. Under this latter description, the realization of the sequence is physically impossible.

Shall we regard (i) the attempt to propel the electrons to a speed of at least 200,000 km/sec. and (ii) the attempt to propel the electrons to a speed of 410,000 km/sec. as one event or two? We tried to achieve the latter, higher velocity, and in so doing (logically) had to try the former as well.

Ordinary speech favors the analysis that would say there was *one* attempt – one that admits of different descriptions. We typically individuate events by means of very meager descriptions indeed, and we then go on to elaborate these descriptions – filling in the details, as it were – all the time thinking ourselves to be describing one and the same event. So long as we persist with the (probably well-taken) resolve to allow that 'one' action may admit of different descriptions, we will have the result that a (nonactual) sequence of actions (or events) may be physically possible under one description and physically impossible under another. (We will return to this point in the section "Singular propositions and physical possibility" in Chapter 5.)

This much constitutes the common core of various theories of physical laws. Physical laws are true; contingent; purely descriptive in their terms; and conditional. They are also general; that is, a physical law is either a universal or a statistical proposition. But, from this point on, the major theories of the nature of physical laws diverge considerably in their respective claims. The question will be whether these various properties constitute merely a set of necessary conditions for physical lawfulness, or whether they might constitute a sufficient set.

FACTS, EVENTS, STATES OF AFFAIRS, ETC.

I have said in the previous section that only pairs of states and sequences of events may fall under physical laws. The intended contrast was with single states and single events. But the question properly arises whether any other sorts of pairs, besides states and events, may also fall under physical laws.

To the extent that scientific laws are surrogates for physical laws, one may assume that they presuppose the same ontology, that is, that the sorts of 'things' that fall under the former fall under the latter. But when one looks for guidance in the answer to this question to the class of *scientific* laws, one is presented with a truly bewildering array. There seems to be virtually no limit to the sorts of things regarded as falling under scientific laws. Events are alleged to be lawfully connected; so are the states of objects, their properties and relations, both qualitative and quantitative; so are dispositions, traits, classes of objects, states of affairs, and facts. Even this list is scarcely complete.

Some authors have argued that physical lawfulness holds between spatiotemporal items; others that it holds between universals (i.e., between properties and relations). Others argue that events are the subject matter of physical laws. Others that numerical magnitudes are. And so on.

Sorting out all of this is quite properly a role for metaphysics. And yet, no attempt will be made to do so here. One cannot solve every problem, and some must be put aside for another day. I think this is one of those problems. To answer the kinds of questions I posed in Chapter 1, namely, having to do with the modality, number, and the truth-conditions for physical laws, one need not have settled views about the subject matter of physical laws.

Now this claim must seem strange. How could the subject matter of physical laws *not* have a bearing on the question of, for example, the modality and truth-conditions of physical laws? To answer this, I must explain more precisely just what it is about the modality and truth-conditions of physical laws that concerns me.

The questions that occupy me in this book are *independent* of those having to do with, for example, questions as to the truth of realism or nominalism. Although realism and nominalism might give (or allow) different verdicts as to the sorts of things lawfully connected by physical law (e.g., nominalists may be expected to eschew universals), neither theory assigns a determinate modal status to physical laws. Thus, suppose it is true that every case of having a lung is also a case of having a heart; and suppose that one were intent to formulate a covering law. What is it exactly that would be lawfully connected? According to one’s preferred theory as to the subject matter of physical laws, one might argue that it is two *classes*, the class of those things having lungs and the class of those things having hearts, that are lawfully connected. Alternatively, one might opt for the theory that it is the *properties*, of having a lung and of having a heart respectively, that are lawfully connected.[11] And still others might prefer to argue,

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[11] E.g., Dretske (1977) argues for this latter theory against the preceding one.

for example, that it is the *event* of one's having a lung that is lawfully connected with the event of one's having a heart. Etc.

As important as these differing views may be, they do not bear on the question I am intent to pursue, namely, what sense are we to make of the notion of 'lawful connectedness,' If *A* is a lawfully sufficient condition for *B*, then whatever sorts of things *A* and *B* might be, we will still want to inquire: Is this relationship of *A*'s being sufficient for *B* (taking the case where the connection is universal, for example) a case of logical sufficiency, nomological sufficiency, or mere universal – but contingent – sufficiency? One's realism or nominalism will not answer these latter questions; indeed, those theories seem not to bear on the matter at all.

Similarly, the specific question I am intent to pursue about the truth-conditions of physical laws seems to me to be independent of whether one takes the subject matter of physical laws to be events, properties, classes, facts, states of affairs, or whatever. My concerns are of a much more global nature. I want to know whether the truth of physical laws comes about because of the events, properties, classes, facts, states of affairs, or whatever else their subject matter might be; or whether these laws might derive their truth from some other source in such a way as to 'make' these events, properties, classes, facts, etc., have the connectedness they in fact instance.

I am happy, then, to be quite liberal in what sorts of pairs might properly be thought to fall under a physical law. I herein usually talk of events and states (and late in the book of classes and quantitative properties) as falling under physical laws. But this is only because I think these categories fit well the standard examples.[12] I am hardly insistent on these specific categories, however.[13] Those who prefer facts, or states of affairs, or something else, can – I think – substitute their own preferences for mine and still leave intact the thrust and tenor of the discussion that follows.

THE PRINCIPLE OF DETERMINISM

When an ordered pair falls under (or equivalently, is subsumed by or covered by) a *universal* physical law, it is customary to speak of its second member as being *determined* by the first

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12 On occasion, I will speak, too, of projects, actions, undertakings, etc. But these I regard as cases of events.

13 I am not even sure that states and events ultimately are different categories. I must confess to a certain attraction to the theory that would make states long-lasting, semipermanent, enduring, or 'stagnant' events.

member and that law. Thus, for example, we may speak of the event of some particular instance of an ice cube melting as having been determined by the antecedent condition of its having been heated to 40° C and the universal physical law that ice melts above 0° C. Similarly, the state of some particular sample of table salt being cubical may be said to be determined by the electronic configurations of its sodium and chlorine constituents and the relevant universal physical law that states the relationship between such configurations and a cubical crystalline structure.

Several different propositions have variously been called the "Principle of Determinism." But in light of the distinctions just given, I propose to adopt the following as the official version for the purposes of this book.

> Every event (/state) is a second member of a sequence (/pair) that falls under a universal (i.e., deterministic) physical law

Two of the most familiar supposed implications, or perhaps alternative formulations, of the Principle of Determinism bear the names (1) the "Principle of the Uniformity of Nature" (alternatively, the "Principle of Repeatability"); and (2) the (Laplacean) "Principle of Predictability in Principle" (alternatively, the "Principle of the Possibility of Forecastability"). In Chapter 11, I will turn to these latter two principles. But for the present, I wish to examine only the official version.

We must take care not to confuse the Principle of Determinism for physical laws with the corresponding version for scientific laws. The two principles are quite distinct. Scientific laws, as I argued in Chapter 1, satisfy a different set of necessary conditions than do physical laws. Scientific laws must, for example, be confirmed, and must bear intratheoretical liaisons with other scientific laws, hypotheses, etc. A Principle of Determinism for scientific laws, modeled after the official version for physical laws, would be unequivocally contingent. (Provided, that is, it were asserted as a truth-valued claim, and not as a methodological precept, e.g., as a precept to the effect "Never abandon the search for covering scientific laws.") It is certainly a contingent matter whether every event (/state) is a second member of a sequence (/pair) that can be brought under some proposition that bears a certain number of epistemic and systemic features. And the truth of any claim to the effect that such is always possible, if knowable at all, can be knowable only a posteriori.

But when a Principle of Determinism is advanced, as it is here, for *physical* laws, its modal status is considerably more problematic. The *epistemic* and *systemic* criteria that figure in the analysis of the concept of scientific law are not features of *physical* laws. Physical laws need no confirmation, no acceptance, no systemic inductive warrant, etc. Physical laws may occasionally be, but hardly need to be, part of a scientific *theory*. The criteria for being a physical law are quite different from those for being a scientific law.

I have, to this point, stated five necessary conditions for any proposition's being a physical law. A proposition is a physical law only if it is a contingently true conditional, of universal or statistical form, all of whose nonlogical and nonmathematical terms are purely descriptive predicates. Shortly, we will see that according to one theory of physical lawfulness, the Regularity Theory, these various necessary conditions are held to be sufficient for physical lawfulness. Now it might occur to some that these various conditions are easily satisfiable, so easily and readily satisfiable, in fact, that were they alone to guarantee physical lawfulness, no event (or state) whatever could possibly fail to be determined. If this suspicion were to turn out to be true, then, according to the Regularity Theory, the Principle of Determinism would have to be reckoned a necessary truth.

It is hardly a sine qua non of a satisfactory theory that the Principle of Determinism turn out to be contingent. Indeed, some Regularists (e.g., Kemeny) have thought the Principle to be necessarily true and have been quite unperturbed at the prospect.[14] Still, we shall want to see for ourselves just what modal status the Principle of Determinism would have were there to be no further conditions required for physical lawfulness than those just remarked.

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[14] Kemeny (1959, pp. 39-41), argues that all events must fall under 'Laws of Nature': "We can prove that any given phase of the world is covered by some mathematical law correctly interpreted" (p. 39). His subsequent example centers on mathematical laws, showing how, in effect, the temperature of New York City satisfies a mathematical law that is itself just the function that maps the times of occurrence onto the changing temperatures of that city. In being a numerical formula, Kemeny's 'law' poses no particular difficulty whatever. But there is a feature of his formula that does prevent his argument from providing a definitive answer to the question concerning the modal status, within the Regularity Theory, of the Principle of Determinism. For the formula Kemeny constructs does not satisfy all five conditions for lawfulness elicited above; specifically, not all its predicate terms are purely descriptive. It tacitly makes reference to a particular place, viz., New York City. Kemeny makes no claim, and it would seem that he cannot, on behalf of his formula being universally applicable. Thus his argument does not clinch the matter for us, who are operating under a more restrictive set of criteria for lawfulness.

For the Principle of Determinism to be contingent, there must be both possible worlds in which it is true and possible worlds in which it is false. The possible worlds in which it is true pose no problem. It is relatively easy to describe some. This world, for example, was for several centuries believed by many scientists and philosophers to be one in which the Principle is true. Any possible world that is as this world was believed to be is one in which the Principle is true. But finding possible worlds in which the Principle of Determinism is false, particularly when the Principle is taken as asserting no more than that events are determined by contingently true universal conditionals having purely descriptive terms, is rather more difficult. As a matter of fact, it takes some ingenuity to construct such a world. Nonetheless, I think it can be done.

Before we try, let’s see why it is difficult. Suppose, for example, there were a series of coin flippings in this world and that the outcomes were truly random, that is, fit no specific pattern. The trouble is that, although no formula could be given for the *entire* series, each *member* of the series could be brought under a universal conditional. Suppose each member of the series has a uniquely individuating description in purely descriptive terms. This is entirely plausible insofar as each member can uniquely be identified by its own spatiotemporal position. Then, for each item, we can construct a proprietary universal generalization of the sort, “Whenever a coin is flipped at *m* seconds after the eruption of a volcano that kills exactly *n* persons (we assume that for some value of *n* this latter is a unique event in the history of the world), and is at a distance of *p* meters from the center of that volcano, then the coin turns up heads (or tails, as the case may be).” (Each coin flipping throughout history will have associated with it a unique ordered pair of constants, $\langle m, p\rangle$.)

Against this background, let’s try to construct a possible world in which some event occurs that is not the second member of a pair of falling under *some* universal generalization. Consider a possible world, *W#*, in which the entire history of the world, save for one series of coin flippings, is cyclical. (I doubt that the inhabitants of the world would know that theirs was such a world; but that would not count against its being such a world.) I hope such a notion is coherent. Many philosophers have speculated that cyclical worlds are logically possible, and I will similarly assume so. The sequence of coin flippings, unlike the other events in *W#,* does not repeat: It is truly random. We must suppose, further, that the tosses are neither taken account of, nor recorded, for these latter events – were they to occur – would have to recycle endlessly. We suppose, that is, that the outcomes of the various tossings have *no* causal consequents. (I must confess to being worried about the intelligibility of the very notion of "some particular toss of the coin" under the circumstances described; but again I will assume that the notion is coherent. If not, then perhaps the Principle of Determinism as currently construed is logically necessary after all.) Under the circumstances described, no toss of the coin is 'determined'; for there is no universal generalization connecting that toss to any previous toss or to any previous run of tosses; neither is there any universal generalization connecting that toss to anything else in its world, for every feature whatever of that world is in some cycles followed by heads and in other cycles followed by tails. Thus – with some bullying perhaps – the Principle of Determinism, even when construed as the claim that events are determined by no more than 'mere' universal generalizations, remains contingent.[15] It would seem, then, that it remains an open question – but one to be answered empirically only with great difficulty – whether and to what extent this world is determined.

Now it is supposed by many that quantum mechanics has already answered this question. Quantum mechanics, many believe, has provided ample empirical and theoretical warrant for our believing that the Principle of Determinism is false in this world, that is, that not everything that happens falls under universal physical laws. A few observations are in order. First and foremost is that the truth or falsity of this claim depends on one's analysis of 'physical law.' If, for example, it is a requirement for an event's falling under a physical law that that proposition be such as to allow the predicting (forecasting) of the event, then – on that analysis – it very much does seem that aspects of this world are undetermined. But, if one adopts some *other* analysis of physical lawfulness, then it may well turn out that a quite unpredictable event was determined (more on this in Chapter 11). Suppose for the sake of argument that individual atoms can be individuated (metaphysically, if not always or even usually in practice) by their unique positions in space in time. (Even this is contentious according to some interpretations of quantum mechanics.) *If* atoms can be so individuated, then, although the moment of decay of a given,

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[15] It may be that it is easier to make the Principle false in less robust worlds; e.g., worlds that lack either spatial or temporal relations. If such worlds are countenanced, then one might simply postulate an eternal series of random occurrences of noises or an infinite random splash of colored patches, etc. See, e.g., Strawson's *Individuals* 1964, ch. 2.

let's say, radium atom may be absolutely unpredictable, that event may still be fully determined insofar as it falls under a proprietary universal generalization of the sort, "Any atom of radium that is at a spatiotemporal distance of 69.46 sec. and 1952.765 cm from the site of the occurrence of an event of sort *XYZ*, decays." Of course, the trouble here is that this latter proposition will not be recognized as true *prior* to the decay of the atom in question; *and* moreover, different atoms will have their moments of decay 'determined' by quite different universal generalizations from those of their comrades. There may even be as many physical laws as there are instances of nuclear decay.

It is hardly my intent to attempt to pursue such matters as the individuability of atomic and smaller entities. There is no need for such inquiries here. The actual truth-value of the Principle of Determinism seems to me to be a matter of as little concern as its modality.

Whether the Principle of Determinism is contingently true or false, and whether it turns out to be true according to the Regularity Theory and false according to some other, leaves quite untouched the fact that a very great deal of what happens in this world *is* determined, that is, falls under universal physical laws. The entire universe does not have to be determined in order that we should have profound puzzles about certain parts that are determined. For example, even if not everything that happens is determined, we still tend to regard our actions as determined, and we must address the problem whether the fact of our actions being determined is incompatible with our being morally responsible for what we do. When we turn in Chapters 10 through 12 to such matters, we will find that whether everything is determined, or some atomic events are not, scarcely matters in our trying to understand what is entailed by something's being determined.

3

Three theories of physical law

Historically, there have been three principal theories that would allow that physical laws are propositions. The earliest of these, the Prescriptivist Theory, has it that physical laws have been issued by God, that He has prescribed that Nature should (would?) behave in certain ways and not in others. Indeed, the very etymology of the expression "physical *laws*" evidences this antique mode of regarding this class of propositions.[1]

The Prescriptivist Theory endures in some religious writings. It can be found, for example, in the Reform Jewish High Holiday service:

> There was a silence; there was chaos; there was a voice. A mind went forth to
> form worlds: now order reigns where chaos once held sway.
> The law makes evening fall; the law brings on the dawn.
> The moon follows accustomed paths, constellations their patterned ways.
> Sovereign is the will that orders the stars in their courses in the endless skies:
> Sovereign is that will! (Stern 1978, p. 25)

Among secularists, however, this belief – that physical laws are prescriptions – is no longer seriously credited, nor, for that matter, is even the weaker thesis that physical laws are legislated instruments subscribed to.

Teachers of secular philosophy, for example, are often quick to point out to their beginning students that there are sufficient disanalogies between physical laws and legislated laws so as to make the commonality of terms ("law") more misleading than helpful. They may argue that

[1] One might think that the thesis that physical laws are prescriptions is incompatible with the thesis that physical laws are propositions. For one might argue that prescriptions are not the sorts of things that can be true or false, and a fortiori cannot be identified with any subset of the class of propositions. But this argument is question-begging. There is no incoherence whatever in saying that one finds out what God's prescriptions are just by finding out which of a certain class of propositions are true. I hardly want to argue that physical laws are prescriptions; indeed, I am adamant to deny this; but I do at least want to allow the logical possibility that they might be. [For an argument (not endorsed by this author) to the effect that moral laws are natural (physical) laws, see Walker 1963, ch. 14.]

although one is probably well-advised to comply with most legislated laws – including God's commandments – one can, at one's peril, ignore them. But no such latitude is possible in the case of physical laws. One cannot, even at one's peril, fail to act in accord with the physical law that water is most dense at 3.98° C. And so on.

Only two theories concerning the nature of physical laws have survived (or so it is thought) in contemporary secular philosophy: the Necessitarian and the Regularity. [Later in this essay (particularly in Chapters 10 and 11), I will criticize the Necessitarian Theory in such a way as to reveal that I think it to be the latter-day successor to the Prescriptivist Theory, that it is nothing but Prescriptivism-without-a-Prescriber. But this is to anticipate considerably.]

Throughout much of this essay, the Necessitarian and Regularist views of physical laws will be hurled at one another. Aphoristically, they may be stated this way:

> *Regularist*: Physical laws derive their truth from the actual (i.e., instanced) connections (between states and between events) in the world. Physical laws, therefore, express only what *does* occur.
>
> *Necessitarian*: Physical laws (and antecedent conditions) determine which connections can and cannot occur; physical laws, that is, express what *must* occur in particular circumstances.

Necessitarianism exists in two versions: the material and the formal. The earlier, the material, was part – although a somewhat inchoate part – of the intellectual milieu of the early eighteenth century. Oddly, it seems to have been Hume himself, in the course of criticizing the theory ("There are necessary connections in Nature"), who gave it its first explicit articulation (see Buchdahl 1969, p. 43). Two hundred years later, Ducasse (1966, 1969) was again to promote the material version. The other version, the formal, is clearly the currently preferred formulation. It is to be found in the writings of, for example, Popper (1959a), Kneale (1950, 1961), Molnar (1969), and von Wright (1974). Where Hume's contemporaries and Ducasse were intent to place the necessity of the causal relation *in re,* these later philosophers place the necessity in physical laws. But the difference, however, is more one of style than of ultimate significance. (More on this in Chapter 4.) Either way, the upshot is the same: Events in the world must accord with a nonlogical, natural (ontological) necessity.

The Regularity Theory might best be thought to be a negative theory. It is the theory that there is no natural necessity, either *in re* or in physical laws. Regularists, that is, deny natural necessity in both its forms and under all its names: “causal,” “ontic,” “nomological,” “etiological,” or what have you.

The Regularity Theory is a species of logical atomism (see Chapter 7). And although hardly as extreme as the brand found in Wittgenstein’s *Tractatus* (1961) – which has it that *all* general truths are reducible to singular (or ‘atomic’) propositions (sections 4.26, 4.411, 4.52) – the Regularity Theory does want to ‘locate’ the truth-conditions of physical laws wholly in the events of the world’s unfolding history and in the states actually instanced. Again aphoristically, this may be stated by saying that physical laws are ‘descriptive’ of what is and of what happens.

The Necessitarian view, while also advertising itself as a descriptive (as opposed to prescriptive) account, assigns to physical laws a different logical-cum-ontological status. Rather than it being physical laws that take their truth from what happens, it is something of the other way around: It is the physical laws that set the bounds on what can and cannot occur. For the Necessitarian, there is some sense in which physical laws have ‘primacy’ over mere occurrences. Laws impose ‘constraints’ on the way the world is and on what occurs therein.

Necessitarianism shares with the Regularity Theory the thesis that physical laws are descriptions; but it also shares with the Prescriptivist Theory the view (just mentioned) that physical laws are irreducible to statements about what happens; physical laws are statements about what *can* or *must* occur. (Later, in Chapter 8, I will call this common aspect of the Necessitarian and Prescriptivist theories – the view that physical laws are irreducible – the Autonomy Theory of Physical Laws. The Autonomy Theory is not a full-blooded theory in its own right, but a partial theory, a shared thesis of two comprehensive theories.)

The Regularist’s naysaymg issues from the same Empiricist sentiments that so effectively challenged the doctrines of substance and spirit. Like substance and spirit, the presumed causal nexus was radically unobservable. Hume argued that the causal nexus (if understood to be a species of necessary connection) was not to be observed either in external events or in internal ones, for example, in willing one’s limbs to move (1955, pp. 74-9).[2]

[2] Traditional Humean exegesis has long taken Hume to have argued that necessary connections in Nature are unobservable because they are nonexistent. But recent research has questioned this traditional interpretation. Some modern writers are now suggesting that Hume’s challenge was only epistemological, not ontological. (See Beauchamp and Rosenberg 1981; Wright 1983, especially pp. 143-4.)

By the turn of the twentieth century, it seemed that there was nearly universal agreement that the (supposed) causal nexus is unobservable. Indeed, an even stronger position began to be championed by a few prominent philosophers. In the first quarter of that century, Russell and Wittgenstein each undertook to argue that the concept of a necessary causal connectedness was dispensable as a theoretical construct. The concept no longer, it was alleged, had any role to play within science and ought to be expunged from philosophical thinking.

> All philosophers, of every school, imagine that causation is one of the fundamental axioms or postulates of science, yet, oddly enough, in advanced sciences such as gravitational astronomy, the word "cause" never occurs… The reason why physics has ceased to look for causes is that, in fact, there are no such things. The law of causality, I believe, like much that passes muster among philosophers, is a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm. (Russell 1965, p. 163)

> Belief in the causal nexus is *superstition*. (Wittgenstein 1961, section 5.1361)

> There is no compulsion making one thing happen because another has happened. The only necessity that exists is *logical* necessity. (Wittgenstein 1961, section 6.37)

Thus, in the early 1920s it may well have looked to a disinterested observer as if the Necessitarian Theory was on the same path as the passenger pigeon: if not already extinct, then soon to be.

It turned out, however, that the Necessitarian Theory had remarkable staying power. Beginning in the mid-1920s, Ducasse kept the theory alive, even though his own peculiar views, particularly about the observability of the causal nexus (1969), have never won many adherents. He argued that he could observe the causal nexus in every event he witnessed; practically no one else has been able to duplicate the feat.

The true renascence of the Necessitarian position has come about more recently, through the efforts of several philosophers, including Kneale, Molnar, and von Wright, who have produced arguments that have seemed to positively require the adopting of some sort of Necessitarian position. They argue in effect that the implications of a Regularist position – if not demonstrably false – are so much at variance with our ordinary thinking about physical laws and causality as to constitute a virtual reductio ad absurdum of the Regularist position.

One feature that has been thought to give Necessitarianism a considerable edge over its nearest rival is that Necessitarianism seems to be favored in our ordinary manner of describing events; that is, this theory is presupposed by our language.

In what sense can a language have a metaphysical theory built into it? Not in asserting any propositions, for a language does not consist of a set of propositions. (See Scheffler 1967, ch. 2, especially pp. 37-44.) A language consists of a vocabulary, a syntax, and a semantics. However, these latter may well sanction certain sorts of constructions that serve to promote particular metaphysical views.[3] For example, ordinary English constructions treat "space" substantively; for instance, "There is space between the chair and the wall" (which is perfectly analogous to "There is air (/a hassock) between the chair and the wall"), and thus tend to support the uncritical view that space is a "thing" not unlike other things that can occupy space. Such confusions are revealed when persons find themselves being baffled as to whether or not, and if so how, space could have an end.[4] Or, to cite another example: Our ordinary language is dualistic in its manner of constructing sentences pertaining to self-knowledge, memory, pain-reports, etc. We say such things as "I saw that my hand was cut," which is grammatically parallel to "I saw that my car was dented," and this has the effect of suggesting to us that we stand in the same relation to our hands as we do to our cars, that is, as owners to possessions. Or further: Our language favors relational, over adverbial, constructions to describe many mental events. Although we may be as likely to say "My knee hurts a great deal" as we are to say "There is a severe pain in my knee," we are not so likely to adopt the adverbial form in reporting visual sense data or in reporting memories. We say "I see a red patch" rather than "I am seeing redly"; and "I recollect John's face" rather than "I recollect John-facely." In these latter cases, the English language would seem

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[3] Penelhum, like Ryle, argues that there are metaphysical theories implicit in the way in which we use language to describe ourselves and the world. Addressing our predisposition to be dualists (as regards mind and body), Penelhum writes:

> All language-users, not just philosophers, tend to be dualists... This raises the difficult problem of how to react to a misleading theory that has filtered into ordinary discourse... Common theoretical misconstructions, though inconsistent with our daily use of such concepts, are usually harmless because of the merciful logical dispensation which allows us to make good sense with our concepts while talking nonsense about them. Occasionally, however, the prolonged continuance of the misguided theory can infect the practice... [When this occurs,] it seems legitimate to replace the bad theory by better and to argue against taking this solution for granted. (1967, p. 106; parenthetical gloss added).

[4] Buber was driven to the brink of suicide by his inability to answer this ill-conceived question. (Buber 1959, pp. 135-7).

to sanction an account of a relation between subject and object over an account of the manner of the subject's activity. Although it is by no means clear that the latter gives rise to a leaner ontology (for it might be necessary, if we were to persevere with the latter account, to quantify over 'manners of activity'), there is little doubt that it does give rise to a *different* metaphysical view of the world.

It is essential to recognize, if not the claims, then the metaphysical leanings of our language. Dualism of mind and matter, however much that theory may be presupposed in our language, has been challenged, indeed with much success. So, too, has the subject-object account of mental activity, although perhaps with not quite the success of the challenge to dualism. The point is that only by being aware of and by resisting the powerful call of our language to its in-built metaphysics can we hope to assess the validity of that metaphysics.

Clearly, our language provides a certain stimulus to the Necessitarian Theory. Our sentences are strewn with modal qualifiers (often in the consequents of conditional sentences): "If his head was chopped off, he had to die"; "If this is copper, it must conduct electricity"; "If you plug the toaster and the iron into the same circuit, the circuit breaker will have to trip"; etc. ad libitum. This is a rich diet of examples, and hard to resist. But they are merely suggestive of a theory. They hardly constitute conclusive proof of Necessitarianism; no more so than that Dualism seems to be favored by our language is convincing proof of the possibility, let alone the actuality, of a disembodied life after physical death. Linguistic conventions cannot be totally ignored: they have stood the test of time and must have some communicative function to have so endured. But that they can be successfully used to communicate does not establish that the theory that spawns them is true.

The considerable predilection our language has toward Necessitarianism must (!) not be overestimated in our trying to decide whether that theory should be preferred over a rival. Theories entrenched in our language may well be true; but they also may be false. Because they are so pervasive, however, they merit particularly critical examination, and examination free of the prejudice that entrenchment is a fairly reliable sign of truth. Too great an attachment to the metaphysics of ordinary speech has led to error in judging other philosophical issues. Deciding between Necessitarianism and Regularity must take the entrenchment of the former into account, but must not give it hegemony among competing arguments.

It might be tempting to think that the debate between Necessitarians and Regularists is only superficial; that ultimately there is no real difference; and that once all the metaphorical and anthropomorphic talk (e.g., “power,” “behavior,” “governed by,” “constrained by,” etc.) is cleared away, there will be no controversy left. But any such hope would be misplaced. There is nothing, either in the long history of the controversy or in the recent literature, to support such a reconciliation. Rather, the debate is as real and profound as any to be found within philosophy.

Choosing between these theories will have to depend on examining their competing verdicts on a variety of issues. Neither theory scores above the other on all counts. Thus one’s eventual preference must rest on a weighted assessment of the pros and cons of each. Such assessments are extremely difficult to make, and we may assume that rational persons will disagree in their final decisions and allegiances. Knowing this, my intentions are modest: to defend the competitor I have come to believe is the better theory, namely, the Regularity Theory; but equally, to try to cast into bold relief the differences between the two theories. For whichever side Truth lies on, it has a chance of being discerned only if the important consequences of each theory are clearly seen. I will try to lay bare some of these consequences and to show how much is at stake in each position.

4

Modal properties and modal propositions; relative and absolute necessity

Consider, for a moment, logical necessity. The *sentence*

S1 "All unmarried men are men"

expresses a nonmodal proposition, that is, a proposition incorporating no modal concepts. But clearly this nonmodal proposition has the modal property of being necessarily true (i.e., is logically necessary). In contrast, the sentence

S2 "Necessarily all unmarried men are men"

expresses a modal proposition, that is, a proposition that incorporates a modal, concept.

Parallel distinctions can be made for other species of modality: epistemic, doxastic, etc. And thus we are prompted to ask: Are physical laws nonalethic modal propositions? And, What nonalethic modal properties do physical laws have? We will take these questions in order.

Are physical laws modal propositions? Everyday discourse, whether of the layperson or the scientist, provides no answer. A sampling of explanations citing physical laws offers both bounteous examples of sentences that depict physical laws as nonmodal propositions and equally large numbers of instances that portray physical laws as being modal propositions.

E1 "Why do you keep your furnace fan motor running throughout the winter, even when the furnace has cycled off?"

"Because (it is a physical law that) convection currents distribute warm air upward. By circulating the air by a fan, we draw some of the warmer air downward, and thus get better fuel economy."

> *E2 "Why can't we travel by a very powerful rocket to Venus in one minute?"*
>
> *"Because Venus is never less than 40,200,000 kilometers from Earth, and because it is a physical law that no object (such as a rocket) having mass can travel faster than the speed of light. Since the speed of light is 299,792 kilometers per second, the minimum time for the trip is greater than 2.23 minutes."*

With little effort, one can manufacture countless other examples of each kind, those that like *E1* are free of modal terms (e.g., "Copper *conducts* electricity," "Sodium chloride crystals *are* cubic"); and those that like *E2* incorporate modal terms (e.g., "Nothing *can* get colder than –273.16° C," "A modulated carrier wave *must* have sidebands").

But really, the situation is even more indeterminate than just portrayed. For not only do quite ordinary examples seemingly provide instances both of nonmodal laws and of modal ones, they even seem to provide cases of nonmodal and of modal versions of the 'same' law, for example, "Nothing travels faster than light" / "Nothing can travel faster than light"; "Sodium chloride crystals are cubic" / "Sodium chloride crystals must be cubic". Indeed, it is probably true that we can with perfect propriety express every law in a weaker and in a stronger version of words: "For every action there is an equal and opposite reaction" / "For every action there must be an equal and opposite reaction."

Which kind of sentence we utter, with or without a modal term, doubtless depends on the pragmatics, or the context, of the explanation-seeking question posed. To mere "How-did/does/will-it-happen-that-...?" questions, we usually reply with sentences relatively free of modal terms. But to "How-is-it-possible-that-...?" and "Why-isn't-it-possible-that-...?" questions, we generally reply with stronger, modalized versions of sentences expressing physical laws. Which version we use is a context-dependent matter, and little should be inferred about the 'real' or 'true' form (analysis) of physical laws from these differing examples

All propositions, whether themselves nonmodal or modal, have indefinitely many alethic and nonalethic modal properties. For example, the nonmodal proposition that two plus two equals four has the alethic modal property of being necessarily true, and the nonalethic modal property of being believed (by someone). Similarly, the modal proposition that it is known that copper conducts electricity has the alethic modal property of being logically contingent and the nonalethic modal property of being doubted (by someone).

Regularists are intent to make two claims about physical laws. The first is that, occasional formulations notwithstanding, physical laws are nonmodal propositions. Regularists must, then, give an account of the modal terms in sentences expressing physical laws in such a way as to allow that these propositions expressed are not themselves modal. The second claim they want to make is that, although physical laws have countless modal properties (e.g., being logically contingent, being believed), there is no need to ascribe to them any special kind of necessity that Necessitarians postulate as conferring lawful status. For the Regularist, lawful status arises out of a combination of ordinary ingredients such as universality, omnitemporal (eternal) truth, and omnispatial truth. The Necessitarian requires something more, a special, unique kind of law-bestowing necessity: nomological necessity.

There is, however, one kind of necessity, physical necessity, that Regularists will allow attaches to physical laws. But physical necessity is not the Necessitarian's nomological necessity. Physical necessity is a weaker, or degenerate, kind of necessity, a necessity by courtesy perhaps. And it is nothing but this innocuous species of necessity, Regularists say, that is connoted by the occasional use of modal terms (e.g., "must," "can't") in sentences (see, e.g., *E2* earlier in this chapter) expressing physical laws.

Regularists and Necessitarians alike subscribe to the same definition of "physical necessity"[1]:

Definition**:** "A proposition *p* is **physically necessary** if and only if *p* is implied (entailed) by the set of physical laws."

Introducing **L** to stand for the set of physical laws, and ◩ to stand for the propositional operator "it is physically necessary that," we have:

Definition ◩**:** $\text{◩}p =_{df} (\exists x_i) \ldots (\exists x_k)[(x_i \in \mathbf{L}) \;\&\; \ldots \;\&\; (x_k \in \mathbf{L}) \;\&\; \{(x_i \;\&\; \ldots \;\&\; x_k) \rightarrow p\}]$

More perspicuously,

Definition ◩**:** $\text{◩}p =_{df} \mathbf{L} \rightarrow p$

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1 I have throughout this book used "physically" as opposed to the less perspicuous "empirically." The latter connotes, in a way that "physically" does not, an epistemological category. I have even changed the terminology in some direct quotations, in the interests of both stylistic uniformity and philosophical propriety. I am quite sure that by so doing I have in no case distorted the original author's intent. In any event, I have marked each place where I have recast (/paraphrased) a quotation.

Obvious parallel definitions are adopted for "physical possibility" and "physical impossibility":

Definition**:** "A proposition *p* is **physically possible** if and only if *p* is consistent with (the conjunction of) all physical laws."

and

Definition**:** "A proposition *p* is **physically impossible** if and only if *p* is not consistent with (the conjunction of) all physical laws."

I have just spoken of certain *propositions* as being physically necessary, physically possible, and physically impossible, respectively. But there is another equally well-established use of these latter concepts, in which they are attributed to states of affairs, situations, or facts in the world. Thus, for example, one may speak of the (true) proposition that there is a pen on my desk now (at the time of my writing this paragraph) as being physically possible; but equally well, one can speak of my pen's being on the desk as being physically possible. What sort of thing is *my pen's being on my desk*? We are inclined to say such things as "My pen's being on my desk is true," which would suggest that my pen's being on my desk is a proposition; but we are also inclined to say such things as "My pen's being on my desk annoyed my wife who was looking for my pen in the bureau drawer," which, on one reading, would suggest that my pen's being on my desk is a physical state or an event that has causal consequences. (No proposition has causal consequences; they are not the sorts of things that do.)

From a strictly logical point of view, it is propositions that are physically necessary, physically possible, and physically impossible. For these latter properties are defined in terms of the relations of implication, consistency, and inconsistency, respectively, and these latter relations, in turn, obtain only between propositions. But with this acknowledged, there seems to be no good reason not to *extend* the notions of physical necessity, physical possibility, and their like to facts, situations, states of affairs, and their like. Indeed, if ordinary usage were to be our guide to logical reconstruction, we would have to put the logical priorities the other way around, since in ordinary speech we are far more likely to say such a thing as "It is physically possible to put a man on the moon" than we are to say "The proposition that we put a man on the moon is physically possible." (However, the ordinary – if somewhat less likely to be uttered – locution, "It is physically possible that we should put a man on the moon" does suggest our attributing physical possibility to a proposition, rather than to a state of affairs.) No matter. Few of the issues to be discussed subsequently in this book turn in any important way on making this distinction rigid. And so I am content, in most cases, to continue to talk, interchangeably, either of certain propositions or of what it is they describe as being physically possible, impossible, etc. Only in Chapters 10 and 11 will I have to be meticulous in insisting on the correct logical priority.

Physical possibility: Physical possibility is a *different* notion from that (introduced in Chapter 2) of falling under a physical law. Falling under a physical law is restricted to subsets of true conditional propositions and of ordered pairs of true categorical propositions. But the class of propositions that are physically possible includes some single propositions that are categorical, as well as some propositions that are false.

Consider, for example, the true proposition that someone is born in Vancouver on February 27, 1972. This categorical proposition hardly falls under a physical law; but since this proposition is true, it cannot be inconsistent with the members of the class of physical laws since they, too, are all true, and truth is a guarantee of consistency. Hence, this proposition is physically possible.

But truth is not a necessary condition for physical possibility. Someone shakes a pair of dice and rolls a seven. Is it physically possible that he should have rolled an eight? We will return to this sort of question later (in Chapters 5-8, 10, and 11) for a more thorough answer. But, for the moment, we can say that if we describe the unrealized outcome simply as "someone rolls an eight," without further elaboration of the particular circumstances that actually prevailed in the rolling of the seven, then we may say that the latter description, even though false of the actual situation, describes a physical possibility.

Physical necessity: According to Definition ◩, physical necessity may be regarded as a consequential or, to use the more standard term, a *relative* necessity: Whatever logically follows from the set of physical laws will be physically necessary. But of course one of the things that follows from the set of physical laws is each and every one of the physical laws themselves. Thus, according to Definition ◩, each and every physical law turns out – on both the Regularists' and Necessitarians' accounts – to be physically necessary. That is, being physically necessary is a logically necessary condition for being a physical law.

Understood thus, the concept of physical necessity cannot figure in the analysis of the concept of physical lawfulness. Were we to include it, we would make the analysis circular. It is important to understand why this is so; otherwise, there is a powerful tendency to regard physical necessity as just one *more* necessary condition of physical lawfulness alongside such other properties as generality, omnitemporal truth, omnispatial truth, and – perhaps – nomological necessity.

By looking at a parallel case, we can see why physical necessity must be proscribed in the analysis of lawfulness. Suppose we wanted to analyze not the concept of being a physical law, but instead, let us say, the concept of being evil. Obviously, one of the logical consequences, and hence a logically necessary condition, of being evil is being evil or being rectangular.[2] Yet we should hardly want to reckon *being evil or being rectangular* among the conditions figuring in the analysis of being evil. Were we to do so, the analysis would become circular.[3] In analogous fashion, to make being physically necessary (which just *means*, one recalls, being a consequence of the set of physical laws) a condition in the analysis of physical law, would render that analysis self-defeating.

Nomological necessity: Regularists and Necessitarians both must regard the property of physical necessity as supervenient on the properties figuring in the analysis of physical lawfulness. But the disputants disagree implacably as to what these latter properties might be. For the Necessitarian argues that, in addition to such properties as generality, omnitemporal and omnispatial truth, etc., physical laws have the property of nomological necessity, which is a real, or absolute, necessity, quite unlike relative, physical necessity.

Inasmuch as the Necessitarian's set of physical laws turns out to be a proper subset of those allowed by the Regularist, the Necessitarian's set of propositions that are physically necessary will be correspondingly smaller; and his set of propositions that are physically possible, correspondingly larger. That is, there will be propositions that the Regularist will want to say are physically necessary that the Necessitarian will want to say are not; equivalently, there will be propositions that the Necessitarian will want to say are physically possible that the Regularist will want to say are not.

The debate opens with a clash of powerful, preanalytic intuitions. Eventually, we will have to take account of remote consequences. But, for the moment, we begin by examining a Necessitarian challenge that alleges that the Regularist's theory of physical laws leads to egregiously counterintuitive consequences.

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2 Concepts, like propositions, have implications. See Bradley and Swartz 1979, 90-1, 240-5.

3 Being a consequence of, and being part of the analysis of, are, then, different notions. The former subsumes the latter, but not conversely. Indeed, the analysis of most concepts is a small finite set of conditions; the consequence-set, an infinite set.

5

Regularity attacked / Necessitarianism defended

This chapter, and Chapters 6 through 11, will be devoted to an examination of *universal* physical laws. *Statistical* laws will be examined in Chapter 12.

MOLNAR'S ARGUMENT

Molnar, taking his inspiration from Kneale, has devised an ingenious argument that is supposed to discredit the Regularity Theory of Physical Laws (Molnar 1969). Molnar's preferred alternative theory abandons the Regularists' view that physical laws are simply true, universal material generalizations. Like all Necessitarians, he denies that physical laws can be *merely* true; he argues that their truth must be strengthened by a modality. Kneale had called this modality "natural necessity." I will call it "nomological necessity."

The pivotal concept in Molnar's paper is not that of nomological necessity, but of physical possibility, which he sometimes imperspicuously refers to as "empirical possibility." More often, however, he simply writes "possibility," foregoing any qualifying term. I will be more careful. In quoting his definitions and the conclusion figuring in his proof, I will explicitly add the qualifier "physical" where it is clearly presupposed.

Molnar' s argument proceeds to draw from three definitions that are the core of the Regularists' theory, a conclusion that allegedly should be unacceptable to anyone who has reflected on the matter of physical laws and kindred subjects. The three definitions (here slightly revised) from which he proceeds are:

(D_1) *p* is a statement of a physical law if and only if:

- (i) *p* is universally quantified; and
- (ii) *p* is omnitemporally and omnispatially true; and

(iii) *p* is contingent; and
(iv) *p* contains only nonlocal empirical predicates, apart from logical connectives and quantifiers[1]

(D_2): If *p* states that a thing exists (or that a state of affairs obtains, or that an event occurs) then what *p* states is physically possible if and only if *p* is consistent with the conjunction of every physical law.[2]

(D_3): What *p* states is an unrealized physical possibility if and only if:
(i) *p* is a statement of physical possibility; and
(ii) *p* is false[3]

From these three definitions, he draws his conclusion, *C*. In *C*, he talks about "empirical propositions," but inasmuch as his points are purely logical and ontological, and not at all epistemological, it is – I think – quite safe to assume that he meant, rather, "contingent propositions." Indeed, in his very next sentence, Molnar himself casually switches to talk of "contingent existential propositions." Making, then, the obvious and required repair, *C* emerges in this way:

(*C*) For any *x*, if *x* is an unrestricted contingent existential proposition, then *x* is not a statement of unrealized physical possibility[4]

Now let us attend carefully to what Molnar goes on to say about *C.*

> The conclusion of the argument ... pits the Regularity Theory of Physical Laws and the definition of a statement of unrealized possibility against each other. It shows that if the Theory and the definition are both accepted there will be a set of statements – namely, the set of contingent unrestricted existential statements, no member of which may be used to express a judgment of unrealized possibility. This conclusion is intuitively unpalatable. 'There exists (somewhere, somewhen) a river of Coca-Cola' is surely not a judgment of

1 Molnar 1969, p. 79. See footnote 1 in Chapter 4. In this quotation, Molnar's original "law of nature" has been changed to read "physical law." Hereinafter, changes to quoted material will be designated by a solidus, i.e. by a "/ ".

2 Molnar 1969, p. 80. Altogether, three changes have been made to D_2: physical law / law of nature; physically possible / possible; the conjunction of every / every. This last change was made for clarification, since a proposition may be consistent with every (i.e., each) member of a set of propositions without being consistent with them all taken together.

3 Molnar 1969, p. 80. Changed: physical possibility / possibility.

4 Molnar 1969, p. 81. Changes: physical possibility / possibility; contingent / empirical. A noncontingent existential proposition would, presumably, be something of this sort: There is a unique number that is twice the number 14.

> which we would want to be forced to say that either it is physically impossible or it is actually true. We all believe that this statement is both false and possible, as are many others like it.[5]

When Molnar writes of the example – that there exists somewhere, somewhen a river of Coca-Cola – that his intuitions tell him “that this statement is both false and possible, as are many others like it,” I take him to be saying that even if it never, ever happens that there is a river of Coca-Cola, there ‘really could be.’ And by ‘really could be’ is meant not just that this proposition is logically contingent (and hence logically possible), but something stronger. For example, the proposition that pigs fly is logically contingent, and hence logically possible. But this sense of bare logical possibility, I presume, is not at all what Molnar has in mind when he argues that it is possible that there is a river of Coca-Cola. I take him to mean that not only is the problematic proposition logically possible (a judgment with which the Regularist will certainly concur), it is in addition *more* than ‘just’ logically possible. It enjoys as well a ‘stronger’ kind of possibility: physical possibility. Such a proposition is not just true in some possible world or other; it is true in some possible world very like this one in certain important respects.

So striking is the dilemma that Molnar believes to reside in the Regularity Theory that it is worth reconstructing meticulously so as to highlight its origin and thrust.

> Suppose we consider any unrestricted existential statement (e.g., “There is somewhere, somewhen, a river of Coca-Cola”). If this statement is true, there is no problem: It is – of course – physically possible. (Truth is a sufficient condition of physical possibility.) But suppose it is not true. Then the falsity of this existential statement logically implies a true universal statement (“Nothing is at any time or place a river of Coca-Cola”). But if, on the Regularists’ account, this latter true universal statement is to be accorded the status of being a physical law, then the original (false) existential statement is not merely false, it is physically impossible, since it is logically inconsistent with its own negation, which is a physical law. In short, unrestricted timeless existential statements are either actually true or physically impossible. For this class of statements there is no third category of being false, but physically possible.

To avoid being impaled on the horns of this dilemma, Molnar considers various alternatives to the premises, trying, that is, to retract the horns. He focuses his attention on the premise that

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5 Molnar 1969, p. 81.. Changes: Physical Laws / Laws of Nature; physically / empirically.

would have it that being true, universal, omnitemporal, omnispatial, contingent, and free of 'local' predicates constitutes a set of *sufficient* conditions for being a physical law.[6] He then examines four further conditions that at one time or another have been proposed as addenda to this set: (1) a requirement that the predicates be nonempty; (2) an epistemic requirement; (3) a requirement that laws be nondeducible from other laws; and (4) a requirement that physical laws be – in his words – "necessarily true." He eventually settles on the fourth condition.

It is strange that Molnar, who takes himself to be reconstructing and advancing Kneale's arguments, fails to observe Kneale's distinction between logical necessity (truth in "all possible worlds"; 1961, pp. 99-102) and what Kneale calls 'natural' necessity (truth in "all possible worlds *of some kind";* 1961, p. 102; emphasis added). Clearly, when Molnar advances what he calls "a necessitarian analysis" and speaks of physical laws as being "noncontingent," he must be understood to be promoting the view that physical laws are *nomologically* (naturally) necessary. It would hardly be creditable to attribute to him the view that physical laws are true in all possible worlds. Surely in *some* possible world, even if not in this world, the physical law that no objects with mass travel in excess of 299,792 km/sec. is false.

The reply to Molnar's, and by extension to Kneale's, argument can proceed on two different levels. On one level, we may focus on Kneale's notion of nomological necessity as truth in all possible worlds *of some kind.* No one seriously can doubt the heuristic value and fecundity of defining various species of necessity by means of restricting the set of all possible worlds. The problem lies not with the idea of the program, but with the prospects for its realization. How, exactly, in a noncircular way might Kneale's qualification be specified? Exactly which one of the infinity of proper subsets of the set of all possible worlds is the relevant one for these purposes? One might be inclined to answer, "those possible worlds only that have the same physical laws as the actual world." But, of course, this answer – although true – is useless. Since Necessitarians want to define physical laws as "those propositions alone that have nomological,

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6 Containing "only nonlocal empirical predicates" – it would appear – is Molnar's concise way of saying that physical laws should make no reference to any specific objects, places, tunes, persons, etc.; i.e., they should be perfectly general throughout.

necessity," they can hardly, informatively define "being nomologically necessary" as "being true in all those possible worlds that have the same physical laws as the actual world."[7]

To date, no one has ever offered a way of restricting the set of all possible worlds so as to construct the 'right' set, without at the same time invoking the very concept the restriction is supposed to explicate, namely, nomological necessity.

If the prospects for a noncircular analysis seem both wanting and unlikely, there is still the opportunity to argue that physical necessity is a *primitive* notion, one that can be illustrated by examples but not further analyzed. Here the Necessitarian might appeal to his intuitions, or even to some special intellectual faculty, arguing that the difference can be 'seen,' 'felt,' or 'recognized,' even though not analyzed, in the two examples:

P1 *No mass travels faster than the speed of light*

and

P2 *There is no river of Coca-Cola*

Both these examples, he would allege, may be regarded – ex hypothesi – as: true, (logically) contingent, universally quantified,[8] omnitemporal, etc.; but only the former, and definitely not the latter, is nomologically necessary.

Regularists fail to catch the difference. Moreover, we fail, too, to see the usefulness of postulating such a difference. And we fail, too, to understand how the day-to-day practice of science – which *does* occasionally sort physical laws from nonlaws – could ever be sensitive to the alleged distinction between *P1* and *P2.*

The second level of reply is the more telling, however, because it is more circumscribed and less ambitious. Rather than challenging the prospects of the Necessitarian's carrying through his analysis of nomological necessity, this level of reply focuses on the specifics of the one argument at hand.

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7 Popper, in his *Logic of Scientific Discovery* (1959a, p. 433), had tried to demarcate the relevant set of possible worlds in this way: ... all worlds that differ from our world, if at all, only with respect to initial conditions." Two pages later, Popper frankly admits that this definition is implicitly circular. Still other faults with his definition are reported by Nerlich and Suchting in "Popper on Law and Natural Necessity" (1967).

8 Negative existential statements (such as *P2*), remember, expressed in prenex normal form become universal negative statements. (See Copi 1973, pp. 263-5.)

In pursuing this latter course of escaping the horns of Molnar's dilemma, we do so, not by retracting the horns, but by denying that the horns even exist. Our reply to be made to Molnar is that there is no real dilemma; that there is only the appearance of one; and that the "intuitively unpalatable" conclusion that it is physically impossible that there is a river of Coca-Cola, is not unpalatable. If the conclusion is unintuitive, then intuitions about this example need reforming.

Molnar's argument must be seen in proper perspective. Indeed, he offers a cautionary note himself: "Kneale's argument does not disbar those who accept these definitions from making ... [some true] ... statements of unrealized possibility."[9] Although I think his ensuing illustrative example is ill-chosen, his general point is perfectly correct. For the simple fact of the matter is that for many – if not the greater number of – kinds of propositions, Regularists and Necessitarians are in perfect accord as to whether these propositions are to be classed as physically possible or physically impossible. We both agree, for example, that the *singular* false proposition

P3 *Swartz owns two Rolls-Royces*

is physically possible, and the *singular* false proposition

P4 *Swartz travels in a rocket faster than the speed of light*

is physically impossible. Clearly, on both theories there will be propositions (e.g., *P3*) that are both false and physically possible. Molnar's complaint about the Regularity Theory is not that in it the category of being false and physically possible is empty; it is rather that this category has fewer members than his theory would allow. The dispute concerns *which* false propositions 'ought' to be physically possible; the dispute is not whether there are any such propositions. Both sides affirm that there are.

Of course, our respective reasons for saying that it is physically possible that Swartz owns two Rolls-Royces differ. The Necessitarian will want to say that this false proposition is physically possible because it is not logically inconsistent with any nomological truths. The

9 Molnar 1969, p. 81. This quotation is slightly modified as indicated for the sake of clarity.

Regularist, on the other hand, will want to argue that this proposition is physically possible because its existential generalization, namely,

> *P5* Someone *owns two Rolls-Royces*

is true, and hence the universal generalization, namely,

> *P6* No one *owns two Rolls-Royces*

is false and is thereby not a physical law. In other words, according to our theory, the proposition *P3*, that I own two Rolls-Royces, would turn out to be physically impossible if it were timelessly true that no one owns two Rolls-Royces; but this latter universal material generalization is false. Thus, although the routes to our respective conclusions about this example are through two different, incompatible theories, the conclusions themselves – for this example – coincide.

The contentious examples occur in one very special class only, namely, among false, contingent, unrestricted *existential* propositions (and derivatively with their singular instantiations). But even of these, only *some* are contentious, for example, the case in point, that there is somewhere, somewhen a river of Coca-Cola. Others are no trouble whatever, for example, that there is somewhere, somewhen an orthorhombic crystal of sodium chloride. The Necessitarian's intuitions tell him that of these two timelessly false, unrestricted existential propositions, one – the former – is physically possible, whereas the other is not. (The Regularist would deem them both on an equal footing as regards physical possibility; that is, they are both physically impossible.)

The crucial point of difference between the two theories does not, however, depend on examples. The Necessitarian's point is general, namely, that there should be *some* false, contingent, unrestricted existential propositions – never mind which ones – that are physically possible. The Necessitarian balks at our claim that this highly specialized class of propositions is empty. His intuitions are that there should be some propositions in this set, even if it is disputable which ones, exactly, they might be.

Intuitions about the properties of existential statements are risky on two counts. First, we are talking about *general* statements, and are thus at one step further removed from empirical data (broadly speaking, experience), which on most – if not all – epistemological theories is directly of singular statements. That is, knowledge of the truth-values of existential propositions is inferential, not direct, knowledge. Then, too, one might argue that knowledge of physical possibility, and the informing of our intuitions about physical possibility, arise from ordinary cases of occurrence and nonoccurrence, and that one ought not to feel much confidence about attributing physically possible existence to a state of affairs that has never occurred.

Indeed, we are now at the crux of the matter. For the Necessitarian is arguing for the physically possible existence of something that not just has never existed, but that ex hypothesi does not now, nor ever will, exist. In effect, his is a claim that certain false kind-statements should be physically possible. For unrestricted existential statements are nothing other than statements that certain *kinds* of events (or constellations of properties) are instantiated. In allowing that certain timelessly false, unrestricted existential statements should be physically possible, the Necessitarian is arguing that certain kind-statements that are never, ever true should – nonetheless – be physically possible (e.g., that there is somewhere, somewhen a river of Coca-Cola). But here Regularists protest: The Regularity Theory does not deny that these events or clusters of properties could occur; when we say that it is physically impossible that they do, we mean only that – as a matter of fact – they do not occur. It is only by reading something stronger into "physical impossibility"[10] that Molnar's argument can be made to appear to threaten the Regularity Theory of Physical Laws. Molnar's intuitions, which have served him well as regards many ordinary, singular examples, cannot confidently be extrapolated to unrestricted, false existential propositions. Although we allow that some false propositions are, incontrovertibly, physically possible, for example, *P3*, we jib at allowing that false, unrestricted existential ones are. For to extend the category of physical possibility to any of this latter class of propositions will, just as Molnar suggests, require considerable emendation to the sufficient conditions for physical lawfulness. And in the clash of intuitions with theory, intuitions do not automatically have dominance. Intuitions sometimes must give way when the overall theory that results is simpler, more fruitful, and less problematic than the original preanalytic, intuitive theory. That unrestricted, false existential propositions turn out – contrary to initial expectations – in a certain theory to be physically impossible, does not by itself refute that theory. Rejection or acceptance must rest on the judicious weighing of the totality of the theory's implications.

[10] Recall the commonly shared definition stated in Chapter 4.

I am inclined at this point to defend the Regularist's concept of physical impossibility by constructing an analogy in which I treat the
two terms "physically" and "impossible" to separate analyses. "Impossible" in "physically impossible," I want to say, functions like "impossible" in the sentence

> *S3* *"If no one ever makes a disc recording of Balbastre's* Piano Quartet, *then it is impossible that Maurizio Pollini does"*

Here the qualification "impossible" does not signify that the proposition expressed by the consequent clause is 'impossible'; it signifies only a relative modality, that this proposition is inconsistent with some other proposition.

Relative modalities in consequent clauses can be modified. For example, sometimes we modify the modal term with "physically," (other times with "morally," "legally," "theologically," etc.) When a relative modality in a consequent clause is modified, the modifier usually serves to identify the special status of the 'other' proposition, that is, the one in the antecedent. Should the modifier be "physically," then we have indicated that the 'other' proposition is a physical law, for example,

> *S4* *"Since no mass travels faster than the speed of light, it is physically impossible that a Saturn rocket does"*

There is no need to think that the term "physically" connotes any special, intrinsic, mysterious quality of the consequent proposition. Compare: One might introduce the relative modality "gramophonologically impossible" in the above example, *S3*, and thereby signify that the antecedent clause is of a certain kind, namely, being a general proposition about the history of the recording industry. We might then want to say that, on the supposition that no one ever makes a disc recording of Balbastre's *Piano Quartet*, it is gramophonologically impossible that Pollini does. The qualified modality here indicates the logical rivals of the latter proposition. It should not make us want to worry about timelessly unrealized gramophonological possibilities, nor should we want to postulate 'Edisonian necessities' (the analogs of nomological necessities) to accommodate them. We should not feel moved to go along with an Historico-Necessitarian who says that only some – certainly not all – gramophonological impossibilities are 'real' gramophonological impossibilities, that is, the real ones are those only that are logically inconsistent with Edisonian necessities.

Where this analogy ultimately fails, and the reason why it does not serve as an irresistible incentive to discard Necessitarianism, lies in the facts that “physical impossibility” – unlike “gramophonological impossibility” – is thoroughly entrenched in our language and that the corresponding concept has taken on ‘a life of its own.’ And thus the Necessitarian can rejoin that the analogy does not go through; that there is something *more* to the concept of physical impossibility than this analogy would attribute to the corresponding concept of gramophonological impossibility.

But even if the analogy cannot refute Necessitarianism, it can highlight the precise area of dispute between the two camps and also suggest how each might formulate its own analysis of the concept of physical possibility. In particular, it shows how Regularists can, in terms of their own theory, deflect Molnar’s criticism. The dispute, it should be clear, is *between* two competing theories. Regularists can, with perfect consistency, deny that Molnar has uncovered a problem *within* their theory.

Perhaps, now, it is time to turn from an analogy to a summing up. A table of pertinent differences elicited to this point has been cataloged in Table 1 (page 60).

By far the most striking difference between these accounts of physical laws occurs in line iii. On the Regularists’ account, a certain contingent proposition, if false, is inconsistent with the set of physical laws, whereas, on the Necessitarians’ account, that proposition, whether true *or* false, is consistent with the set of physical laws.

What this difference comes down to is that, on the Regularists’ account, the contents of the set of physical laws are highly ‘sensitive’ to the truth-values of (certain) existential propositions; on the Necessitarians’ account, the contents of the set of physical laws are much less ‘sensitive’ to the truth-values of (certain) existential propositions. Which of these accounts is ultimately to be preferred remains to be judged.

SINGULAR PROPOSITIONS AND PHYSICAL POSSIBILITY

Attributing physical possibility to *singular* propositions is somewhat more problematic than attributing physical possibility to particular (or existential) propositions. Consider a slight variant of the singular proposition *P4* cited earlier in this chapter. Consider, instead, the proposition that Swartz (himself) travels faster than the speed of light. We want to say that this singular proposition is physically impossible. But note:

Table 1. *Necessitarian and Regularity theories applied to three test propositions*

Necessitarian theory		Regularity theory	
	I. There is a river of Coca-Cola		
i.	Is logically contingent (i.e. could be true and could be false).	i.	Is logically contingent (i.e. could be true and could be false).
ii.	Is – presumably – physically possible, whether true or false.	ii.	Is physically possible, if true; is physically impossible, if false.
iii.	Is – presumably – whether true or false, consistent with all physical laws.	iii.	Is, if false, inconsistent with at least one physical law.
	II. Nothing is a river of Coca-Cola		
iv.	Is logically contingent.	iv.	Is logically contingent.
v.	Satisfies all conditions of D_1 (i.e., is true, universal, omnitemporal, omnispatial, etc.).	v.	Satisfies all conditions of D_1 (i.e., is true, universal, omnitemporal, omnispatial, etc.).
vi.	Is – presumably – not nomologically necessary.	vi.	Is *not* nomologically necessary. (*No* proposition whatsoever is nomologically necessary.)
vii.	Is *not* a physical law (because of vi above).	vii.	*Is* a physical law (because of v above.)
	III. No mass is propelled beyond the speed of light		
viii.	Is logically contingent.	viii.	Is logically contingent.
ix.	Satisfies all conditions of D_1.	ix.	Satisfies all conditions of D_1.
x.	Is nomologically necessary.	x.	Is *not* nomologically necessary. (*No* proposition whatsoever is nomologically necessary.)
xi.	*Is* a physical law (because of ix *and* x above).	xi.	*Is* a physical law (because of ix, alone, above.)

It is, only if we assume something more than is in fact claimed in the proposition itself; that is, the physical impossibility follows only from this singular proposition taken in conjunction with another, namely, that Swartz is (/has) a material body. Without this understanding, the claim is not incompatible with the physical law concerning the maximum attainable velocity. For that law is not unconditionally general, but only conditionally so: It applies only to bodies having mass. “Things”across the surface of an object that is at an angle to the expanding wavefront of the light can achieve any velocity up to and including an infinite velocity. To argue, then, that it is physically impossible that Swartz should achieve a velocity in excess of that of light requires a tacit assumption beyond that stated in the proposition that I do; we must tacitly assume that I have a material body.

It is easy to overlook the categorizations we make of things when we invoke their names or denominate them with gestures, demonstratives, etc. Now, although I am certainly not advancing a theory of naming, I do want to suggest that singular propositions whose physical possibility is in question must be construed within a context of categorizing their subjects before the question can have any determinate answer. Is it possible that Julie should lay an egg? Well, it all depends. Who is Julie? Is Julie male or female? Is Julie a primate or a fowl? Is Julie living or deceased? Is Julie a living thing or an inanimate object? Does Julie have functioning ovaries? Etc., etc.

The point can perhaps better be made by switching to the material mode from the formal. The claim can then be put this way: Whether a situation, a sequence of events, or a constellation of properties, etc., is physically possible or not, depends critically – as was insisted in Chapter 2 – on what description one gives. As descriptions become more robust, the probability decreases of the situation that is being described being physically possible. Suppose there is no lamp on this desk. Is it physically possible that there should be? The answer is “yes,” if by “this desk” we intend nothing more than “a desk”; but if we intend something more specific, if we understand by “this desk” not just “a desk” but (as this desk in fact is) one made of balsa wood with two of its three legs cracked clear through and held temporarily only with a twist of cellophane tape, the preferred answer may well be “no.”

Existential statements often are more specific as to categorizations than are singular statements. Contrast “Is it physically possible that Julie should lay an egg?,” with “Is it physically possible that a primate should lay an egg?” That existential statements often have categorizations of their subjects “built-in,” as it were[11] should not, however, blind us to the need to *provide* those categorizations in the case of singular propositions whose physical possibility is at issue.

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[11] Often, but not always; e.g., “It is physically possible that *something* (unspecified as to kind) should exceed the speed of light.”

6

Failure versus doom

THE POSSIBILITY OF KNOWING THAT A PHYSICAL LAW IS NOMOLOGICAL

Viewed in one way, Molnar's objection (see chapter 5, pp. 50-61) to the Regularity account can be seen as criticizing the claim that the existential proposition, that there is somewhere, somewhen a river of Coca-Cola, turns out to be physically impossible. In effect, this criticism says that the predicate "physically impossible" is being given too wide a range of application, that certain propositions that we would not intuitively expect to turn out to be 'physically impossible' do turn out so. To this, I have replied by saying that the sense in which Regularists use the predicate "physically impossible" is a weaker sense than what Molnar seems to have in mind. More specifically, if what in fact motivates his objection is his belief that there 'really could be' a river of Coca-Cola, the reply to be insisted upon is that the Regularity Theory does not in the slightest preclude the existence of such a river. Indeed, the Regularity Theory – in withholding physical possibility from rivers of Coca-Cola – asserts only what Molnar himself hypothesized: namely, that there *never* are any such rivers. It is a positive distortion of the Regularity Theory to take its assertion that something is physically impossible as equivalent to an assertion that that thing could not exist.

But there is another way to view Molnar's objection. We can imagine his objection being taken to support the following contention:

> If "physical impossibility" is explicated to mean nothing more than "inconsistency with a timelessly true, contingent, universal material generalization," then there is no way for a Regularist to explain the difference between, on the one hand, a project that is undertaken but *fails* (e.g., an attempt to swim Lake Superior from east to west), and, on the other, a project that is undertaken but is *doomed* (e.g., an attempt to propel a rocket beyond the speed of light).[1]

[1] The style, although not the specifics, of this particular extension of Molnar's argument was suggested to me by Jonathan Bennett.

Here the point is that, if we allow the predicate "physically impossible" to apply to a false proposition such as

> *P7* *Some specific person,* a, *swims Lake Superior from east to west*

then we seem unable to account for the felt difference between this proposition and the false proposition

> *P8* *Some specific rocket,* b, *is propelled beyond the speed of light*

How can a Regularist account for this difference?

To begin, I would wholeheartedly agree with critics that there is a difference between those projects that simply fail and those that are doomed. Projects that simply fail, I would say, are those whose descriptions (i) are false and (ii) are *not* incompatible with any timelessly true, contingent, universal material generalizations (i.e., physical laws), whereas those that are doomed are those whose descriptions (i) are false and (ii) *are* incompatible with one or more timelessly true, contingent, universal material generalizations.

Thus there is no problem of a Regularist's being able to explicate a difference between a project's simply failing and its being doomed. What problem there is, if any, would seem to lie only in the specific cases cited. Does my account attribute doom to cases that merely fail?; does it attribute mere failure to cases that are doomed?

There is no dispute between the Necessitarian and me about the second case cited. Both of us agree that any attempt to propel rocket *b* faster than the speed of light is doomed. We agree, that is, that *P1* – viz. that no mass travels faster than the speed of light – is a physical law. (Of course, as I said in Chapter 5, we disagree as to what properties, exactly, *P1* possesses that make it a physical law. But *that* disagreement does not carry over and infect either our specific agreement that *P8* is physically impossible, or our higher-order agreement that *any* attempt to propel a rocket beyond the speed of light is doomed.)

Now what about the first case? According to the Regularity account, does the false proposition *P7*, namely, that person a swims Lake Superior east to west, describe a project that merely fails or one that is doomed? I am unable to answer this question straightaway. I need more information about the case. For, as it is described, there is nothing to suggest that *P7* is logically inconsistent with any timelessly true, contingent, universal material generalization. So it would seem, then, that there are two ways the answer might go. Let us examine each of them in turn.

Suppose, contrary to fact, someone succeeded in 1979 in swimming Lake Superior from east to west. Then the universal generalization

P9 *No one (in the past, present, or future) swims Lake Superior from east to west*

would be *false.* Therefore, according to the Regularity Theory, proposition *P7* would not be logically incompatible with a physical law, and no attempt (provided, of course, that it is described merely as an attempt, and not more specifically) before or after 1979 to swim Lake Superior from east to west would be doomed. Once again, the Necessitarian and I would agree as to the proper description to be applied; in this instance, it would be "mere failure" for any unsuccessful attempt. This leaves only one other alternative to be examined, namely, the case in which no attempt to swim Lake Superior from east to west is successful.

How many attempts need we consider? It turns out that the actual number of attempts is irrelevant. It makes no difference whether there are no attempts at all, exactly one attempt, or 10 million. Provided that there are no *successful* attempts (which of course will be trivially true if there are no attempts at all), the conclusion will be the same.[2] For illustrative purposes, I will concentrate on an example featuring exactly one attempt.

Suppose that in the entire course of the world's history – past, present, and future – one and only one attempt is made to swim Lake Superior from east to west: In 1891, a swimmer is hauled

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[2] I am sure that many of us harbor conflicting intuitions about the 'zero-attempts' case. If asked whether a project is doomed just because it is not undertaken, I think many of us would be inclined – like the Necessitarian – to reply that it is not. But against this is our common tendency to encourage our children, students, and one another by saying such things as "If you won't even try it, you won't get better / pass the exam / overcome your fear of water / etc., etc." Here, our words would seem to reveal a Regularist sentiment: Projects that are not undertaken are *automatically* doomed. The moral: Beware of philosophers bearing intuitions.

exhausted out of the lake long before she reaches even the halfway point.[3] Wouldn't I then be committed to saying that *P9* – that no one swims Lake Superior from east to west – because it is timelessly true, is a physical law? And that *P7* is incompatible with a physical law, and hence that the project that *P7* describes (i.e., swimming the lake) is doomed?

To this I would have to reply: Yes. Indeed, we can generalize this conclusion: Any project that is one of a kind and does not succeed is to be viewed as one that is doomed.[4] Generalizing still more, we can say that if *all* – whether few or many – attempts at some project fail, then projects of that kind are doomed.

Doesn't this, finally, show the untenability of the Regularity account? I think not.

The argument in defense of the Regularity Theory takes the form of a challenge to the Necessitarian: "Why under the circumstances described – namely, the failure of the undertaking – do you wish to say that such a project is *not* doomed?" How shall the Necessitarian answer? We will examine one possible answer in this chapter and another in the next.

Presumably, one thing a Necessitarian might say in reply would be something of this sort:

> One of a kind projects need not be doomed simply because they fail. Consider the example at hand namely swimming Lake Superior from east to west. This kind of project is not doomed even if the one attempt at swimming the lake was a failure. Surely the

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3 Strictly speaking using Lake Superior in my examples violates the requirement laid down in Chapter 2 for unrestricted descriptive terms This minor difficulty can be circumvented by replacing Lake Superior with any uniquely referring description of Lake Superior We need not explicitly do so however It suffices for the points we are making that in principle it can be done

4 I would like to forestall both the objections (1) that *every* event (or project) is one of a kind and (2) that *no* event (or project) is one of a kind. The first objection might be thought to follow from the truth that every event has some description such that no other thing has precisely that description and the second objection from the truth that every event has some description such that at least one other thing also has that description. The conclusion that I am here deriving from the Regularity Theory is this: If a project under a certain description has but a single instance and that instance is a case of nonsuccess, then all projects of that description are doomed. Thus, although every project to swim Lake Superior is also a project to swim at least one thousandth of the way across Lake Superior, the latter *sort* of project need not be doomed even if the former sort is.

> 1891 undertaking could have turned out otherwise; that is, the statement that someone swims the lake is not incompatible with any physical law. In particular, *P9* – the statement that no one (ever) swims the lake – is not a physical law.

And then, growing expansive in his explanation, the Necessitarian might continue:

> Understand that I am not challenging the hypothesis that *P9* is true. Clearly, *all* the evidence we have at hand, namely, the one unsuccessful attempt in 1891, is evidence that *P9* is true. And given that no one to date has managed to swim the lake, were I to argue that *P9* is false, I would have to be appealing to knowledge of future occurrences, and I hardly want to present myself as precognitive. No, the dispute between us is not whether *P9* is, in fact, true. Still less is it a question of whether we, who cannot operate sub specie aeternitatis, could ever discover the truth-value of this temporally unrestricted proposition. The issue at hand is only: "If this proposition *were* true, would it be a physical law, and would all attempts – past, present, and future – therefore be doomed?" And to this question, I reply: "No." *P9* is not a physical law – could not be a physical law – for the simple reason that it is not nomologically necessary.[5]

Here the Necessitarian's argument is very much in the tradition of his school. Other Necessitarians have professed similar insights: Molnar, as we have seen, as regards there being a river of Coca-Cola; and still others as regards such diverse phenomena as the occurrence of nickels among the coins in one's pockets; the maximum life span of moas (now extinct); the color of ravens; etc. In each case, there have been Necessitarians who have championed the view that, even if certain universal material conditionals about these phenomena are true (e.g., No moa lives longer than fifty years; All ravens are black; etc.), these propositions are not physical laws.

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5 Were it to be objected that I have set up a straw man in requiring the Necessitarian to promote an unlikely example, I plead innocence. I have tested this example on several ready-at-hand defenders of Necessitarianism and have in each case drawn the same reaction: *P9* is not a physical law. Be that as it may, if anyone thinks that the example is unfairly stacked (one way or the other), I invite him to substitute an example of his own choosing that he finds more congenial. For, in the end, the specific example is quite unimportant. The essential point is that the Necessitarian argument being examined in this chapter is to the effect that the Necessitarian claims to know of a proposition that the Regularist would say is a physical law (and whose truth is not being contested) that it is not nomologically necessary. All that is required for the debate to proceed is that there should be some such example. It is really of no particular concern – on either side of the debate – just which example is settled on.

It would seem, then, that some Necessitarians argue for an ability to detect whether an unrestricted, true, universal material conditional is nomological or not.

Whence could such knowledge arise? Whatever grounds the Necessitarian cites to support his knowledge claim must, of logical necessity, be either empirical or a priori. Can either of these modes provide the knowledge claimed?

Remarkably few Necessitarians have proposed that nomological necessity is empirically ascertainable. Undoubtedly the most optimistic among these few was Ducasse. He argued that necessity (later he came to call it "etiological" necessity, the necessity holding between a concrete cause and its effect) was *directly* observable. In a series of papers and books, beginning in 1924 and ending in 1966, he returned regularly to this theme, held to it steadfastly, and tried to defend it. For all his efforts, as I said in Chapter 3, he won few supporters. Indeed, his critics are legion. Even among Necessitarians, his views have not been taken up.

Von Wright is at once more cautious and more daring: more cautious in that he thinks that nomicity (as he calls it) can only be *inferred;* and more daring in that he tries to describe experimental procedures for "a dive under the surface of actual reality into the depths of unactualized possibilities" (1974, p. 37). His is a subtle and ingenious attempt to amalgamate Necessitarianism and the Manipulability Theory, the latter being the theory that "the concepts of cause and nomic necessity" ... "presuppose, are dependent upon" ... "the concepts of action and agency" (p. 48; quotation is slightly reordered for stylistic reasons). Von Wright advances Bacon-Hume-Mill's Methods considerably; his insights are instructive, and his presentation is elegant. But there is one overriding fault: If his experiments are *actually* carried out, then their results must agree *identically* with those of the Regularity Theory; and if they are not implemented, then there are no results, and one is left with the same indeterminacy as to nomicity that the Regularist is left with as to timeless truth.

Von Wright asks how one can distinguish a merely true universal generalization from a nomic generalization. He proposes various tests for manipulating the antecedent conditions, trying to see what happens when one induces a new condition, suppresses an existing one, etc. (1974, parts 2 and 3). Suppose, for example, one is concerned to find out whether "Whenever *P*, then *Q*" is 'merely' true or nomically so. Suppose, then, that one brings it about that *P* on an occasion when *P* would not otherwise have occurred. (Plainly, there is a problem here of explicating both ‘bringing it about that’ and ‘an occasion on which it would not otherwise have occurred’. Von Wright is sensitive to this need and offers explicata. We will not pause over these analyses because there are more serious problems to be remarked.) Having brought it about that *P***,** when *P* would not otherwise have occurred, we observe that *Q* does *not* follow. According to von Wright, unless we wish to postulate some further, hitherto unnoticed, inhibiting condition, we will conclude that “Whenever *P*, then *Q*” is not a nomic universal. And if, on the other hand, our inducing *P had* been followed by *Q*, we would have confirmation (although hardly verification) that “Whenever *P*, then *Q*” is a nomological.

But this “dive” as it were “behind reality” is illusive. The results of this getting our feet (and bodies and heads) wet are identically the same results – save the honorific designation “nomic” – that the Regularist would attribute to these cases when he speaks, more simply, of these generalizations as being timelessly true or false simpliciter. That is, if the alleged Necessitarian experimental methodology yields positive results, then the Regularist will, according to the Regularity Theory, want to say that the proposition has been confirmed as being true and hence is (probably) a physical law; whereas if the experiment yields negative results, the Regularity Theory will say of the disconfirmed proposition that it is (probably) false and hence (probably) not a physical law.

Necessitarians believe that the test, or mark, of nomicity is a proposition’s ability to support a counterfactual conditional. And clearly von Wright’s project is designed to provide the experimental means of sorting out those propositions that do support counterfactuals from those that do not.

But the Regularist has no particular trouble accommodating counterfactuals within his theory as well, and he does so on the same experimental basis as the Necessitarian, but without attributing nomicity to universal propositions.

Suppose, for example, a researcher wants to find out whether a new medication *XYZ* causes blurring of vision. She proceeds along familiar lines. (There is no Necessitarian experimental methodology distinct from Regularist methodology.) She administers the compound to persons who would not otherwise have consumed it; she withholds it from a control group; she records the visual acuity of each group, particularly the test group, before and after ingesting the drug; she subjects her data to careful mathematical analysis; and she manages in due course to convince us that the compound does indeed degrade vision. What can this experimenting show us about the *necessity*, and the ability to warrant a counterfactual, of the proposition that the compound *XYZ* degrades visual acuity? In particular, can it show us, as von Wright believes, that the proposition has a nomological necessity?

What is conceded by both parties to the dispute is that the connection between the two phenomena is (at least) regular. But can regular association suffice to warrant a counterfactual conditional?

It all depends on how 'pervasive' the regularity is. We can imagine the counterfactual at issue being challenged:

> The experimental data show that, under certain laboratory-controlled conditions, drug *XYZ* induces visual impairment. But one cannot assume from these limited data that *XYZ* will impair vision under all circumstances. Perhaps there are foods or other drugs that if taken along with *XYZ* would block its effect, in much the same way, for example, that milk is antagonistic to the proper working of tetracycline.

The objection has merit. The universal conditional "Drug *XYZ* impairs vision" will support a counterfactual, for example, "If one were to take *XYZ*, one's vision would be impaired," only if the regularity between taking the drug and subsequent impairment of vision is pervasive, that is, *independent* of other conditions.

Laboratory data, of course, never suffice to establish pervasiveness, but they may well be indicative of pervasiveness. Often, it is reasonable to assume that a factual regularity *is* unconditional. Such knowledge, however, is never a priori; it comes about through our individual and shared experience of the world. Experience has taught us what we may reasonably (but never with certainty) regard as 'similar'; as cases in which the assumption of pervasiveness has turned out to be confirmed. For example, we know empirically that the melting points of metals are independent of location, of the source of the applied heat (e.g., whether a gas flame or an electrical current), of the nationality of the artisan, etc. And likewise, it is by empirical means that we have come to know that there is an imperfect regularity between seeding clouds and subsequent rainfall.

Pervasive regularities can, and do, support counterfactual conditionals. Pervasiveness, however, need not be regarded as a modal property, that is, as any kind of nomic or ontic necessity.

For the Regularist, warranting the counterfactual "If one were to take *XYZ*, one's eyesight would become impaired" depends on its being a physical law that taking *XYZ* is followed by visual impairment. This latter proposition will be a physical law provided the truth of the matter is that there is no condition, *ABC*, that is antagonistic to the action of the drug. This is to say, the counterfactual is warranted if the physical law is of the form: "When one ingests *XYZ*, blurring of vision results"; and is not warranted if the physical law (i.e., the truth of the matter) is of the form: "Whenever one ingests *XYZ, provided* ABC *does not also obtain*, then blurring of vision results."

What von Wright interprets as telling evidence of natural necessity, the Regularist interprets merely as evidence of the paucity of the class of ceteris paribus conditions, that is, as evidence of broad (encompassing) application of the proposition. Von Wright's and the Regularists' methodology for science is identical; the dispute lies wholly in their respective interpretations of the results of the application of this methodology. For von Wright, a discovered constancy amid the deliberate manipulating of experimental variables signals necessity; the same result for a Regularist shows only a universality with a particularly broad range of application; that is, it shows pervasiveness.

Other Necessitarians are far less sanguine than Ducasse and von Wright about the possibility of finding a test for nomicity.

> We cannot ... ever find out of any given non-logical statement that it is in fact naturally necessary: the conjecture that it is remains a conjecture for ever (not merely because we cannot search our whole world in order to ensure that no counter instance exists, but for the even stronger reason that we cannot search all worlds that differ from ours with respect to initial conditions). (Popper 1959a, p. 433).

["All worlds that differ from ours with respect to initial conditions," remember, (Chapter 5, footnote 7), is Popper's way of denoting all those possible worlds that have the same physical laws as the actual world.] Rescher reaches the same pessimistic conclusion.

> No matter how massively the observational evidence may be amassed .it is clear upon reflection that this evidential basis must always be grossly insufficient to the claim actually made when we class a generalization as a law. ... It is obvious that this basis will be *deductively insufficient* because the evidence inevitably relates to a limited group of cases while the applicability of the law is unrestricted. Moreover the evidential basis will also be *inductively insufficient.* For inductive procedures are designed to warrant the step from observed to unobserved cases, whereas a law – whose very lawfulness arrogates to it nomological necessity and counterfactual force – not only takes this inductive step from observed to unobserved cases, but also takes the added step from actual to hypothetical cases. ... And the premiss for such an induction will obviously always be

> unavailable. The evidential foundation for generalization [to a nomological] is thus afflicted by a double insufficiency, not only in the *deductive* mode, but also *inductively*. ... The basic fact of the matter – and it is a fact whose importance cannot be overemphasized – is that the elements of nomic necessity and hypothetical force are not to be extracted from the evidence. (1970, pp. 105-7; parenthetical gloss added)

Popper's and Rescher's criticisms are so incisive and uncompromising that the wonder is that they were penned by Necessitarians themselves and not by their critics. In Chapter 13, we will return to Rescher's special brand of Necessitarianism, but for the moment let us continue with Popper. Popper is unrelenting in exposing difficulties in his own Necessitarianism. Having argued against its empirical status, he goes on to reject any pretensions it might have to being known a priori.

> I believe, … the idea that there are necessary laws of nature, in the sense of natural or physical necessity … metaphysically or ontologically important, and of great intuitive significance in connection with our attempts to understand the world. And although it is impossible to establish this metaphysical idea on empirical grounds (because it is not falsifiable) *or on other grounds,* I believe that it is true. (1959a, p. 438; italics added)

Popper gives no reasons for rejecting, as he does, an a priori ascertaining of nomological necessity. The possibility remains to be examined. Can one intuit, recognize, infer, or in any other way determine a priori that there are any nomological propositions? More specifically for our concerns, could one ever know a priori of any designated proposition that *it* is nomologically necessary?

The paradigm of a priori knowledge is analytic knowledge, knowledge gained through the analysis of the concepts figuring in a proposition. Might conceptual analysis provide the litmus test for detecting nomological necessity? Consider, again, the contentious *P9,* the proposition that no one (in the past, present, or future) swims Lake Superior from east to west. I am sure it is safe to presume that no Necessitarian would want to argue that one could have analytic knowledge of the nomological necessity, or lack of it, of *P9.* Indeed, it would be singularly implausible to argue of *any* putative physical law, (e.g., "Aluminum melts at 660° C") that its nomological necessity could be determined analytically. But if an analysis of concepts is not to provide the demarcation between nomological necessity and 'mere' timeless truth, what other a priori method is there? From here on, we must be particularly cautious.

If a proposition's being nomologically necessary is something knowable a priori, then this knowledge must lie in uncharted territory. But one suspects that there really is no such kind of nonanalytic a priori knowledge. If there were, it would be hard to explain why all Regularists, most if not all scientists, and not a few Necessitarians themselves seem to lack it. Then, too, if such knowledge were seriously posited, it would be difficult to explain why every putative physical law that has come to be overthrown in the long history of science could have been mistakenly thought to have been nomological when in fact it was not.[6] A far simpler hypothesis to explain the historical evolution is that persons were mistaken as to the empirically ascertained truth-values of these putative laws. The only other explanation is that these persons were mistaken as to *two* things: the truth-values *and* the modality. But if that hypothesis is advanced, then this supposed a priori 'knowledge' of nomological necessity is at least as unreliable as empirical knowledge, and – curiously – whenever we are wrong about the truth-value of a putative law, we have *also* made an error in our a priori reasoning about its modality.

Still, this is hardly an incontestable refutation of the existence of the requisite kind of a priori knowledge. Nonetheless, if such knowledge exists, it would seem to be bestowed on only a select few philosophers and not to be acquirable by the rest of us.

Where, exactly, have we now arrived? Even more to the point, how have we come to be discussing epistemological matters when we began by trying to find the proper analysis of the concept of a project's being doomed?

The discussion has taken the turn it has because the Necessitarian claims to know that certain kinds of projects, contrary to what the Regularist says about them, would not be doomed even though they in fact fail. But a Necessitarian who chooses to argue in this fashion adopts a very different sort of argument from that of the Regularist.

Note that Regularists make no categorical claims whatever about the physical impossibility of any unique project. Our claims are purely conditional:

> *P10* If *a project is one of a kind and* if *it does not succeed, then it is physically impossible, that is, doomed*

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[6] I am here assuming that being true is a necessary but not sufficient condition for being nomological. If one wants to assume that some false propositions are nomological, this problem will present itself: Why, in overthrowing putative physical laws, do we always seem to do so because of a reconsideration of their truth-values, rather than of their modality? I.e., why is it that their modality always seems to be idle in the case of the rejection of putative physical laws?

A particular instantiation (specialization) of this would be the following:

> *P11* If *one and only one attempt is made to swim Lake Superior from east to west and that project does not succeed, then that project is physically impossible, that is, doomed*

The Necessitarian wants to deny *P10*, and one way of doing this (remember we will examine another way in Chapter 7) is to refute some proposition (such as *P11*) that is a specialization of *P10.* Thus, to refute *P10,* all the Necessitarian need do is to find a case, any one at all, in which a unique project fails but is not physically impossible. And to do the latter, all he need do (according to his theory) is to show that a true material conditional, whose antecedent describes the project and whose consequent expresses the failure of that project, (e.g., "Anyone who tries to swim Lake Superior does not succeed"), is not nomologically necessary. His claim, then, is not conditional, as is the Regularists', but is categorical; he claims, of at least some failed projects, that they are unconditionally physically possible.

The Necessitarian thinks that what he wants to establish is relatively easy to do and has not one, but several, examples (concerning, e.g., moas, ravens, coins, etc.) at the ready. But these examples, when scrutinized, prove troublesome. It is one thing for a Necessitarian to present these as cases of propositions that are not nomologically necessary; it is quite another to explain how the judgment is arrived at and how it is to be justified. When pressed, no Necessitarian has offered a plausible explanation as to how it is possible, either empirically or a priori, to determine nomicity.

One Necessitarian, Taylor, seems totally unperturbed by this difficulty in the theory. He breezily dismisses the worries of the Regularists:

> The dispute has been carried on in the spirit of ideology and debate. ... [Regularists] have adduced numberless irrelevancies, such as pointing out that ... no necessary connection is observable, that the empirical sciences presuppose no such idea, and so on. (1983, pp. 82-3)

Later, he describes a hypothetical situation in which we would (allegedly) withhold lawful status from a universally true conditional because we know that the connection is not, as he puts it, "necessary." Quite rightly, he anticipates the question as to how we might acquire such knowledge. His answer, however, is extraordinary:

> This observation [that we do not see any necessary connections] ... whether it is true or not, has no relevance to the question before us. The question is not how causes are known, but rather what they are. We began by assuming that we know, at least in some

> instances, that certain things are causally [i.e. necessarily] connected. The most untutored person knows this. *How* these connections are known is an interesting question, but not the question we are asking. Our question is rather what one *means* when he affirms the existence of a connection that is thus so confidently known. (p. 86; parenthetical phrases added)

Few, if any, other writers on the subject share Taylor's indifference to the epistemological difficulties. If "the most untutored person" *knows* that there are necessary connections in nature, surely it is more than just an 'interesting' question to inquire where such knowledge originates.

Taylor argues that the question of how we might in practice determine that a natural necessity obtains is, in the end, 'irrelevant' to what a claim to that effect might *mean.* Now although this may sound at first like a standard rejection of the verificationist theory of meaning, it is really more problematic than that. For unless there is some determinate way to ascertain the nomological status of a proposition, the very attribution of meaningfulness to a claim that some particular proposition is nomological would seem to be without foundation. Nomological necessity is not a property like contingency that can be determined a priori; propositions bear their *logical* modalities of logical necessity (see Bradley and Swartz 1979, pp. 333-9). Nomological necessity is a property supposedly born only by a proper subset of contingent propositions. If it is to be meaningfully attributed to some contingent propositions and not to others, there must be distinctive conditions for its application. If none are specified, we must then be at a loss to understand what this property of nomicity is, or what a proposition attributing it to another proposition is supposed itself to mean. How, for example, is natural necessity supposed to differ from the property we invent on the moment and arbitrarily christen, let us say, "primal sovereignty"? If we don't specify under what conditions either nomicity or primal sovereignty is to hold, how shall we distinguish one from the other and either from sheer fiction?

For Regularists, Necessitarians' claims that they are able, on occasion at least, to determine of certain propositions that they are nomologically necessary appear to be cases of self-deception or of unrecognized dogmatism. Regularists are incapable of seeing how Necessitarians could possibly have the knowledge that they are here presupposing and using to attack the Regularists' theory.

Having made this point, the Regularist might then be moved to generalize on it:

> No one can, in advance of one of its kind being actual, justifiably claim to have knowledge that a kind of event is physically possible. Some Necessitarians seem driven

> to ascribing nomological necessity to physical laws because they seem to think that they know, in advance of empirical evidence, for at least some cases, what is physically possible and what is not. But no one has ever plausibly explained how such knowledge could be possible.

It would be easy to minimize the depth of the dispute on this particular issue. It would be easy to think that the Necessitarian has here simply overstated his case and that, with a little patching up, it can be made to work.

Couldn't the Necessitarian backtrack just a bit? For example:

> All right, we Necessitarians do not *know*, in some strong sense of "know," that it *is* physically possible to swim Lake Superior. Likewise, we do not know that it is physically possible to make a river of Coca-Cola. But surely we have *excellent* empirical grounds to warrant our claim that these sorts of occurrences are physically possible. There have been, after all, similar sorts of things that have occurred and that we know about. We are in a position to perform a Reichenbachian 'cross-inductive' inference: Other persons have performed prodigious athletic feats, and calculations on body weight, oxygen exchange, and the like show that swimming Lake Superior is within human capability. And as to the river of Coca-Cola, all that really seems to bar its existence is someone's will to waste his money in that way. After all, there was a river of molasses in Boston on January 15, 1919.[7]

The first part of my reply will probably surprise the Necessitarian:

> I agree with much of what you have to say. It certainly is consistent with everything we know that someone should swim Lake Superior and that there should be a river of

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[7] "Towering over the lunchtime loungers and this neighborhood of tenements and historical sites was a 90-foot-high metal tank, 282 feet in circumference ... used for storage of molasses by the Purity Distilling Company. With a low rumbling noise, followed by a series of sharp explosions, the tank burst open and a black flood of molasses poured into the streets. Faster than anyone could run, a wave of sticky syrup, initially 20 to 30 feet high, flowed through the streets, burying workmen, strollers, and lunchtime idlers. An estimated 2 million gallons of molasses, weighing some 27 million pounds, had been released from the burst tank. The flood knocked several buildings from their foundations and drowned or suffocated 21 people where they stood. Sections of the ruptured tank sliced through building walls and sheared off columns supporting an elevated train line. ... The odor of molasses hung over the city for a week, and the harbor remained brown-tinged for almost five months." (Cornell 1976, p. 235).
Cornell offers a bibliography on the Molasses Disaster on p. 365.

> Coca-Cola. Indeed, I will even go so far as to say that were there many attempts to bring these events about, it is probable that at least some of them would succeed. Moreover, I would even be willing to bet on their successful outcome.

But with the second part of my reply, we are at loggerheads again.

> But we still disagree on the essential point, and really your invoking the probability of there being a river of Coca-Cola and the like is at cross purposes to our dispute. You are making an epistemological-cum-practical point, namely, that on the basis of what we know, such and such is probable, and indeed should be expected under certain easily conceivable circumstances. So long as I share the same data base as you, and subscribe to the same probability calculus, there can be no disagreement on these matters. But none of this answers, indeed it does not even address, the question of whether these sorts of events are physically possible. What may be highly probabilified by our knowledge, may – for all that – be false, indeed even be physically impossible. For example, on the basis of observing a variety of many metals, it would be perfectly reasonable to claim that it is physically necessary that all metals expand when melted. But this warranted inference has a false conclusion; antimony-tin, for example, contracts when melted. In short, you are confusing two quite different concepts: "physically possible" as used to describe those propositions that are consistent with what we take to be knowledge in science; and "physically possible" as used to describe those propositions that are consistent with actual physical laws (known and unknown).

DISCUSSION

Nec(essitarian): I am unsatisfied with where you have drawn the dividing line in the class of failed projects between those that are cases of mere failure and those that are (physically) doomed. Let's look again at the case of the swimmer attempting to cross Lake Superior. In a way, you have made the case too easy for yourself, by having the one swimmer who attempts the swim fail miserably. What if, instead of falling far short of her goal, she came within a few meters? Suppose that she was within 30 meters of the western shore, when – horrors – a careless crew member in one of the boats in the welcoming flotilla tossed an anchor overboard and knocked her unconscious. Clearly her attempt failed. But, under the circumstances, namely, her having just about reached the finishing line while still swimming strongly, wouldn't it be totally unreasonable to claim that the project was doomed?

Reg(ularist): You continue to read something stronger into "doom" than what I mean. When I say that a project is doomed, what I mean is that it is logically inconsistent with some universal proposition. Now because the swimmer's attempt is, ex hypothesi, the only attempt – past, present, and future – to swim the lake, and because it fails, it logically follows, then, that *every* attempt to swim the lake fails. But the latter proposition *is* a universal one; and hence the singular proposition, that the one attempt was physically possible, is false.

Nec: Your use of the term "doom," although certainly consistent with our mutual agreement that it is required where a singular proposition is inconsistent with a physical law, seems misapplied in this instance. The reason is that we ought not to regard the proposition that no one ever swims the lake (even if true) as being a physical law. Compare this statement with the proposition that no mass travels in excess of 299,792 km/sec. This latter proposition *is* a physical law. But the universal generalization about no person swimming the lake is not a law. Its truth is, as we say, merely accidental.

Reg: I would agree with you if it weren't for two facts.[8] The first is, as we have seen in this chapter, that there is no known method – either empirical or a priori – for drawing the distinction you insist upon. This I regard as a powerful objection. If the distinction between nomicity and accidentalness were viable, then there ought to be some pretty clear means of determining it, or, at the very least, the outlines of such a means ought to be discernible. But not even the latter is at hand; and indeed many Necessitarians themselves, for example, Popper and Rescher, explicitly deny that such a means could exist.

The second fact is that the distinction you intuit can be explicated without any need to attribute occult, modal properties to certain universal truths.

Our objection to your finding nomicity empirically is not mere skepticism about an opponent's claims. It is not that we fail to believe what you do it is rather that we believe that what you claim to be able to do cannot be done, by anyone. Moreover, we believe that the Regularity Theory is perfectly adequate to explain our empirical knowledge of the world, its laws, and counterfactual conditions. Such knowledge, all of it, comes about through our observing the world and finding out what sorts of things happen in it. If we feel reasonably confident in saying, for example, that it is (physically) possible to do some things that no one ever has, such as making a river of Coca-Cola, it is because similar sorts of things have already occurred in this world and we know of them empirically (e.g., the Molasses Disaster). Our reasonable confidence arises not from any knowledge that a certain universal proposition is not nomologically necessary, but rather through our knowledge that certain similar sorts of events have already occurred in this world.

8 There will be additional problems cited in Chapters 8 and 10.

Let's return to the two propositions, one, that no mass travels in excess of 299,792 km/sec., and two, that no person successfully swims Lake Superior. You have insisted that there is a difference between these two. There is. But I would not describe it as being the difference between nomicity and accidentalness. The difference is that the former has far more *epistemic warrant* than the latter. We have – by experimenting and theorizing – excellent grounds for believing that it is true that no mass travels in excess of 299,792 km/sec. We have far less evidence on which to base a comparable certainty in the case of a person's swimming Lake Superior. Indeed, failure to swim lakes, without further qualification, we already know is not a pervasive feature of this world. Most of us know of, and in some case know personally, persons who have successfully swum across lakes of considerable size. And certainly, had we been on one of the boats in the welcoming flotilla, we would have been quite irrational to believe, just before the anchor was thrown, that the swimmer would not make the shore within the next few moments. If asked to make a claim about the physical possibility of her success, all of us – whether Regularist or Necessitarian – would, if rational, say that on the evidence then available it certainly looked as if success were possible.

Regularists are no better or worse at predicting the future of the world than are other persons. Regularists will make the very same bets as Necessitarians as to what is and is not physically possible. We, like everybody else, go on the evidence available to us. If, however, at the end of time, we were to discover that no one has ever swum across Lake Superior, we would then have to conclude that the task was physically impossible (i.e., that it did not occur). But that we should eventually at the end of the world have to say that no one has ever swum the lake is perfectly compatible with our having rationally predicted otherwise on the less-than-complete history of the world we would have known earlier when we were watching the swim in progress and seeing the swimmer approaching her goal.

Nec: I agree that the epistemic problems inherent in claiming that there is a difference between nomicity and accidentalness are serious. But still I am unconvinced. For I want to insist that, even if it were *known* that (timelessly) there never *is* a successful attempt to swim Lake Superior, under the circumstances described – the swimmer's having been within a hairbreadth of her goal – it would be rational to assert that, in spite of all failures, the feat was still physically possible. The difference between the two propositions – that no one ever (past, present, or future) swims Lake Superior, and that no mass (past, present, or future) travels in excess of 299,792 km/sec. – is not *just* epistemological: There is an ontological distinction between these two propositions.

7

State-descriptions and reductions

If he is not to appeal to knowledge that he cannot justify (Chapter 6), there seems to be only one way for the Necessitarian to try to rebut the Regularist's claim,

> *P10* *If a project is one of a kind and it does not succeed, then it is physically impossible, that is, it is doomed*

And that way is to meet this contention head-on; to argue that it is not logically true:

> That a unique project is undertaken and fails ought not to turn out to be a logically sufficient condition for attributing impossibility to projects of that sort (even if there are no other instances). Some of these unique projects are physically possible, which is to say, counterfactually, they could have succeeded. By "could have succeeded" I mean, using the possible worlds idiom, that in some other possible world very like this one, some of these projects *do* succeed.

The sentiments expressed in this last rebuttal are clear and doubtless strike a sympathetic resonance in many critics of the Regularity Theory. But if we are to pursue this line of criticism, we must be very careful as to what shall be reckoned "some other possible world *very like* this one."

Although it is easy enough to imagine another possible world that differs from this world in just one event, it is hard to see how that world could also be 'very like' this world if that world didn't also have – as a result of that different event – a somewhat altered future from that of the actual world. Consider again the swimmer who sets out to cross Lake Superior but who does not reach the far shore. Could another possible world W_1 share the same physical laws as the actual world and yet differ from the actual world only in the fact that in 1891 the attempt to swim Lake

Superior was successful? Surely we must assume that in W_1, if the swimmer had been successful, the subsequent newspaper accounts would have reported success, unlike the accounts in the actual world that reported failure. In the actual world, the swimmer failed to collect the prize money; but surely she would have in W_1. In the actual world, the swimmer had promised before her attempt that if she were successful she would endow her college with a scholarship; because she made the same promise in W_1, she would have had to carry through her promise in W_1 or would have had to do some explaining as to why she was reneging; etc.

Most of us believe that this world we find ourselves in (the actual world) is pretty uniform, and the idea that another possible world could differ from this world in some large-scale event – of the sort that the Necessitarian is wont to say (counterfactually) could have occurred – without that event having profoundly different consequences from those that occurred in this world, is a nonstarter.[1] If we are going to try to advance these investigations by invoking alternative possible worlds, Regularists and Necessitarians alike are going to have to impose some reasonable and realistic constraints on the manner and extent of the allowable variations between the possible worlds compared.

There are probably as many different ways to impose these constraints as there are philosophers who have tackled the problem, from Todd (1964) to D. Lewis (1973) to Kahneman (1982). Fortunately, we do not have to review this bewildering variety, for the very nature of the problem, as we have here been examining it, suggests the kinds of constraints appropriate for our purposes.

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1 "There are such things in nature as parallel cases, that which happens once, will, under a sufficient degree of similarity of circumstances, happen again." (Mill 1965, p. 201). The lesser the degree of similarity required for repetition, the greater the uniformity of a world. A world, W_j, may be said to be more uniform than another world, W_k, if *fewer* properties must be instanced by an event for that event to be repeated (i.e., for there to be another event of that same event-kind). In the actual world, for example, the ceiling light turns on whenever I, my wife, my daughter, my son, a babysitter, a houseguest, a tradesman, or a friend flicks the wall switch (well, nearly always). But in a *less* uniform world, the ceiling light comes on only after the switch is flicked by a blue-eyed, forty-two-year-old, twice-published, deaf poet. There are, of course, worlds *more* uniform that the actual world. Such a world would be, e.g., one in which any two liquids mixed together always yielded a precipitate. This happens only for very special cases in the actual world.

I would hazard a guess that, on a scale of uniformity, the actual world is a middling one. But I must admit that I am very unsure about this. In any event, the topic of uniformity will constitute the entirety of the section titled "Seminar of April 13: Uniformity" in Chapter 11.

For the Regularist, *singular* statements are ontologically primary. Physical laws are logically derivative. Contingent universal material generalizations derive their 'legitimacy', as it were, from their being reducible to conjunctions of singular propositions, that is to propositions containing only individual constants, purely descriptive predicates and relations, and truth-functional connectives, for example: $\sim Ra \vee Ba$; etc.[2]

Extending Carnap's terminology of 1942 (Carnap 1961), we may say that a *state-description* of a possible world *W* is the class of (or the conjunction of) all the true propositions obtaining in *W*. Then, in terms of this extended concept of a state-description, the Regularity Theory may be expressed thus: All physical laws of a possible world *W* are reducible[3] to some subset (simplification) of the state-description of *W*. In other words, Regularists disallow that there are any actual or possible physical laws whose truth derives from anything other than a world's *singular* facts.

It was stated in Chapter 3 that Regularity is a species of Reductionism. Clearly, the Regularity Theory of Physical Laws is a necessary, but not a sufficient, condition for Absolute Reductionism, the theory that *all* general truths – whether physical laws, moral laws, aesthetic principles, etc. – are reducible to singular propositions, that is, to subsets of a world's state-description. Put another way: Absolute Reductionism holds that a possible world is specified *completely* by its state-description. But although a Regularist is free to maintain this latter, stronger thesis of Absolute Reductionism, it is not required by his own theory. One can promote the thesis that physical laws are reducible to singular truths without being logically required to make the same claim for other general truths.

The problem at issue – examining physically possible alternative worlds – becomes tractable against this background of making singular propositions ontologically basic, provided the state-description model is a viable one. If it is viable, we should then like to see how, in terms of it, the differences between Regularity Theory and Necessitarianism can be spelled out. Is the state-description model viable?

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2 Numerical laws will be discussed in Chapter 13. There it will be argued that numerical quantities are just members of infinite classes of purely descriptive predicates.

3 The use of the term "reducible" (and kindred terms, such as "reduction") here is perfectly apt, although some care ought to be taken so as not to confuse the current sense with another. Here we are talking of the possibility of a general proposition being 'reducible to' singular ones. This contrasts with the sense in which one theory or law may be said to be 'reducible to' another. E.g., phenomenological thermodynamics has often been said to be reducible to statistical mechanics, and optics to the theory of electromagnetic radiation.

There are four worries about the appositeness of this model. Each must be addressed.

The first problem arises concerning the account we are to give of the ‘singular statements’ that comprise the model. For if a state-description is thought to be composed of sentence-tokens, then in a finite universe there can never be enough sentence-tokens to describe *everything*. For every sentence-token itself would have to be described by some *further* sentence-token, and this condition cannot be satisfied among a finite number of things. In other words, we would have here an instance of Russell’s ‘Tristram Shandy’ Paradox (1938, pp. 358–60). Since we hardly want the applicability of the state-description model to depend on an empirical claim as to the finitude of the material universe, we avoid the paradox by making the ‘statements’ in the state-description abstract entities that exist in unlimited number: sentence-types or propositions, according to one’s preference.

The second problem arises from a discovery by Bar-Hillel: Once the primitive vocabulary of a formal language *L* is extended beyond monadic predicates to dyadic and *n*-adic relations, there is no *general* solution to the number of state-descriptions constructible (Bar-Hillel 1951). However, this formal barrier poses no problem for our particular use of the concept of a state-description. We are not constrained to regard the only acceptable sense of “state-description” as being one that pertains to a linguistic construction. We are free to define a sense of “state-description” that makes the term refer to a set (perhaps infinite) of propositions whose existence has nothing whatever to do with our specifying a vocabulary or indeed even with our ability to know their truth or to enumerate them. Rather than conceiving of worlds as constructed out of state-descriptions, we may regard the logical priority the other way around. We can conceive of a world (especially *this* world), as antecedently given; and a state-description as the set of *all* the singular propositions true in that world.[4]

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[4] To speak of the world, as I just have, as antecedently given must surely invite questions about the status of the physical world and raise the specters of incommensurable descriptive statements and alternative conceptual schemes. I happen to be a Realist about the external, physical world. I am convinced that the world is not of my making, nor of the making of scientists; that it existed temporally prior to our existence; that science – although it has essential creative elements – is ultimately directed to finding out how the world *is*; and that how the world is, apart is from the surface of this planet, *[footnote 4 continued on page 83]*

The third problem addresses the question of what is meant, precisely, in saying that a universal material generalization is 'reducible' to singular propositions. One might think that a 'reduction' would consist simply in the conjunction of all the (true) 'Nicod instantiations' or 'confirming instances' of that generalization. After all, "*Sa* & *Pa*" and "*Sb* & *Pb*" are supposed, each, to confirm "(*x*)(*Sx* ⊃ *Px*)"; and thus what could be more natural than to assume that "(*x*)(*Sx* ⊃ *Px*)" is reducible to "*Sa* & *Pa*" and "*Sb* & *Pb*" and the like?

One has practically only to write down the suggestion to see that it will not work. The proposition "(*x*)(*Sx* ⊃ *Px*)" is logically equivalent to "(*x*)(~*Px* ⊃ ~*Sx*)" whose Nicod instantiations (e.g., "~*Pa* & ~*Sa*") are pairwise logically inconsistent with each of the Nicod instantiations of "(*x*)(*Sx* ⊃ *Px*)" (see Hempel 1965). This is a pretty unpromising tack to take: Logically equivalent universal propositions would end up having reductions logically inconsistent with one another.

The species of reduction that works is what is called the 'quantifier-free equivalent' (*QFE*, or more exactly QFE^k, i.e., the quantifier-free equivalent with respect to the universe *Uk*, the universe consisting of the *k* distinct individuals, *a*, *b*, … *k*). (See Faris 1964, pp. 115–24.)

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4 *[cont.]* is with rare exception not of our doing. But with this said, I am content to leave the matter. Not because I think I have given a persuasive argument for Realism (I haven't). But because I think that a proper argument deserves a separate treatment; and more importantly, because the issue is separable from the one at hand. One needn't be a Realist (although I think it is easier if one is) to conceive of there being a set of singular propositions – known or unknown – that are true of the world. One may wish ultimately to give a different analysis from the one I would venture as to how contingent propositions acquire their truth; but these differences need not affect the eventual answers to questions as to whether, and which, contingent propositions are nomologically necessary, physically possible, etc. In other words, to the extent that persons subscribe to the Laws of the Excluded Middle and of Noncontradiction, they need not agree absolutely as to the nature of truth to proceed to the questions of whether general truths are grounded in singular ones and whether any contingent statements are nomological.

The companion specters of incommensurable descriptive statements and alternative conceptual schemes are much more difficult to exorcise. Once again, the attempt will not be made here. A disbelief that there are, in the end, incommensurable descriptive statements and conceptual paradigms of sufficient difference as to preclude judgments of consistency, etc., makes the job at hand far easier. But, again, it is not essential for the task. Regularists and Necessitarians can share, or not, beliefs as to whether there is, or can be, only one conceptual scheme adequate for describing the world. Whatever their views on this issue, the fundamental debate will still remain: Do physical laws bear a nomic necessity, and, if so, what account is to be given of this necessity?

Intuitively, the *QFE* is simply the result of eliminating universal quantifiers in favor of conjunctive strings of singular propositions, and existential quantifiers in favor of disjunctive strings. Thus, for example, the *QFE* of $(x)(Sx \supset Px)$ is:

$$(Sa \supset Pa) \ \& \ (Sb \supset Pb) \ \& \ \ldots \ \& \ (Sk \supset Pk)$$

For convenience, I will call the converse of the relation of being-the-*QFE*-of a "packing of." Thus, "$(x)(Sx \supset Px)$" may be said to be a *packing of* "$(Sa \supset Pa)$" with "$(Sb \supset Pb)$," along with "$(Sk \supset Pk)$."

On this score, then, on defining a precise formal sense in which a universal proposition may be 'reduced' to singular propositions, the state-description model passes muster.

The fourth problem, however, concerns a challenge to the very coherence of the notion of such a reduction. For – this challenge would say – when it is further examined what the relation of reducibility is, it will be found that it presupposes an irreducible universal proposition and thus vitiates the larger theory in which it is embedded.

This last problem has been lurking since the earliest attempts to explicate the relation of reducibility. Russell, in his 1918 series of lectures, "The Philosophy of Logical Atomism" (in section *5*, entitled "General Propositions and Existence"), had spoken to it directly. (In the following, when he says "general" and "particular," I am sure he means "universal" and "singular.")

> I do not think one can doubt that there are general [universal] facts. It is perfectly clear, I think, that when you have enumerated all the atomic facts in the world, it is a further fact about the world that those are all the atomic facts there are about the world, and that is just as much an objective fact about the world as any of them are. It is clear, I think, that you must admit general [universal] facts as distinct from and over and above particular [singular] facts. (Russell 1965, p. 235; parenthetical glosses added)

A few years later, in 1922, when Wittgenstein's *Tractatus* first appears in print, we find a brief allusion to the same issue:

> Propositions comprise all that follows from the totality of all elementary propositions (and, of course, from its being the *totality* of them *all*). (Thus, in a certain sense, it could be said that *all* propositions were a generalization of elementary propositions.) (Wittgenstein 1961, section 4.52)

Wittgenstein is not as expansive as Russell, and does not say – as does Russell – that there are universal facts "distinct from and over and above particular [singular] facts." Indeed, Wittgenstein may have been loath to say such a thing, given his larger reductionist program.[5] But whatever his reasons for not following Russell in positing irreducible universal propositions, Wittgenstein's remarks invite, as do Russell's, questions about the adequacy of the set of singular propositions that figures in the theory.

Russell speaks of a complete enumeration, and Wittgenstein of the totality of elementary propositions. What is the status of this requirement, which we may aptly call 'closure'? If it is to be stated by another proposition subjoined to the original set of singular propositions, then the resulting set contains a universal proposition, and thus no state-description – understood to consist wholly of singular statements – could possibly be an adequate description of this world or of any other. But if the closure condition is not a universal proposition to be added to the original set, what, then, might it be? Even if Wittgenstein did not address this question explicitly, it is not one a modern-day Regularist can ignore. For, the Regularist, like Wittgenstein, is pursuing a reductivist program that makes singular propositions ontologically basic and that disallows irreducible physical laws. If Wittgenstein's theory – the prose forerunner of Carnap's formal state-description theory – harbors, however implicitly, Russell's irreducible universal propositions, then the modern-day Regularity Theory is in danger of losing its keystone.

Notice how Wittgenstein talks of generalizations as 'following from' singular propositions.[6] Is this mere infelicity, or is it meant literally? If taken literally, the way is open to challenge the theory. For, it might be argued, no universal proposition 'follows from' a conjunction, however long, of singular propositions:

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[5] As a matter of fact, there is a problem as to which of these two philosophers originated the idea of enumerating singular facts. Russell, in his preface to his lectures, says that the lectures are "largely concerned with explaining certain ideas which I learnt [prior to 1914] from my friend and former pupil Ludwig Wittgenstein" (1956, p. 177, parenthetical gloss added). It may well be, then, that Wittgenstein has not dropped an inference that Russell earlier made (1918), but that Russell infers from Wittgenstein's theory (of 1914) something that Wittgenstein himself would not have.

[6] Actually, Wittgenstein spoke of 'elementary' propositions, which were supposed to be a certain proper subset of the class of singular propositions. Whether or not a useful distinction of this sort can ever be drawn between 'elementary' singular propositions and 'nonelementary' ones, we have no need of such a distinction here. What the state-description model requires is that there be a set of all singular propositions true in a world. If some of these singular propositions happen not to be 'elementary' (i.e., are deducible from others in the set), no matter. Redundancy, in any amount, is perfectly tolerable in a state-description as described above on page 81. At most, redundancy will simply amount to logical overdetermination of the universal conditionals that are true in that world (i.e., that are generable from the state-description). The self-consistency of the model will be assured by the requirement that all its members be true.

> No set of singular propositions implies a universal proposition, for no matter how many true singular propositions of the form "$Sn \supset Pn$" one strings together, there is always the theoretical possibility of there being some constant q such that Sq & $\sim Pq$. In other words, packings are not cases of deducibility. Clearly, to ensure logical implication, a further premise is needed to the effect that all the relevant constants (individuals) have been enumerated. Suppose, for example, that we were considering a possible world of only three individuals, *a*, *b*, and *c*; and suppose that the following is true:
>
> (**S**) $Ga \supset Ha$
> $Gb \supset Hb$
> $Gc \supset Hc$
>
> In such a world, the following proposition would also be true:
>
> *P12* $(x)(Gx \supset Hx)$
>
> But this latter universal proposition, this packing of the set S of singular propositions, is not *deducible* from S. To ensure the relation of logical implication, a further premise is needed, namely:
>
> *P13* $(x)(x=a \vee x=b \vee x=c)$
>
> But *this* premise is itself universal, and it is indispensable to the validity of the inference. Thus it is impossible, in principle, to reduce a universal generalization to singular propositions. QED.

This argument about closure has convinced many persons that no case of reduction of universal propositions – whether physical laws, moral laws, aesthetic principles, or what have you – to singular propositions can be valid.

But Regularists have a rebuttal: The argument for closure, attractive as it is, rests on a confusion. To show this, we begin by examining the inference the other way around.

> Suppose we have the universal generalization "All human beings are mortal," that is, "$(x)(Hx \supset Mx)$." Is the following deducible from this universal proposition?
>
> *If Swartz is a human being, then Swartz is mortal (alternatively, $Hs \supset Ms$)*
>
> On virtually all accounts, the latter singular proposition does logically follow (is deducible) from the former universal one. But how can this be? Shouldn't we have to conjoin to the former a 'domain'-condition? For example, something of this sort:
>
> (x)(x=Swartz $\vee$ x=Hume $\vee$ x=Lili Pons $\vee$ x=Terry Fox … $\vee$ … $\vee$ …)
>
> Such an additional premise is not required, and it is easy to see why. It is a presupposition in the use of the quantifier "(x)" that it range over all and only those items in a possible world. But because this is so, we hardly need "$(x)(x{=}a \vee x{=}b \vee x{=}c)$" to get from the complete set of singular conditionals (of the form "$Sn \supset Pn$"), for example, the set **S**, to a proposition of the form "$(x)(Sx \supset Px)$," for example, *P12*.

What we logically require is that the set of singular conditionals *be* complete; we do not require an additional premise *stating* that the set is complete. An explicit closure condition is required for inferences about unspecified worlds; but when the world is specified, the closure condition, contra Russell, is otiose.

P12 and **S** are not logically equivalent (like-valued in all possible worlds), and Wittgenstein stumbled slightly when he described all propositions (including, presumably, universal generalizations) as 'following from' singular propositions. But neither are *P12* and S *merely* materially equivalent, that is, merely like-valued in the actual world. They are an intermediate case: like-valued in all possible worlds in which $(x)(x{=}a \vee x{=}b \vee x{=}c)$. *P12* ↔ **S** is false, that is,

$$\Box\,(P12 \equiv \mathbf{S})$$

is false. But

$$\Box\,[(x)(x{=}a \vee x{=}b \vee x{=}c) \supset (P12 \equiv \mathbf{S})]$$

is true, that is, $P12 \equiv \mathbf{S}$ is a relative necessity in all those possible worlds in which $(x)(x{=}a \vee x{=}b \vee x{=}c)$. Provided we are talking about one such of these worlds, we may say unproblematically that *P12* is a packing of the set **S**, and thus that *P12* is reducible to **S**. The packing relation, although not the relation of logical implication, is nonetheless far stronger than mere material implication, is perfectly intelligible, and is free of internal incoherence. Wittgenstein was right, then, not to take Russell's step of positing irreducible universal propositions. A state-description model, either nascent (Wittgenstein's) or developed (Carnap's), need not be encumbered with irreducible general propositions.

In the end, the state-description model emerges intact, and it can be used to illuminate the differences between the Regularist's and the Necessitarian's respective views about physical possibility.

By insisting that the mere failure of a unique project ought not to constitute logically sufficient grounds for all projects of that type being physically impossible, the Necessitarian finds himself claiming:

> Two possible worlds, W' and W'', have identical physical laws. But in W', project X is undertaken and fails; in W'', X is undertaken and succeeds.

Is this point of view compatible with the state-description model, or does it require that the Necessitarian adopt a different model?

The state-description model is a very uncompromising view of reality. For one, it ties the universal generalizations that are true in a world very closely to that world's singular facts, far more so than one might at first suppose. Naive intuitions tell us that there should be considerable leeway possible in constructing a world to fit a given set of universal generalizations, that singular facts in a world can vary greatly while the universal generalizations remain constant. But the state-description model allows for little of such flexibility. A god setting out to design a world different from this one but in which all the same generalizations were to hold true, would find himself limited to a far greater extent than we would have initially surmised.

For example, one might suppose that merely increasing the number of individuals in a possible world is compatible with there being no concomitant change in the universal propositions true in that world. But this is not so. Consider a world, W_1, in which there is only one thing, *a*, and it has the properties *G* and *H*; and a world W_2, in which there are exactly two things, *a* and *b*, and both have the properties *G* and *H*. For example, W_1 consists solely of a single green hexagon, whereas W_2 consists of two green hexagons and nothing more. One might assume that these two worlds share exactly the same universal generalizations, for example, "Everything that is green is hexagonal." But surprisingly, there is a universal generalization that is true in W_2 that is false in W_1:

$$(x)([Gx \ \& \ Hx] \supset (\exists y)[(Gy \ \& \ Hy) \ \& \ (x \neq y)])$$

'Mere duplication' of any one or of several items, events, or states in a possible world will change the set of universal generalizations obtaining in that world. In the state-description model, possible worlds cannot differ from one another merely in their numbers of constants without also differing in their universal generalizations.

Suppose *M* stands for a kind of project (for example – recalling our earlier discussion – an attempt to swim across Lake Superior) whose successful outcome we will designate *N*. Let two possible worlds, World′ and World″, be worlds in which *M* has exactly one instance *a* in each; that is, *M* is a unique project in World′ and is a unique project in World″. Suppose further that *a* fails in World′; that is, ~*Na* is true in World′. In World″, however, *a* succeeds; that is, *Na* is true in World″. Can World′ and World″ share identical physical laws in a state-description model? We can see in Table 2 that they cannot.

Table 2. *Worlds differing in the outcomes of counterpart unique projects*

	World′	World″
I. State-descriptions (*partial listing*)		
	Ma & ~NA	*Ma & Na*
	Sb & Yb	*Sb & Yb*
	•	•
	•	•
	•	•
II. Consequential universal generalizations (*UG*) (*partial listing*)		
	UG'_1: $(x)(Mx \supset {\sim}Nx)$	UG''_1: $(x)(Mx \supset Nx)$
	•	•
	•	•
	•	•

For if *a* is the only instance of *M* in each of these worlds, and *a* is *N* in one and ~*N* in the other, then the respective (or counterpart) universal generalizations, *UG*, pertaining to events of kind *M*, that is, UG'_1 and UG''_1, must differ from World′ to World″. Clearly, unique projects confer special constraints on the set of universal generalizations true in a world. If being a true contingent universal generalization having unrestricted terms is a sufficient condition for being a physical law, then two possible worlds that differ in the outcomes of their respective unique projects must differ in their physical laws.[7] This conclusion is perfectly general. It has nothing to do with the specifics of our examples (swimming Lake Superior, making a river of Coca-Cola), nor with the number or variety of predicates in the state-description, nor with the number of individuals.

The Necessitarian must, then, eschew the classical state-description model. So long as physical laws are identified with universal propositions reducible to the singular propositions true in a world, the Necessitarian's desire that counterpart unique projects should have differing outcomes in possible worlds sharing the same physical laws cannot be realized. Two choices are open to the Necessitarian. He can either (1) modify the state-description model or (2) reject that model altogether, arguing in this latter instance that physical laws are irreducible to singular propositions.

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[7] Note that, even though UG'_1 and UG''_1 (see Table 2) are consistent with one another (there is some possible world in which they are both true, viz., any world in which nothing is M), these two generalizations are not both true either in W' or in W''.

8

Potentialities

ACTUALIZED AND UNACTUALIZED DISPOSITIONS

Nomological necessity and physical possibility vary inversely. As Necessitarians narrow their class of nomologicals, allowing that only some contingent universal truths are physical laws, their class of physical possibilities must thereby increase. The Necessitarian, thus, is committed to more existential statements being physically possible than is the Regularist. In what might the truth-conditions of such unactualized possibilities be grounded?

One idea worth exploring is that of grounding these unactualized possibilities in the dispositions of actual items in the world. Various examples Necessitarians have cited in advancing their theory (see, e.g., Pap 1962, pp. 273–306, and Madden 1969) have suggested that there is an intimate connection between nomicity, warrant for counterfactuals, and dispositions[1] of things in the world. For example, a standard warrant for the counterfactual conditional "This undissolved lump of salt would dissolve if placed in water" is that this tacit physical possibility arises from salt's *disposition* to dissolve when placed in water. Suppose we were to extend the state-description model (see Chapter 7) by allowing the singular statements that comprise a state-description to include reference to dispositional properties (e.g., is soluble) as well as to manifest ones (e.g., has dissolved).[2] Could the unactualized physical possibilities of the Necessitarian be grounded in such an augmented factual base?

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1 Alternative nomenclature includes "capacities," "abilities," "powers," and "potentialities." Stochastic dispositions are called "propensities" (more on this in Chapter 12).

2 How, precisely, state-descriptions might be modified to accommodate dispositional properties is relatively unimportant for present purposes. Our first order of business must be to examine whether Necessitarians, by invoking dispositions, can ground their attributions of unactualized physical possibilities.

(For an early attempt to incorporate dispositional properties into an extensionalist language and hence into a state-description model, see Carnap 1953.)

Let us see how this might be thought to work. The New York mansion of Cornelius Vanderbilt II, built in 1880 and enlarged in 1894, was demolished in 1927. Suppose that a crazed anticapitalist had tried to set fire to the landmark in 1918. Obviously, the fire did not catch. Suppose, too, that this was that house's only near-conflagration. On the Regularist's account, as we have seen, it would logically follow from these facts that it was physically impossible that the house (given a unique description of it in purely descriptive terms) should be consumed by fire. But the Necessitarian objects, and he wants to insist that, in spite of the failure of the attempt, the torching of the house was nonetheless physically possible.

In the view now being explored, the Necessitarian will ground the physical possibility of the building's burning not in its actual burning but in its disposition to burn in this world.[3] According, now, to the Necessitarian Theory being assayed, even if the building were never to burn, it was nonetheless physically possible that it should have, and this for the reason that the building was *flammable.* Allow "is flammable" as one of the predicates figuring in a state-description along with "burns," and one has, it would seem, the means to prevent "It is physically impossible that *x* burns" being necessitated by "Nothing burns" or by "Item *x* never burns."

The discomfort some philosophers have felt with postulating dispositional properties is at least as old as the debate about physical laws themselves. Dispositional properties seem mysterious and hidden, and hence suspect. Indeed, many philosophers who have thought little about the wider debate between Regularity and Necessity have been puzzled about dispositions.

According to the Regularity account, whatever dispositions the Regularist is inclined to attribute to things, he does so on the basis of things of that sort actually exhibiting, at some time

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[3] It is trivially simple to explicate potentiality in terms of physical laws. E.g.:

> "disposition to burn (in the actual world)" $=_{df}$
> "incineration in some possible world having the same physical laws as the actual world"

But what the Necessitarian is after, recall, is to pull the trick off the other way around: The particular Necessitarian program being examined in this chapter requires that physical laws have their truth-conditions grounded in potentialities. It is the potentialities that are being assumed – for the moment – to be logically or ontologically basic, and the physical laws derivative or dependent.

or other, the actualization of the disposition, or on the basis of that very thing itself having exhibited the realization of the disposition. “This ruler on my desk now is flammable” is true (i) because this ruler happens to be made of wood, and (ii) because wood is the sort of stuff that burns; that is, there are instances of wood that has burned, is now burning, or will burn. In short, because wood’s burning when held to a flame is a *regular* feature of this world, the Regularist is prepared to allow that wood may be said to have the dispositional property of flammability. Similarly, because her tape recorder has exhibited a certain kind of behavior in the past, a Regularist would have no difficulty in saying of it, “This tape recorder would seize up if it were left running for more than two hours.”

But the account we are to give of the dispositional properties of particular items (razed mansions, tape recorders, etc.) and of natural kinds (“wood burns,” “copper melts at 1083.4° C”) is not the principal issue here. The question we have to keep in mind is whether by invoking dispositions, Necessitarians can provide the truth-conditions for all those propositions that they regard as being physically possible although drawn from among the class of timelessly false existential propositions.

Although invoking dispositions does seem to allow attributing physical possibility to some of the propositions that the Necessitarian wants to be so imbued, introducing dispositions will not readily capture all of the class of nominated possibilities. The recalcitrant cases range from those in which the attribution of the relevant disposition is ‘out of character’ to those cases in which there does not seem to be any candidate whatsoever to bear the disposition.

Certain examples, particularly those attributing potentialities to *specific* items, would be, admittedly, plausible cases in the Necessitarian’s armor. It is certainly plausible to attribute the physical possibility of burning to the Vanderbilt mansion and the physical possibility of conducting electricity to the Cellini saltcellar. But even among this class of specifically identified individuals, there are problem cases. In his adult years, as legend has it, Churchill was hardly temperate in his consumption of distilled beverages. One presumes, however, that it is in the spirit (!) of the Necessitarian approach to claim that it was nonetheless physically possible that the prime minister should have been more abstemious. That is, we may presume that the Necessitarian will want to argue that a person’s refraining from drinking brandy is not inconsistent with any physical law. In the proposed account, this means that we should want to attribute to Churchill a disposition or potentiality for temperance. Does it matter that this attribution is entirely out of character? Similarly, it is, one supposes, in the Necessitarian view, physically possible (even if unlikely and hardly to be expected) that Cesare Borgia should have been a saint rather than a cardinal. Did Borgia have a disposition toward saintliness? By all accounts, that was pretty unlikely.[4]

This is only the beginning of difficulties. The theory becomes increasingly problematic when we turn to examples of *indefinite* attribution.

Back in the days before Roger Bannister became the first person in history to run a mile in less than four minutes, persons used to wonder whether it was physically possible for a human being to accomplish such a feat. The question was answered definitively on May 6, 1954, at a track meet in Oxford. If one is going to plump for potentialities, then Bannister clearly had the potential to run a four-minute mile (as did Landy and a great many other athletes, it now turns out).

Given this history, it is easy to ground the claim "It is physically possible to run a mile in less than four minutes" in potentialities. Bannister had such a potential, as did Landy. For it to have been true, let us say in 1950, that it is physically possible to run a mile in less than four minutes, it was sufficient that someone or other should have the potential to accomplish the feat, and that was *true*: Bannister (as evidenced by his subsequent success) had that very potential.

But what if Bannister, and everybody else, had failed to run the mile in less than four minutes? Suppose the world had come to an end on May 3, 1954, three days before Bannister became the first person to run the four-minute mile. Well, there is a prima facie plausibility in attributing to him the potential anyway: After all, he was getting pretty close to that speed in his latest track meets. He certainly looked at the end of April as if he might very well some day soon break the four-minute barrier.

But the Necessitarian position cannot make do solely with cases of success and near success. So long as one is going to argue that physical possibilities are grounded in potentialities, rather than solely in actualities, there will have to be *some* cases where the feat in question is physically

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4 Perhaps we should contemplate introducing grades of potentiality, from bare capacity to strong proclivity. But we will not pause over this question. Whatever its resolution, greater problems are in store below.

possible and yet no attempt at realizing it even comes close. Indeed, there will have to be some cases in which the feat is physically possible and is not even attempted. No Necessitarian can argue that physical possibility is restricted just to actualities or to failures-that-are-very-close-to-successes. The general point is that mere failure – even repeated, habitual, unrelieved, indeed eternal failure – must not by itself constitute logically adequate grounds for physical impossibility. So even if one is going to allow potentialities in the case of success, and even – reluctantly perhaps – in cases of near success,[5] there will still remain the problem of locating potentialities in cases where nothing comes close to success.

To clarify the latter problem, let's change our present example slightly. Suppose, as before, that the world is at an end, but this time the year is A.D. 4059. Again, the four-minute barrier remains unconquered. But this time suppose that Bannister's lifetime best performance had been only 6 min., 31.89 sec. And suppose further that the best anyone ever managed had been 5 min., 42.33 sec. Had that been the case, where then should we want to locate the potential for running a four-minute mile? In every human being? A very implausible suggestion. ***I*** certainly do not have that potential. (And it is safe to assume that the vast majority of readers of this book do not either.) Well, how about locating the potential in the world's very best runners, in Bannister, Landy, etc.? This is more plausible, but only minimally so. After all, they all tried the feat, many repeatedly for years, but not one of them – as we are now telling the tale – came close.

Nonetheless, the Necessitarian *must* say that running a four-minute mile under the circumstances latterly described is physically possible. Remember, we are talking about *this* world, and in this world, the feat *is* possible: It's been done (and from this it follows that, even if it hadn't been done, it could have been.) But according to Necessitarians, it was an accident that Bannister should have been the one to do it; even more to the point, it must be considered an accident that anyone did it.[6] In other words, according to Necessitarians, what is physically possible in this world doesn't depend on the accidental singular facts (antecedent conditions) of

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5 But do recall the Regularist's two-part reply on pages 75–6.

6 We may say that it is an accident because – according to Necessitarianism – there will be other possible worlds having the same physical laws as this world, but in which no one runs a mile in less than four minutes. As a matter of note, in some of these worlds that have the identical physical laws, there aren't even any persons.

this world (recall the quotation from Popper in Chapter 5, footnote 7). But if none of us were athletic, or – to take an even more extreme case – if none of us had existed in this world, where then should we locate the potential for running a four-minute mile?

Need there be a determinate (even if unknowable) answer to this question? Might we not just attribute the potential to some individual without being committed to its being a property of anyone in particular? For example:

> "It is physically possible that someone win the Nobel Prize and the Miss America Pageant." Who? Anyone with Einstein's genius and Bo Derek's sex appeal.[7]

But against this, consider this case. Suppose I were being given a tour of an anthropological museum by the curator and we stopped in front of one display containing a handsome basket woven in the style of the Salish Indians. I ask the curator, "Who wove that basket?," and she replies, "No one in particular." Now if by "No one in particular" she means, as we often do using that expression in ordinary speech, "No one famous" or "No one you would have been likely to have heard of," I will understand her perfectly. But if, instead, she explains that the basket was woven by somebody but that somebody was not any particular person in the history of the world, I will think she is making a joke. Of course the basket was woven by *somebody*; but that is because it was woven by some *specific* (even if totally unknown) individual.[8] It certainly was *not* woven by some indefinite (or general) individual. Indeed, this latter claim – that the basket was woven by someone, but by no specific person – could not possibly be true.

The *manifest* property of weaving a Salish basket is attributable to someone only if it is attributable to someone or other, that is, to *a* or *b* or *c* or ... , where *a* and *b* and *c*, etc., are actual (past, present, or future) persons. Parallel reasoning would suggest that attributing *potential* properties to someone ought to be assumed to imply that there *is* (at some time) somebody or

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7 My thanks for this example to an anonymous reviewer for Cambridge University Press.

8 We may put the point perspicuously this way: The *existential* (general) proposition "Someone wove the basket" is true just in case some *singular* (nongeneral) proposition (of the form) "Person *a* wove the basket" is true, and it is false otherwise.

other who in fact actually has that potential property. If not, then if we are to persist with the hypothesis that physical possibilities are to be grounded in the potentialities of actual items, we would have to believe that we need not have our potential properties actually, but may have them potentially. Now although I have no definitive argument that we do not, it would seem that a theory that postulates our having potential properties potentially rather than actually has forfeited any claim it might have had initially to being grounded in common sense or to capturing our prephilosophical intuitions. Do I *actually* have the potential to run a four-minute mile? As I said a moment ago, I assuredly do not. Might I, perhaps, have the *potential* of having the potential to accomplish such a feat? I do not know how to answer. I have utterly no idea what would count for, or against, an answer's being true.

Necessitarians' own examples of unactualized possibilities include, as we know, a moa's living longer than any actual moa lived and there being silver coins in your pocket even if you never have any. So long as one considers straightforward, easy examples such as these latter ones, the special problems of Necessitarianism will remain hidden. For in these cases, it is plausible to assign the physical possibilities to specific individuals: "Take the oldest moa, *it* was the one that had the potential to live to fifty. Or consider yourself: Surely you do have the potential of putting some silver coins in your pocket." But Necessitarianism cannot restrict its attributions of physical possibility merely to the mundane, or to cases of success and near success. It is the essence of that theory to insist that there will be some cases at least that are physically possible and yet remain far from having been realized, for example, as we saw suggested a moment ago, someone's receiving the double accolade of the Nobel Prize and the Miss America title, or (my example) someone's running a mile in four minutes even though the best anyone ever manages is *5* min., 42.33 sec. It is cases such as these that, I suggest, are the most troubling for any attempt that would explicate physical possibility in terms of potentiality. For in these latter cases – where there is no attempt that comes close to success, or no event or thing or person that comes close to realizing the physical possibility in question – there doesn't seem to be any reasonable candidate to bear the potentiality.

This is a serious difficulty for Necessitarianism. It means that the truth-grounds of physical laws are not exhausted by the actual (or manifest) properties of things in the world, not even when the class of properties is extended to include the dispositions of things. Physical possibility, according to this theory, must finally transcend the actual and potential properties of items in the world.

There is, however, one remaining way, which we have not yet examined, for the Necessitarian to try to ground unactualized possibilities. And that way is to ground them, not in the potentialities of these or those items in the world, but in the world itself. One Necessitarian, von Wright, says precisely this. (I don't want to suggest that considerations such as the ones we have reviewed in this chapter are what led von Wright to his particular theory, but it is illuminating to see that he does ground potentialities in the world as a whole rather than in items in the world.) He writes that *p* (a generic state of affairs) may be "a *potency* or *latent possibility* of the world" (1974, p. 20). Here it is the world itself that has a potential to actualize (or "materialize," in von Wright's vocabulary) an instance of some generic state.

But this latter way of grounding physical possibilities presents its own special problems. For one, it raises the immediate problem as to what we shall understand by 'the world.'

How are we to regard 'the world'? As an *abstract* object (in particular, a class or collection) whose members are the physical items of the universe, for example, subatomic particles through to galaxies? Or as a *concrete* (merological) object, a gigantic physical object whose material parts are scattered about at varying distances one from another? Either way, there are difficulties.

How can an abstract object ground *physical* possibilities? Arguably, an abstract object can have *contingent* properties, that is, properties that that object has in one possible world but not in another. Although the existence of abstract objects is necessary, some at least of their properties will vary from possible world to possible world. For example, the abstract object that is the class of planets will in some possible worlds have the property of having no members; in other possible worlds, including this one, the property of having nine members; and in still other possible worlds, the property of having eleven members. Similarly, the abstract entity, the proposition that Harvard College is located on the banks of the Charles River, has the contingent, intentional property of being believed by me. Other properties of abstract objects are, of course, essential or logically necessary ones, ones that those objects bear in all possible worlds. For example, the number nine bears the property essentially of being the positive square root of eighty-one; and the proposition that there are twelve Apostles bears its contingency of logical necessity. But none of these properties –whether contingent or necessary – of abstract objects is a *physical* property. (This is a truism.) Whatever further properties abstract objects may have, they surely lack mass, position in space, color, temperature, valence, electrical charge, sex, dexterity, viscosity, flammability, fallibility, fear, passion, toothaches, and rhythm – to name just a few. Abstract objects are just not the right sorts of things – ontologically speaking – to ground, account for, or constitute the truth-conditions of, physical possibilities. That this world might, according to the Necessitarian's account of physical possibility, actualize a river of Coca-Cola, a fifty-year old moa, or a four-minute miler even if there never had been rivers, Coca-Cola, moas, or persons, etc., cannot be explained or accounted for by the properties of any abstract object, whether that object is a class of few things or the class of every physical thing that exists.

We turn then to the second contemplated way to ground unactualized possibilities. To construe 'the world' not as an abstract entity but as a large, very large, physical (concrete) thing itself, presents quite a different set of problems, but in the end allows of no more satisfactory a solution. For if one were to try to ground unactualized physical possibilities in the physical object that is the universe itself, one would then be faced with accounting for the manner in which a thing managed to have properties that its parts apparently do not have.

Now, in general, this is not an insuperable problem. Indeed, the relationship between the physical properties of any physical thing and the physical properties of its parts is always a contingent one. Even in the case of mass, for example, one cannot blithely assume that the mass of a physical thing is just simply the scalar sum of the individual masses of its originally spatially separated parts. As a sheer contingent fact about this world, that assumption is false: The mass of a spatially connected, integral whole is often less than the scalar sum of the masses of its parts. A certain amount of the mass of the parts (the so-called mass defect) may be transformed into the energy needed to bind the parts together. And in other cases, too, wholes (e.g., tables) often have properties (color and temperature) that their parts (atoms) do not have; and the parts, in their turn, often have properties (electrical charge) that the whole does not have. Thus, in general, one need not have global concerns at the prospect of wholes having properties different from their parts. But the case at hand is special, for it advances the thesis that the universe, taken as a whole, has certain dispositional properties – for example, to actualize a fifty-year old moa, a river of Coca-Cola, or a four-minute miler – that are not to be accounted for by the properties of any of its parts.

Now if anything has been true of science's treatment, and indeed of our extrascientific conception, of dispositional properties it is that dispositional properties of things are to be accounted for in terms of, or by means of, the properties, both manifest and dispositional, of things' *parts*. If a liquid (e.g., gasoline) is flammable, this is because its molecular constituents have a disposition to unite in certain chemical bonds with oxygen; if a wine glass is fragile, this is because its molecules are not bound together in the kinds of lattice arrays typical of metals; if a person is intelligent, again it is because (we assume) her neural cells are actually configured in so and so a manner rather than in such and such a manner. Nowhere in our entire conceptual scheme is there a single case of a disposition that we would not be inclined to account for (if we only knew enough) by reference to the properties of its constituent parts.

Nowhere, that is, except in the suggestion under review that the Necessitarian's unactualized physical possibilities are ultimately to be grounded in the world itself and need not be grounded in the potentialities of any of the items in the world. In this regard, the Necessitarian's physical possibilities are sui generis; they are nothing like any of the familiar unactualized potentialities we daily encounter, for example, the flammability of gasoline and the solubility of salt.

But even this is hardly the end of it. In insisting that a world may have unactualized physical possibilities that are never, ever realized, we then must allow that there should be two worlds identical in all their actualities but different in their possibilities. This claim is implicit (and very near the surface) in Popper's talking of possible worlds that share the same physical laws but differ in their singular facts, their initial (i.e., antecedent) conditions. But this means that the physical possibilities are not grounded in anything, or to be accounted for by anything, that happens in those worlds. Two worlds that would be utterly indistinguishable at the empirical level would nonetheless differ in their eternally 'hidden' properties, in their potentialities. It is for this reason that I spoke in Chapter 3 of the 'Autonomy Theory of Physical Laws.' The Necessitarian account, it seems to me, must eventually maintain that the truth-conditions of physical laws are *not* grounded in the facts of the world, certainly not in anything that might conceivably be regarded as an *empirical*[9] fact. If two possible worlds can be identical in what

[9] I.e., as something knowable through sense experience however broadly construed. Even if one had perfect extrasensory intuitions of these unactualized possibilities, one could never know – either empirically or a priori – that one's intuitions were in fact accurate and not mere fantasies.

happens in them, and yet differ in their respective physical laws, then it does seem warranted to say of their physical laws that they bear their nomicity 'autonomously,' that is, in a manner not to be accounted for by what happens. Actual truth is a *necessary* condition for nomicity; but not a sufficient condition. *Sufficiency* arises from something other than what happens in a world. What is nomic in a world, then, is a conceptually distinct feature from what is true in a world (although the latter is a necessary condition for the former). Nomicity implies truth, but not conversely. But if this is so, then what happens in a world cannot be thought to account for the physical laws of that world. Quite the contrary, the Necessitarian picture is – as I will endeavor to show in Chapters 10 and 11 – quite the opposite: Physical laws determine what the facts are to be in a world. What does happen as well as what *can* happen in a world, according to Necessitarianism, is 'determined' by the physical laws of that world. This is an exact mirror image, so to speak, of the Regularist account, which argues instead that what happens in a world is what accounts for the physical laws of that world.

SUMMARY

This latest characterization, that to the Regularist, the Necessitarian appears to make the nomicity of physical laws autonomous, may appear surprising. The route to this conclusion has been lengthy. It will, perhaps, be useful to review the argument briefly, attending to its several stages.

There are a number (an infinite number, perhaps) of true universal, material conditional statements (propositions), all of whose terms are perfectly descriptive, that is, make no reference to any particular time, place, person, or thing in the world. The Regularist is content to allow that all these true universal, material conditionals are physical laws, but the Necessitarian wishes to divide this class into two mutually exclusive and jointly exhaustive subclasses: the nomologically true and the accidentally true. The difference is to be explicated this way: The nomologically true are logically inconsistent with the physical possibility of their existential contradictories; the accidentally true are logically consistent with the physical possibility of their existential contradictories. For example, the (presumably true) universal material conditional that there is no river of Coca-Cola would – in the Necessitarian's account – be a nomological truth only if it were physically impossible that there be a river of Coca-Cola; but it would be a mere accidental truth if, instead, it were physically possible that there should be such a river. Thus the two problems – (i) stating truth-grounds for nomicity, and (ii) stating truth-grounds for physical possibilities – are interchangeable in that solving either one automatically provides a solution to the other. Nomicity and physical possibility are interdefinable concepts, and thus the problem of providing truth-grounds for nomicity may then be construed – equivalently – as finding the truth-grounds for physical possibility. But of course, doing the latter should not itself involve nomologicals, for then either the analysis is circular or merely postponed.

Actual truth is, of course, a *sufficient* condition for physical possibility. Whatever is actual is physically possible. But it is central to the Necessitarian account that actual truth is not a *necessary* condition for physical possibility. How, then, might one account for physical possibility in the absence of actual realization?

The most obvious recourse is to dispositions. For example, a piece of wood need never actually burn to be regarded as having the physical possibility of burning; and one need not subject a specific piece of glass to an actual test to say of it reasonably that it lacks the physical possibility of conducting electricity.

But these straightforwardly attributable dispositions are insufficient to ground the entire class of the Necessitarian's nomologicals. It is of the essence of Necessitarianism to argue that some events or properties are physically possible even though there may be nothing in particular in the actual world that has a disposition to realize those properties. For example, the theory requires that it be physically possible that someone should run a four-minute mile even if everyone were (accidentally) lame; indeed, that someone should run a four-minute mile even if there never had been any persons at all.

It is these latter kinds of cases of physical possibility that mark the sharpest dividing line between the two rival theories. The Regularist does not comprehend *how* such existential propositions might acquire their modality. He does not understand what it is about the world that these propositions are supposed to be describing.

In the absence of specific items in the world to which to attribute the physical possibilities in question, it would seem then that these physical possibilities must be features, not of this or that part of, or item in, the world, but of the world itself taken as a whole. Thus, of the two uninstanced universal truths, for example, "All *A*s are *Bs*" and "No *A*s are *B*s," the Necessitarian is prepared to allow that one of them might be a nomological truth while the other is not, even under the condition that there never are – in the past, present, or future of the world – any *A*s. The Regularist cannot see how such a distinction can come about. For the Regularist, the claim that there are truth-grounds for these two true propositions that would allow the one to be nomological and the other a mere accident remains unexplicated. Attributing the source of the nomicity of the one and of the accidentalness of the other to a physical possibility of 'the world as a whole' remains unintelligible. World-potentialities look to the Regularist to be sheer invention, postulated just so that there should be some 'fact' for irreducible physical possibilities to correspond to. To the Regularist, these irreducible general truths seem to bear their nomicity autonomously.

DISCUSSION

Nec(essitarian): I don't understand your squeamishness about admitting physical possibilities. After all, you have had no misgivings yourself in invoking all sorts of metaphysical arcana, for example, propositions, possible worlds, logical possibilities, classes, etc. It strikes me as arbitrary, indeed as theoretically inconsistent, to become suddenly diffident at the prospect of introducing physical possibilities.

Reg(ularist): You are right that I am gravely suspicious of your brand of physical possibilities. But my concerns have little, if anything, to do with the prospects of increasing the set of abstract entities. My concerns have to do with the reasons given for wanting to introduce these entities and with their very intelligibility ultimately.

Nec: How so? Why should physical necessity cause you any more concern than, let us say, logical possibility?

Reg: To begin with, there are determinate, effective procedures in *at least some cases* for making the distinction between what is logically possible and what is not. Many propositions can be symbolized by finite, manageable sentences, and some of these sentences, in their turn, can be assessed for self-contradiction by purely formal, indeed literally mechanical, means. Many others yield to conceptual analysis. Although there are problem cases aplenty, there are at least *some* cases in which a definitive verdict can be reached as to logical possibility. Logical possibility, then, is established as being distinct from actual truth. But there is no analogous procedure for distinguishing between accidental falsity and nomological impossibility, or –equivalently – between accidental truth and nomological necessity. A priori reasoning is certainly not going to work. And every empirical test Necessitarians have suggested amounts to careful watching of the world or to manipulating experimental variables and attending to what results. But this is just what a Regularist does in his attempt to find out what is universally true. Nothing that anyone might advance could possibly answer the question of what ***would*** happen if the antecedent conditions were never actually to be realized.

Nec: Does your criticism then, finally, come down to a concern about the lack of an empirical test for nomicity?

Reg: In part, yes. But it is not an objection of the sort one might raise about there being no empirical test that would settle, for example, whether an ancient shroud really was placed over the body of the historical Jesus. My objection is not that there isn't any empirical test; my objection is that in principle there couldn't be any such empirical test. Indeed, I don't see how there could be any test whatever, either empirical *or* a priori.

My worries about nomological necessity and its distinctive correlative notion of physical possibility are akin to my concerns about postulating a material substance underlying, supporting, or unifying the physical properties of ordinary material things. I have no notion of a conceptually distinct thisness in ontological union with a whatness. The postulation of the former, to the extent that it is even intelligible, seems to me to be perfectly idle. So, too, with nomological necessity. I know what physical possibility means when it is predicated of an event-kind that occurs in this world. I am at a loss to understand what physical possibility is supposed to mean when predicated of an event-kind that never occurs. Logical possibility presents no such equivalent problem. A false existential proposition is logically possible if it is not self-inconsistent; and there are determinate tests for self-inconsistency in at least some cases. But there are no comparable tests for physical possibility beyond actual truth, nor have I ever seen any argument to make plausible the contention that there could be. Indeed, it seems to be intrinsic to the concept that there couldn't be. I must then retain my skepticism as to the very claim that the concept is intelligible.

PART II

Applications

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Miracles and marvels

Both Prescriptivist and Necessitarian theories maintain, in contradistinction to the Regularity Theory, that physical laws are irreducible to singular propositions, that physical laws owe their truth to some source other than the singular facts of the world. This shared view of Prescriptivism and Necessitarianism I have called the Autonomy Theory of Physical Laws.

It is difficult to be a thoroughgoing Regularist, not because the theory's implications are remote and difficult to ferret out, but because persons mistakenly believe they are subscribing to a Regularist theory when in fact they hold beliefs incompatible with that theory. This intellectual schizophrenia arises out of the fact that the Autonomy Theory is so firmly entrenched in our ordinary world view that one hardly recognizes it for the *theory* that it is. Long ago, this competing theory passed into the realm of seemingly indisputable fact, with the result that some of its distinctive implications are thought to be simple data that would be consistent with any respectable theory of physical laws, the Regularity Theory included.

Hume's writings are a case in point. Hume was an imperfect Regularist (if indeed, he was a Regularist at all [see Beauchamp and Rosenberg 1981, especially Chapter 1]). In the *Enquiry* and the *Treatise,* we find the genesis of the Regularity Theory. But even in these works there are conflicting tendencies. In Section 10 of the *Enquiry,* "On Miracles," Hume (1955, p. 122) writes:

> A miracle is a violation of the laws of nature

and again, shortly thereafter (1955, p. 123):

> A miracle may be accurately defined, a *transgression of a law of nature by a particular volition of the Deity, or by the interposition of some invisible agent.*

There can be little doubt that these definitions capture the ordinary conception of miracle. And against this background, Hume proceeds to treat the answer to the question of whether there are, or have been, any miracles as a *contingent* one, meriting both an empirical investigation of the alleged facts and a conceptual examination of the proper doxastic attitudes to take in weighing contrary testimony.

What Hume seems to have overlooked, however, is that the account he gives of miracles derives from the Autonomy Theory and is logically inconsistent with the account he has earlier given of physical laws. *If* physical laws are 'constant conjunctions' (Hume's own words in "On Miracles"), then it is *logically* impossible that a physical law should be 'violated.' Nothing can be both 'constant' and 'violated', that is, without exception and with exception. If Hume is going to allow that it is possible that a physical law should be violated, then he cannot, with consistency, define physical laws to be constant conjunctions.[1]

I can imagine someone trying to salvage Hume's account of physical laws by likening this case to the ancient conundrum about God's omnipotence. God's omnipotence, we recall, was supposed to be impossible because were God to be omnipotent He could create a rock so heavy that He could not move it, and in doing that He would not be omnipotent. The rescuing of the idea of God's omnipotence came about, simply, through arguing that an omnipotent god can, being all-powerful, give up his omnipotence if he wants to, and he will remain omnipotent only so long as he does not create such a rock. So if God is omnipotent, He does not create such a rock; but He could – at the expense of His omnipotence – if He wants to.

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[1] Of course, one can equivocate on "laws," taking "laws" sometimes to refer to scientific laws and other times to physical laws. Swinburn, in *The Concept of Miracle* (1970) tries to rebut McKinnon's contention that "the idea of a suspension of a natural law is self-contradictory" (1967, p. 309). Swinburn, in attempting to refute McKinnon's claim, makes much of the points that "any proposed law of nature will be corrigible" (p. 25); that "among simple formulae supported by the data, the simplest is the best supported and regarded, provisionally, as correct" (p. 24); and that "if the formula survives further tests, that increases the evidence in its favor as a law" (p. 24).

All these criteria – corrigibility, simplicity, selective confirmation, prediction of unexpected data, etc. – are clearly directed to the question of how we go about choosing what we are to adopt as *scientific* laws. Swinburn seems insensitive to the distinction between *physical* laws and what we might adopt at some point in history as useful proxies. As a result of his blurring this distinction, his rebuttal of McKinnon misses the mark. McKinnon's is an ontological-cum-logical point; Swinburn's, an epistemological-cum-historical one. The two arguments are utterly distinct; in particular, the latter surely does not rebut the former.

Analogously, couldn't one say that some proposition, *P*, is a physical law just so long as it is not violated? More particularly, can't we preserve a Regularity account just so long as God does not perform any miracles?

The answer: No. And the reason why the two cases are disanalogous has to do with the modalities of the propositions that figure in them. The argument that would attempt to salvage the Regularity-compatible-with-miracles account looks like this:

1. It is possible for God to perform a miracle
2. If God performs a miracle, then physical laws are not timelessly true propositions.
3. Physical laws are timelessly true (general, conditional, contingent, etc.) propositions.

∴ 4. God does not perform a miracle.

Unquestionably, the argument is *valid.* But is it sound? More particularly, is the premise-set self-consistent? Premise 2, I have just argued, is necessarily true. What about premise 3, the principal tenet of the Regularity Theory? What is its modal status? The Regularist, in advancing 3, is urging an *analysis* of the concept of "physical law." And philosophical analyses – even those that present themselves as reconstructions or explications – may be supposed to be necessarily true. But if 2 and 3 are necessarily true, then so is 4. (The relevant inference rule is: $\Box (P \supset \sim Q),\ \Box Q \vdash \Box{\sim}P$). But if 4 is necessarily true, not just contingently so, then 4 is inconsistent with 1. But any premise-set that implies a proposition inconsistent with any of its members is itself self-inconsistent. Therefore, premises 1, 2, and 3 cannot jointly be true. Since 2 and 3 are true, then 1, namely, that it is possible for God to perform a miracle, is false.

Thus the mere possibility, the bare logical possibility, of God's performing a miracle is inconsistent with the Regularity Theory. One cannot preserve a Regularity account and allow that God could (although He does not) perform a miracle.[2]

By insisting that not even God can violate or suspend a timeless regularity, we are not diminishing God's power in any way. Traditional Christian theology has always insisted that

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[2] Incidentally, the Necessitarian Theory fares no better in allowing for miracles. Genuine miracles seem to be compatible with only two theories, viz., the 'time-limited' theory (considered four paragraphs hence) and the Prescriptivist Theory.

God's omnipotence must be thought to be constrained by the Law of Noncontradiction; that is, not even God can bring about a self-contradiction. To deny that God can perform a miracle is only to deny that God can bring about a self-contradiction.

Thoroughgoing Regularists, only on the pain of inconsistency, can pray for miracles. What they ought to be praying for, to use Hume's own vocabulary, are marvels. Of course, phenomenologically, marvels are indistinguishable from what usually are called "miracles."

From a Regularist's point of view, how are divine marvels, God's intervenings in the course of the world, to be explained? Easily: It is just a contingent truth about this world that whenever God says (in Aramaic) "Let so-and-so happen," so-and-so happens.[3] Throughout all history, this pattern of success has been without exception. (In other possible worlds, God is not nearly so successful. And even in this world, recall, Jupiter and Wotan were not half as favored by Nature as is Jehovah.) In short, divinely caused marvels need hardly be construed as preternatural, requiring a different status under physical laws than events that are not divinely caused. Marvels may be of two varieties: secular and divine. Both can be accorded the same treatment by the Regularity Theory.

How, exactly, are divine and secular marvels, events that *seem* to contradict physical laws, to be subsumed under physical laws? If physical laws cannot be violated or suspended, might they be 'time-limited'? Couldn't we allow that certain regularities might hold for certain stretches of time, only to 'give way' (be replaced by) other regularities subsequently?

Two considerations tell against this proposed alteration. First of all, positing time-limited laws is not in keeping with the traditions of the Regularity Theory. Hume certainly did not mean "for some period of time" when he spoke of "constant." By "constant," he meant something like "invariable" (or at least later writers, for example, Mill, have so taken him). But apart from doing violence to the theory as it is ordinarily conceived, the major trouble with this way of reconciling the Regularity Theory with the possibility of the occurrence of marvels is that both the possibility as well as the actuality of marvels may be accommodated *within* the Regularity Theory; there is no need to modify the theory.

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3 I am here speaking somewhat colloquially, and, although what I am saying has the appearance of violating the principle not to quantify into quotation marks, what I am asserting can easily be formulated unproblematically. It is simply that whatever God says should happen, does.

To see this, we need an example of an event that, were it to occur, would look like a 'violation' of physical laws. Let's put divine marvels behind us and return to secular matters. Goodman's case of the fickle emeralds is as good as any and perhaps better than most. Suppose, contrary to all rational expectations, emeralds really *are* grue (see Chapter 2). Suppose, too, that the fateful moment of their changing from green to blue is the stroke of the New Year, 12:00:01 A.M. A.D. 2047. Surely the scenario is logically possible. If it were to occur, what adjustments would be required in our conception of physical law and of physical possibility? In Chapter 2, I argued that nothing of the sort "All emeralds are green before January 1, 2047, and blue thereafter" can be reckoned a physical law, for this proposition refers to a specific time, and physical laws are purely general propositions. But if this proposition is not to be reckoned a physical law, what choices are then open to us? Shall we want to say that the physical laws of the world *changed* on January 1, 2047?

This latter choice is not the only one available. The event of emeralds changing from green to blue on January 1, 2047, more than likely *can* be subsumed under a purely general, universal, timelessly true proposition. Although it is a contingent matter, it is altogether reasonable to suppose that one or more events occurring just prior to the momentous ushering in of New Year, 2047, enjoy a unique description in purely descriptive terms. Suppose Times Square in 2047 has a description, **D**, such that no other thing in the past, present, or future of the universe satisfies that description. Suppose further that at the first moment of 2047 there are exactly 625,342 persons gathered in Times Square. And finally suppose that there never has been before, nor ever is again later, exactly this number of persons in the square. If these conditions were all to be satisfied, we would then have the following purely general, universal, timelessly true proposition under which emeralds changing from green to blue would fall:

> Whenever 625,342 persons congregate in a place **D**, emeralds change from green to blue.

By according this proposition the status of a physical law, the Regularist can accommodate the extraordinary event without having to posit either violations of physical laws or time-limited physical laws. It turns out that "Emeralds are green," given the counterfactual story we are telling, never was a physical law and was thus neither violated nor time-limited. The truth of the matter, that is the physical law, is (timelessly): Prior to 625,342 persons gathering in a place **D**, emeralds are green and are blue thereafter.

To be sure, this latter 'law' has about it an air of the fantastic. Can one seriously propose that such a bizarre truth could be a physical law? Doesn't this, if nothing else, finally demonstrate the untenability of the Regularity Theory?

There are no easy triumphs on either side in this debate, and the Regularist is ready with a defense:

> If "Whenever 625,342 persons congregate in a place **D**, emeralds change from green to blue" has about it the air of the fantastic, remember just what prompted offering up this proposition for recognition: emeralds everywhere changing from green to blue. *That* is where the air of preposterousness originates. Just think how dumbfounded we would be if Goodman's hypothesis were not merely a philosopher's curiosity but a true prediction. How *would* we account for such an unprecedented singularity? Would we posit new, unknown forces propagating instantaneously throughout the universe? (Remember, emeralds *everywhere* are supposed to change *at the same time*.) Could we fall back on a common historical cause? This seems unlikely because not all emeralds are equally old, nor did they originate in the same place. Surely, for an event as truly extraordinary as emeralds everywhere simultaneously changing from green to blue, all informed bets are off as to what laws subsume that event. In the legal profession, there is an adage to the effect that hard cases make bad law. There is a parallel in the present case: Outlandish hypotheses positing incredible behavior require that there be extraordinary physical laws.

The point is not that the proposed physical law is true. I am sure it is false. Like Goodman, I remain confident that emeralds are *not* going to change from green to blue. The point is that even worlds in which our most exotic counterfactual imaginings are true need not be worlds in which physical laws are suspended or time-dependent. The Regularity account of physical laws allows that behavior imagined to be remarkably different from that typically (regularly) found in our ordinary experience, can still fall under timelessly true physical laws (although of course under different laws than those that actually hold). Indeed, it is very difficult to describe circumstances that would induce us to believe that laws may be violated, or that laws are time-dependent.

But the debate about this present case has hardly run its course. For a new element was hinted at a moment ago, and the Regularist's opponent is quick to seize on it.

> Contemporaneous with the unique event of there being exactly 625,342 persons in a place **D**, there surely are indefinitely many more events all themselves having unique descriptions. According to the Regularity account, there will be, for all practical purposes, an unlimited number of physical laws under which this marvel (viz., emeralds changing from green to blue) may be subsumed. The Regularity Theory is encumbered by an embarrassment of riches. It succeeds too well. A philosophical theory that allows that an indefinitely large number (an infinite number perhaps) of different physical laws can each and all subsume the same event fails to accord with the ordinary view that events are explained by citing small numbers of relevant physical laws. With such a superabundance of laws indiscriminately all explaining the same event, no sense can be made of the actual practice of science, which is emphatically not at all like this.

The Regularist replies by denying certain presuppositions of this criticism. In particular, he wishes to drive a wedge between the two concepts of an event's *falling under* a physical law and that event's being *explained* by citing that law.

> Of course, the Regularity Theory posits a great many more physical laws than do opposing theories. It was this very point that lay at the heart of Kneale's and Molnar's criticisms. And I agree, too, that ordinary scientific practice does not invoke just any universal proposition in offering explanations of events. The difference between us is that you think that the class of physical laws is a small, finite, proper subset of the class of what Regularists call "laws" and that what distinguishes that subset is that each of its members enjoys the property of nomological necessity. You view science as trying to discover which those privileged members are. The Regularity Theory, too, allows for a privileged set among what we call "physical laws": Only some of them will be found suitable for invoking as scientific laws. (Recall it was argued in Chapters 1 and 2 that scientific laws are not a proper subset of physical laws. Other propositions, including many false propositions and some that are not purely general, are also used as scientific laws.) The vast majority of physical laws, for any number of reasons – including such facts as that most of them are unknown and that many are too unwieldy and too intractable for our computations and comprehension – will not be regarded as scientific laws and will not be invoked in our attempts to explain the world.

A not insignificant problem with using the physical law concerning the consequences of there being 625,342 persons in a place **D** as a scientific law, is that this physical law would not be *seen* or *known* to be true. Even if it were true, there would be very little inductive evidence for its truth. Moreover, in the absence of good inductive evidence of its truth, there would be similarly little evidence that the claim is pervasive (see Chapter 6), that is, that it has few, if any, ceteris paribus conditions. Even worse, it is a member of a class of propositions (concerning assemblages of persons and colors of gemstones) that, available evidence strongly suggests, are false. The color of the stone in my college ring, for example, seems, to date anyway, to be perfectly indifferent to the numbers of persons about. We may reasonably expect, then, that the troubling claim – even if it were true – would not be adopted as a scientific law and would not be used in an attempt to explain the exceedingly strange behavior of emeralds' changing their color. But this is hardly to prove that the claim is not a physical law. Our science only imperfectly captures Truth; much that is true escapes its net (and much that is true is discarded as worthless, unsubstantiated, etc.)

To see just how different are the properties of physical laws and scientific laws, in particular their respective utility in explanations and the like, imagine traveling back in time to the twelfth century and trying to offer explanations, citing (true) physical laws, as to the causes of rainbows, the causes of hemophilia, or the clouding of photographic plates, etc. The physical laws cited ex hypothesi are true, but they would not be acknowledged by the audience as scientific laws. Not only would the concepts at play in these laws be foreign (unknown); there would be no evidence available that would warrant their being believed or adopted.

What makes a proposition suitable for use in scientific explanations, predictions, and the like is an exceptionally complex brew having to do with such things as manipulability, observability, simplicity, 'integration' into wider theories, evidence of pervasiveness, and doubtless much more besides. A satisfactory analysis of these features is probably as difficult to achieve as an analysis of what makes for a good piece of art. But whatever these features are, they are properties of scientific laws and only accidentally, that is, not essentially, characteristics of physical laws.

Physical laws are timelessly true, universal or statistical, conditional, contingent propositions whose descriptive terms are all purely descriptive. None of these properties, singly or conjointly, guarantees explanatory power. Physical laws need have no epistemic properties whatever. They need not be believed, known, suspected, or even enjoy a single scrap of empirical evidence in support of their truth. Still less need they ever figure, or indeed even be able to figure, in our explanations, predictions, theories, hypotheses, etc. Scientific laws, at least many of them, in contrast, do have explanatory power. But scientific laws are sometimes not purely general and are, more often than not, false.

Two important consequences follow from these differences. One is that there is probably an exceedingly large number of physical laws. (The Necessitarian regards this superabundance as profligate and has tried, as we have seen in the preceding four chapters, to reduce it appreciably. But this profligacy will figure, to the benefit of the Regularity Theory, in Chapter 10.) The second consequence is that almost anything that happens, however marvelous, may be subsumed under a physical law. If we break the mistaken conceptual tie between being a physical law and being explanatory and assign the latter to a separate class of propositions, then it is far easier for us to conceive of the world as being determined, for then what falls under a physical law need not be understood or explicable. Both these consequences bear importantly on the historic problem we next turn to.

10

Free will and determinism

The latter half of Part I was principally concerned with questions about the physical possibility of failed attempts and of projects not undertaken. In this chapter and the next, we look at the complement of those discussions: at the supposed physical necessity of events that do *occur.*[1]

We also broaden somewhat the compass of our investigations to include not only Necessitarianism but all theories that would vie with Regularity. I am especially concerned to challenge any theory – whether it be a Necessitarian theory, a Prescriptivist account, or any other Autonomous account – that alleges that what happens in the world 'accords with' or 'is governed by' physical law.

'The' problem of free will versus determinism is an artifact of the Autonomy Theory of physical laws.

Once upon a time, an immigrant arrived from Mars. He was a product of Martian culture, which, as we all know, means he was reared on the Regularity Theory. He had recently begun his graduate studies in philosophy, but he had been offered the opportunity to complete those studies on Earth, and he eagerly accepted. Here he enrolled in a joint program in ethics and psychology. But it was not long before he was experiencing some profound difficulties. Certain of the problems his professors addressed were thoroughly familiar to him, echoing as they did traditional problems addressed by academics and reflective thinkers at home on his distant planet. He could perfectly well comprehend questions about diminished responsibility, excusing conditions, the contrast between motives and causes, and the efficacy and justification of punishment.

[1] The one paper that has informed my thinking more than any other on this subject is Scriven's "An Essential Unpredictability in Human Behavior" (1965), an important, unjustly neglected paper that deserves to be anthologized.

But other problems proved well-nigh incomprehensible to him. In particular, he was deeply puzzled why anyone would think that determinism posed a threat to free will and to one's being accountable for one's actions (some of them anyway). In his view of physical necessitation, according to his theory, that is, of what a physical law is, there was no tension, no conflict, between someone's being free and at the same time having her actions subsumable under one or more physical laws.

From time to time, persons with whom he discussed the problem characterized his position as "compatibilism." But this only deepened the Martian's frustration. He could perfectly well see why, for example, theories of certain Christian apologists might be called "compatibilist." To be sure, there is a prima facie tension in positing an all-good Creator and in admitting that this world is beset with evil. Reconciling those two views really did seem to him to be aptly described as "compatibilism." But the present case was different. It struck him as odd to call his way of looking at things "compatibilism." After all, one did not stick that particular label on his belief, for example, that doubts and itches should coexist.

Every attempt to explain 'the problem' to him sooner or later posited a class of physical laws to which the events of the world, including human (and Martian) actions, were supposed to comply. The vocabulary changed as different philosophers attempted to explain the problem. Some spoke of events being "governed" by these laws; others talked of events happening "in accord" with these laws; and still others preferred to say that "given these laws and the antecedent state of the universe, something other than what happened, could not have happened." In every case, one kept coming up against this troublesome set of laws.

The Martian remained baffled. Back home on Mars, philosophers certainly used to talk about physical laws, too. But they never seemed be having these particular problems. As they conceived of laws, these problems did not even arise.

Finally, our local philosophers (i.e., Earth folk) asked the Martian to explain what his notion of physical law was and the nature of its relationship to human (and Martian) behavior.

At first the Martian was nonplussed. He certainly had not reckoned on coming to Earth to give a seminar. He was supposed to be here to learn. So he asked for some time to prepare himself, to try to put his own thoughts in order. He clearly was not prepared to explain why he could not understand their problem. (One can *admit* incomprehension; but *explaining* it is far more difficult.) And so he spent the next few months intensively reading local philosophy trying to piece together our prevailing philosophical system, which generates so many puzzles for so many of us. Eventually, he thought he understood, and, with some trepidation, he offered his first seminar to his new colleagues.

THE MARTIAN'S FIRST SEMINAR

When I first undertook to learn English at home, my instructor warned me that you English speakers are sometimes perversely economical with vocabulary, that you will sometimes use one word to express two different concepts. For example, you here in Western Canada use the single word "know" to cover two different concepts, whereas we on Mars use "savoir" and "connaître."[2] It would never occur to anyone at home that there is any commonality between these two concepts.

So it is, too, with your use of the word "law." At home, we have a word "edict" that translates pretty closely into your language as an "order," "proclamation," "command," or some such thing. We also have another term, which is unpronounceable among English speakers, but which would translate into a phrase such as "grand physical truth," or something like that. An example of such a grand physical truth is the proposition "No mass travels faster than the speed of light." Another example would be "The charge on an electron is 4.803×10^{-10} esu." And still another is "Whenever someone runs, his heart rate increases." Oddly enough, you English speakers call both proclamations and grand physical truths by the same name, "laws." Back home, it would not occur to anyone to see much, if any, commonality between these two classes of things, still less to call them by the same name.

I suppose this latter difference in our languages is to be accounted for by the fact that we have had very different intellectual evolutions. For one thing, the religious bent of mind seems missing in the Martian. We never did have an Aquinas, a Suárez, or a Montesquieu who seriously promoted the view that what we call grand physical truths are God's proclamations to

[2] [How extraordinary that Martians should use the same words as Quebecers. What are we to make of this? Sheer coincidence? Convergent evolution? Interplanetary telepathy? Or, perhaps there really were itinerant ancient astronauts, francophone ones at that. –N.S.]

moving objects, electrons, beating hearts, and the like. And thus we never needed a J. S. Mill or a Karl Pearson to point out the ambiguity in the use of the single word ("law") to cover these two remarkably different cases.

All of you claim to understand the two different senses in which you use the term "law," but, after turning the matter over for some months now, I have reluctantly been forced to conclude that you really do not keep the two concepts separate. So much of what you want to say about physical laws (grand physical truths) seems appropriate only for proclamations, orders, commands, and the like. Let me explain.

The prevailing picture among you is something of this sort: Given antecedent conditions and physical laws (grand physical truths), the subsequent behavior of things is determined. Oddly enough, we Martians *say* just about the same thing. But we do so for different reasons, and differ in what sense we give to the term "determined" that occurs here.

Many of you have a notion that objects behave "in accord with" physical laws. You have a notion that physical laws are something like causal agents, that, given these laws, physical things, both material objects and human agents, cannot but behave in the way they do. (One is tempted to say physical things "have no say in the matter," but that would make the anthropomorphism so blatant that doubtless everyone would balk. But no matter how neutral you try to make this description, it does seem to me to be at heart an anthropomorphic account, a remnant perhaps from deepest antiquity, when it was quite respectable to regard all Nature as animate. But I digress, and this is obviously anthropological speculation of a pretty untestable kind.) Try as I might, I cannot free myself of the belief that you folks harbor a notion that together initial conditions and physical laws are coercive agents. Von Wright captured the flavor of this attitude perfectly when he offered this characterization of (ontic) determinists:

> The statement that it will certainly be raining tomorrow can be understood ... in an *ontic* sense, meaning that the facts which are true of the world, together with the laws ("laws of nature") regulating the development of the world, *determine* tomorrow's weather in such a way that *it* is certain to be raining tomorrow.[3] (1974, p. 21)

Von Wright has aptly summarized a position that is widely believed. I am sure it lies at the root of many persons' thinking about the problem of free will and determinism. But it is not *always*

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[3] The odd emphasis on the word "it" arises out of a contrast, not here quoted, with another interpretation in which the certainty is epistemic and resides in *us*.

submerged and merely a presupposition. Some authors, particularly those analyzing the concept of physical law, have been forthright and have subscribed to this view quite explicitly. Witness:

Popper:

> Natural laws set certain limits to what is possible... Natural laws *forbid* certain events to happen, … they have the character of *prohibitions*. (1959a, p. 428)

Swinburn:

> What happens is not solely a function of which laws operate. Laws state the subsequent effect of certain initial conditions, and what happens is a function as much of the initial conditions as of the laws.[4] (1970, p. 4)

Reichenbach:

> Physical phenomena ... do not always openly display the rules followed by them; but physicists have been able to show that all such phenomena are controlled by very precise rules. (1954, p. 14)

Note the terminology: Laws (/rules) "set limits," "forbid," "have the character of prohibitions," and "control physical phenomena." And, "what happens is a function . . . of the laws."

In a popular book, intended for lay readers, the physicist Heinz Pagels (1978) has written:

> Genes just do what they are told to do by the laws of chemistry. (p. 110)

> Looking for the natural laws is a creative game physicists play with nature.... the goal is finding the physical laws, the internal logic that governs the entire universe. As scientists search for natural laws the ancient excitement of the hunt fills their minds; they are after big game – the very soul of the universe. (p. 292)

> Physical laws are ... unlike social "laws" which simply stipulate invariances. The difference between social law and physical law is the difference between "thou shalt not" and "thou cannot." (p. 293)

> The universality of physical laws is perhaps their deepest feature – all events, not just some, are subject to the same universal grammar of material creation. This fact is rather surprising, for nothing is less evident in the variety of nature than the existence of

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4 Swinburn, note, assigns laws a dual role: of *stating* effects and of being themselves the *causal determiners* of events.

> universal laws. Only with the development of the experimental method and its interpretative system of thought could the remarkable idea that the variety of nature was a consequence of universal laws be in fact verified. (p. 296)

The prose here is forgivably overblown in the way in which popularizations often are. Pagels, we may be sure, does not believe, for example, that the laws of chemistry literally speak. But if we disregard his picturesque metaphors, we are still left with the same kind of notion evidenced in the writings of Popper, Reichenbach, and Swinburn: Physical laws, if they don't actually 'command,' at least *influence* behavior. In his words (above): "The goal is finding the physical laws, the internal logic that *governs* the entire universe"; "all events … *are subject to* the same universal grammar of material creation"; and "the variety of nature … [is] … a *consequence of* universal laws" (italics added).

I do not believe that Popper, Swinburn, Reichenbach, and Pagels are eccentric in what they profess. To the contrary, I am sure that they have done no more than make explicit a view that is very widely subscribed to. Indeed, the view is *so* widely held and so familiar that Pagels can caricature it without having it appear utterly ludicrous. Nonetheless, this account of physical laws is importantly wrong. Physical laws simply do not have the kinds of properties or powers here being attributed to them.

A great many persons with whom I have spoken explicitly deny that they hold the view that I am suggesting is virtually pandemic. But their denials notwithstanding, I still think they do hold such views. I say this because their *examples* betray this very concept. For, on the one hand, they will claim that the 'necessity' assigned to physical laws is not ontic, but epistemological, that it reflects a privileged status of a certain class of propositions in our (current) corpus of science; whereas, on the other hand, they will persist with arguing that there is a 'real' difference between, for example, it being an accident that no moa lives to the age of fifty, that there is no 40 kg diamond, etc., and it being a physical necessity that no massy object travels faster than the speed of light. In particular, they will argue that certain counterfactual propositions reveal the difference. "Even if there never is a meteor impact that cleaves a watery planet asunder, there *could* be; but there *could not* be a meteor that travels faster than light."

This difference they try to highlight may be said by them to be no more than epistemological, but in fact it usually goes deeper. That it does go deeper is revealed in another counterfactual claim they will make, namely, that even if we human beings *had never done science*, even if, more extremely, we *had never even existed*, it would still be true that it would be merely an accident that no meteor ever destroys a watery planet, but it would be a physical necessity that no meteor ever travels faster than light. For such a theorist, the difference between the two counterfactual claims does not, then, ultimately rest on our knowledge of the world or on our doing science; it goes beyond to a real difference *in the world itself*. It would obtain even if we were totally ignorant of such matters; indeed, even if we were never to have existed.

But if we are not to adopt this standard account, what other is there? Let us see.

At an earlier time, philosophers used to worry about the threat that *logical* determinism seemed to pose for free action. Aristotle was troubled by its being true today that there would be a sea battle tomorrow (1963; *De Interpretatione*, section 18b17). If it were true today that such a battle would occur tomorrow, then it seemed *determined*, nay *destined*, that the battle would occur.

But gradually it became clear that the sense of "determined" at play in this case is no cause for concern. Its being true today that the battle occurs tomorrow does not cause, force, or coerce the battle's taking place. It is rather that what happens tomorrow brings it about (and this is a *semantic* relation, not a *causal* one) that a certain proposition is true today, and always has been for that matter (see Ryle 1960; Bradley 1967; and Bradley and Swartz 1979, pp. 104-7). What necessity is operative here is just the necessity of the Principle of Identity; that is, it is necessarily true that if (and only if) a sea battle occurs tomorrow, then it is true today that that battle will take place. Note that even if there were any random events tomorrow, those random events would be *fully determined* in this just mentioned sense of "determined. " I grant, of course, that the concept of randomness is problematic, but we need not particularly concern ourselves with it here. (See "Randomness" in Pagels 1983, pp. 82-9; and von Mises, 1961.)

Obviously, the moral to be drawn is that logical determinism poses no threat whatever to freedom of action. Indeed, many future contingents have the truth-values they do today precisely because tomorrow I will freely choose to do something, for example, brush my teeth with Brand X toothpaste rather than Brand Y.

Doubtless, some of you will now be thinking that I have gone too far and am now begging precisely the very question at issue here, the question of how to reconcile free will with physical determinism. For many of you have convinced yourselves that while *logical* determinism poses no threat to free action, *physical* determinism does, and that in what I have said about freely choosing Brand X, I have thoroughly confused the two senses of “determined.”

We are at last at the heart of the matter. On whose side does the confusion lie, on mine in treating logical and physical determinism alike, or on yours in thinking them to be importantly different?

Let me state it as forcefully as I can: The *only* difference between logical determinism – as it is usually depicted in traditional examples – and physical determinism has to do with the *generality* of the propositions involved.

I put it to you that the following two cases, one of ‘logical’ determinism and the other of ‘physical’ determinism, differ *only* in that the latter invokes a universal generalization.

‘Logical’ determinism

It is true today, that is, February 27, 2467, that the prime minister of Canada brushes her teeth tomorrow with BriteWhite toothpaste.

∴ On February 28, 2467, the prime minister of Canada brushes her teeth with BriteWhite toothpaste.

‘Physical’ determinism

A white precipitate is formed whenever a silver nitrate solution is mixed with a sodium chloride solution. (physical law)

Efrem is now mixing a silver nitrate solution with a sodium chloride solution. (initial conditions)

∴ A white precipitate will shortly form.

The grand physical truth (physical law) does not force, coerce, or what have you, the events of the world. The sense in which it determines what happens is as gentle as that in the case of logical determinism (it is, in fact, identical to the latter). And logical determinism is more gentle by far than the softest breeze or the lightest feather. Physical determinism poses no threat to human behavior simply because it does not force or coerce or constrain or necessitate any behavior whatsoever, neither that of the most insensate lump of clay nor that of the most unfathomable dreamer among us.

The problem of reconciling free will with physical determinism is a chimera. *Nothing* acts ‘in accord’ with physical laws, not electrons, planets, or human beings. Rather, it is because, for example, all planets travel in elliptical orbits (we’ll pretend that they do) that the proposition that they do is a grand physical truth (physical law). Similarly, it is because human beings avoid pain (we’ll pretend that they all do), that the proposition that human beings avoid pain is a grand physical truth.

Traditional solutions to the free-will problem infrequently manage to elicit from you much conviction. Defining an action as “free” if it is not coerced, forced by torture, or extracted by threat, drug, hypnosis, etc., although exactly correct, certainly has not put an end to the controversy. This Hobbesian solution strikes most of you as at best only a partial solution, because, even of this class of actions, you are still inclined to say (or think) that they ‘take place under the sway of physical necessity.’

The stumbling block to a fully satisfactory solution to the free-will problem is the mistaken theory of physical laws. It is interesting and significant to note that, in the several-hundred-year history of the freewill debate, this has been the *least* examined feature.

A case in point: On February 9 and 10, 1957, twenty-four of the most respected philosophers and philosopher-scientists of that time met in a symposium in New York City to discuss determinism and freedom. (The proceedings have been published; see Hook 1958.) Although many of the participants wrestled with the question of whether any physical laws might be stochastic, or whether ultimately they are all universal, no one stopped to inquire about the analysis of the concept of physical law itself. The closest anyone came to even touching on the matter was Brand Blanshard, who asked what is the sense of “must” in “given A, B must occur” (Hook 1958, p. 4). Surprisingly, however, no sooner had Blanshard raised the question, saying that it cannot be evaded, than he dropped it altogether, hoping “you will not take it as an evasion if at this point I am content to let you fill in the blank in any way you wish” (p. 4). He never returned to his question. Later, Hempel briefly showed (pp. 158-60) how crucial it is to settle the issue, how very different theories of determinism result according to how one understands this “must.” But Hempel’s reply was just propaedeutic; the necessary enlightenment was not forthcoming, either from him or from anyone else in the symposium.

A second example: In a penetrating essay (“One Determinism,” Honderich 1979), Honderich reaches conclusions that he admits some others will find “intolerably dark”: “that one can only act as one actually does" (p. 260); "that we cannot decide in ways other than we do" (p. 263); and, "that our actions are never free or voluntary" (p. 263). The error that leads to these conclusions occurs almost immediately at the beginning:

> To say of a state that it had a cause is to imply, rather than assert, that the state was the effect of some sufficient set of conditions. *It will make no substantial difference* if one understands sufficiency in terms of constant conjunction or in terms of some stronger notion. (p. 245; italics added)

What Honderich thinks makes *no* difference, I maintain, makes *all* the difference.

Of course, seventeenth-century scientists were right to insist that there are physical laws. And of course, twentieth-century existentialists were right to insist that we are often, usually, free to choose. Freedom is no illusion. It is false that, although we 'feel free,' seeming even to experience freedom, deep down 'behind the appearances' we are constrained by physical necessity. The relationship between freedom and physical necessity has been utterly misconceived, and this for the reason that the relationship between anything's happening and physical necessity has been misconceived.

Right now I am wearing a blue shirt. My wearing a blue shirt constitutes the *truth-grounds* of the proposition that I am wearing a blue shirt. My wearing a blue shirt *accounts* for that proposition's being true. Colloquially, we are inclined to put the point by saying that my wearing a blue shirt 'makes' the proposition true. Yet this 'makes' is not a causal relationship, but a semantic one. It cannot possibly be causal because the truth of the proposition is not an event; it is not the sort of thing that *could* be caused.

But if my wearing a blue shirt does not cause the truth of the proposition, even less does the truth of that proposition cause or 'necessitate' my wearing a blue shirt. What *is* necessitated is only the identity proposition, "If the proposition that I am wearing a blue shirt is true, then I am wearing a blue shirt." Aristotle made much the same point in the *Categories*. His writing "is in a way the cause of," I take to be his denial that the relationship is genuinely causal, but is instead, as I have chosen to characterize it, semantic:

> If ... [a man] ... exists, then the statement in which we assert his existence is true, and conversely, if the statement in which we assert his existence is true, he exists. But the truth of the statement is in no way the cause of his existence, though his existence is in a way the cause of the truth of the statement.[5] (Aristotle 1963, sections 1015-20)

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5 This particular translation is not that of Ackrill (Aristotle 1963) but occurs – unattributed – in Prior 1967. The anonymous translator in the latter case has produced much the more idiomatic piece of prose.

No runner, bullet, rocket, electron, or indeed any physical object, travels beyond the speed of light. That this is so 'makes' it a grand physical truth (physical law) that no massy object travels beyond the speed of light. The latter proposition does not 'constrain' massy objects, any more than the true proposition that I am wearing a blue shirt necessitates my wearing a blue shirt, or that its being true that a man exists necessitates or causes that man to exist. Events 'make' (but do not cause) propositions to be true; true propositions, even if they happen to be physical laws, do not necessitate events, either by themselves or in concert with other propositions.

There is a remarkable consequence of this conceptual reorientation that I am urging. It is this: It is partly up to us to decide what the grand physical truths (physical laws) of the world are. By choosing to do this rather than that, we 'make' it a timeless truth of this world that, in such and such circumstances, persons do this.

Beware. I am not saying that it lies entirely within our province to choose the grand physical truths of this world. But what I am saying is that it is not wholly outside our will, either. We are not straws driven by the irresistible winds of natural necessity.

All sorts of physical laws seem to be quite outside my sphere of influence. I cannot (I have tried) cause a friend to regrow a severed leg by waving my hands. Nor can I choose that it is a grand physical truth that human beings have three sets of adult teeth. Experience has shown me that this is the sort of world in which these things are not up for grabs, that no amount of willing and trying on my part will bring about these desired effects.

But the world is not totally beyond our control, and certain – indeed many – physical laws derive their truth from our choosing and doing certain things. Suppose I am faced with a unique situation: I am cast in the role of arbiter in the dispute as to whether or not this society should use merged-gender or sex-distinct mortality tables. Let's suppose, further, that no one before or after me is ever posed this same vexious question. I choose that we will use merged-gender tables.

And by so choosing I make it a grand physical truth (physical law) that whenever *A*, that is, someone is posed this problem, he does *B*, that is, chooses that merged-gender mortality tables be used.

The number of physical laws is for all practical purposes infinite.[6] Adopt the view that laws are nothing other than general statements of what happens, and one has the means to accommodate free will. Human beings (and Martians) – as a sheer matter of fact – have evolved to a sufficient degree of complexity that their behavior can be described only by a (potentially) infinite set of laws. This situation may be as utterly determined as one could like, in the sense that every action may be subsumable under one or more universal physical laws. But it also allows human choice. I am presented with a difficult decision. There are strong arguments both for and against choosing merged-gender mortality tables. I weigh the probable consequences; I reflect on my principles of fairness; I look at previous similar, but not precisely the same, precedents; I try to balance the cost-savings against the measures of outrage; and eventually I *decide*. Nothing *forced* my decision, although it was completely determined in the sense of being deducible from timelessly true physical laws and antecedent conditions. But note (and this is perhaps my most important point and shows just how antithetical the Regularity account is to the Autonomy account): If I had chosen otherwise, that is, had chosen instead that the sex-distinct tables should be used, that choice, too, would have been determined. That choice, had I made it, would have, too, been subsumable under a timelessly true physical law, and would have been deducible from that law and a statement of antecedent conditions. Clearly, I could not choose both alternatives; but I could choose either. And in choosing the one, I 'made' *it* the one that was deducible from physical laws and antecedent conditions. But in every sense in which one could possibly want, I was free to choose the other.

Doubtless the single, most paradoxical-sounding corollary of the Regularity Theory is this: If a person is in a unique situation and chooses *B*, then his choosing something else that is logically inconsistent with *B*, for example, *C*, is physically impossible; nonetheless, his choosing *C* may well have been unconditionally possible. The way to remove the seeming air of contradiction is to remember that, according to the Regularity account, "physically impossible" means nothing more or less than that such an event (e.g., choosing *C*) never, ever occurs. But ex hypothesi, this

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6 [See Chapter 9. –N. S.]

is true; for remember as well that we have just stipulated that the situation in which the chooser opts for *B* is *unique*. It is logically impossible that he should choose both *B* and *C*; so whatever he chooses, the other would thereby become physically impossible. Still, he could choose – unconditionally – the physically impossible action if he wanted to. It is his choosing one of the two alternatives that makes the other one physically impossible. But he could choose either.

Note, finally, how much better the Regularity Theory is as a basis for doing ethics than is presupposing the Autonomy Theory. The perennial worry is laid to rest about whether "ought to have done *x*" (where a person did not do *x*) is logically compatible with "could have done *x*." We want to argue that "ought" implies "can," but you remain troubled about whether a person "really can" do *x* in those instances where he does not. Problems like these are idle in the Regularity view of physical laws. If you will give up your distorted view of physical necessitation, all these seeming paradoxes fall away, leaving a residuum of *genuine* problems.

What makes an action ethically neutral, praiseworthy, or blameworthy remains a challenge to spell out. But that such categories should rationally be applied to some acts is not in the slightest threatened by adopting the Regularity Theory. Indeed, we can see how it is easier on this account to attribute blame. Persons who are not coerced, who are not hypnotized, who are not drugged, etc., are 'free' to choose as they want.

Persons who are rational, who know well what the consequences of their actions will probably be, who are not forced or coerced to perform evil, but who nonetheless do perform evil, may with perfect appropriateness be blamed. In as strong a sense as one could possibly want, they did not have to do what they did. (Although, of course, what they did was *completely* physically determined.)

In short, all the standard ways we go about assigning excuses and blame remain precisely intact. We excuse persons who are irrational, who are too young to be able to anticipate the consequences of their actions, whose actions had unforeseeable consequences, etc.[7] And we blame persons who could see the harm of their contemplated actions but who deliberately wreaked havoc anyway, etc.

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7 How *do* children go about learning what the foreseeable consequences of actions are? By having enough experience of the world to see what typically follows upon what. Surely not in being able to detect an underlying necessity.

So far as we can tell, our actions are determined; many of them are free; certainly many of them are praiseworthy, and some others are blameworthy. Being determined, being free, and being praiseworthy or blameworthy are the happiest of bedfellows on the Regularity Theory of grand physical truths (physical laws). There is a tension among them only when you assume that physical laws are something like irresistible forces, compelling us to behave in certain ways. Instead, conceive of those physical laws that subsume our behavior simply as propositions deriving their truth from what we *do*. Give up the idea that physical necessitation forces events to occur, and the free-will problem is solved so thoroughly that it cannot even be stated coherently.

The Martian then sat down rather abruptly. He was exhausted. (For it is – you know – a grand physical truth, er, physical law, that persons raised in an environment of low gravity experience fatigue easily on planets of high gravity.) The chairman then invited the members of the seminar to adjourn for coffee. As they were filing out, some of the audience were heard to remark that they thought the Martian's program of changing persons' minds would, given time, succeed; others said they thought the program would fail; still others volunteered that the program was doomed.

Coffee was followed by a dinner of Alberta beef served at a buffet in the faculty club. Toward the end of the meal, a few at the table began to press the Martian on some of what he had said. They were especially concerned about his characterizing the problem of free will as arising out of a belief that physical laws were regarded as 'coercive agents.' They argued that they had never thought of the problem in quite that way and wondered whether 'the problem' could be given a less tendentious formulation. The Martian agreed with some of their points, admitting that his motive had been to contrast the two views in as extreme a way as possible. But he also insisted that the problem remained even if one were to try to construct a far less anthropomorphic view of physical laws. As they chatted, the Martian gradually regained his volubility and felt the need for a blackboard. So several of the dinner party repaired to a small seminar room in the faculty club, and over cognac and through cigar smoke, the Martian offered an epilog.

EPILOG TO THE MARTIAN'S FIRST SEMINAR

When I arrived here a few months ago and was first introduced to the problem of free will, I was struck by the apparently insuperable difficulty, within standard theories, of reconciling determinism with one's ability to have done otherwise than what one did. Many writers have explicitly addressed this problem, and some have argued – as I would as well – that no account of moral responsibility is viable that does not provide for one's having been able to have done otherwise. Thus, Mabbott writes:

> I remain convinced that moral responsibility requires that a man should be able to choose alternative actions, everything in the universe prior to the act, including his self, being the same… I do not see how anything clearer can be said than that we seriously mean "he could have done otherwise" categorically. If analysis fails to do justice to this; so much the worse for analysis. (1961, pp. 301-2)

The identical requirement has been insisted upon by H. D. Lewis:

> We can only retain the ideas of obligation and guilt as properly ethical ideas, if we can also believe in actions which could have been other than they were although everything else in the universe had remained the same. (1952, pp. 615-16)

Why is this requirement so difficult to satisfy? What is there in your concept of something's having happened that implies that that occurrence could not have been otherwise? There is no comparable problem within the Regularity Theory. What, then, is the precise source of the profound difference between the two theories? I set about trying to isolate that critical difference.

The intransigent problem within your theory is supposed to go somewhat like this: Either what happens is determined, or it is not. An event is determined if its description – or better, a statement to the effect that the event occurs – is logically deducible from a statement of antecedent conditions and a statement of physical law. But – it is alleged – if an event was determined, then it could not have but happened; that is, it had to occur, and hence one was not free to choose that it should occur. But if, on the other hand, an event was not determined, which is usually taken to mean that it was a random occurrence, then, again, one was not free to choose that it should occur. In other words, we are supposed here to have a classical dilemma, in which both horns preclude free choice.

Having come from a tradition in which it would not occur to anyone that determinism and free choice were incompatible, I was not much inclined to try to argue for freedom on the basis of free choices not being determined. Instead, I set about trying to find just what it is in your conception of determinism that makes it so unsuitable for accommodating free choice. I had, that is, to find the unstated premises that would take one from "is determined" to "is not a free choice."

Obviously, those who claim to find a problem of free will in the standard theory were not claiming that *a*'s doing not-*P* was logically impossible. This reading of the problem would have been grossly unfair. Surely, those who are troubled and think that determinism is incompatible with free will are not denying that *a*'s doing not-*P* is logically contingent.

The second possibility I explored was to see whether the necessity that is supposed to attach to the universal law is what, somehow, makes it impossible to have done other than what one did. This, on the face of it, is a more promising tack to take. But it, too, fails to generate the problem.

If we combine the Necessitarian's account with the Determinist's (and note that they are logically independent of one another[8]), we get the following scheme for *a*'s doing *P*, (where "$\acute{\Box}$" signifies that the operand is nomologically necessary):

$$\begin{array}{l} \acute{\Box}(x)(Sx \supset Px) \\ Sa \\ \hline \therefore\ Pa \end{array}$$

That is, in the case of *a*'s doing *P*, there will exist both some nomological universal generalization and some singular proposition (statement of antecedent conditions) such that, together, they logically imply *Pa*.

It is very tempting to argue that the sense in which *Pa* could not have been otherwise devolves from the nomological necessity of the universal premise. That is, it is tempting to argue that the two premises above logically imply not just *Pa*, but something stronger, namely, $\acute{\Box}Pa$:

$$\begin{array}{l} \acute{\Box}(x)(Sx \supset Px) \\ Sa \\ \hline \therefore\ \acute{\Box}Pa \end{array}$$

8 Determinism says that every event is a second member in a sequence that is subsumable under a universal physical law; Necessitarianism, that every physical law is nomologically necessary.

Rescher, it would seem, subscribes to this thesis:

> To explain a fact scientifically is thus to adduce reasons to show why *this* fact obtains rather than some one among its possible alternatives. This requires going beyond establishing that the fact *is* actually the case to showing that (in some sense) it *had to* be the case – that it was *necessary* and inevitable, that it should be so – or at least *probable* and "to be expected." (1970, p. 11)

> … a subsumption argument will transmit the necessitarian aspects of the laws to the derivative explanatory conclusion (1970, p. 12)

From *this* version of Necessitarianism, generating the problem of free will is virtually assured and but a minor further step. Nonetheless, we should resist seeing this as the source of the problem.

In attributing nomological necessity to the conclusion of an argument in which a nomological generalization figures as a premise, it would appear that Rescher is either committing a modal fallacy or implicitly informing us that what is generally a modal fallacy is not in the special case of nomicity. In general, that some proposition, ϕ, logically follows from a set of propositions, one of which is 'necessary,' does not make ϕ 'necessary.' For example, from the true, contingent proposition that John borrowed $1,000 and from the necessary truth that $1,000 is more than $800, we may validly deduce the true proposition that John borrowed more than $800. But, clearly, the latter proposition is *not* logically necessary. If nomological necessity is unlike logical necessity in this regard, if, that is, a proposition, ψ, that is nomologically necessary *can* induce necessity in the conclusion of any argument in which ψ occurs essentially, then we will need powerful reasons to convince us of this exceptional modal property. Rescher has not, so far as I can see, produced those reasons. Nor do I think that his claims about the 'inheritability' of nomicity comport with those of other Necessitarians. His particular views on this matter seem more idiosyncratic than representative of his school.

Necessitarians are committed to maintaining that whatever is logically implied by a nomological necessity is itself a nomological necessity. But *Pa* is not implied by a nomological necessity (i.e., $\acute{\Box}(x)(Sx \supset Px)$ does not – by itself – imply *Pa*), and hence there is no inducement to regard *Pa* as being nomologically necessary. The source of the Determinist's problem seems to be elsewhere.

A third possibility presents itself: If the antecedent conditions – *Sa* in our example – were themselves nomologically necessary, then one could, plausibly and validly,[9] infer the necessity of the conclusion from the joint necessity of the premises. But from where could the nomological

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[9] The relevant inference rule would be:

$$(\alpha \,\&\, \beta) \rightarrow \gamma,\ \acute{\Box}\alpha,\ \acute{\Box}\beta\ \vdash \acute{\Box}\gamma$$

necessity of the antecedent conditions arise? Only from the necessity of their (still earlier) antecedents and the necessity of (presumably) still other physical laws. Clearly, we have here the incipient generation of an infinite, or at least a very protracted, series of events stretching back into prehistory. We have a domino theory of nomological necessity: An event is nomologically necessary if any of its causal antecedents was. Two possibilities arise:

(i) At some time in the past, either a finite time ago or an infinite time ago, events *acquired* the property of nomological necessity. (Remember, if the universe is infinitely old, it will have infinite proper parts.) According to this alternative, at some point in the past the events in the universe 'switched' from being mere occurrences to being nomologically necessary. The trouble with this alternative is that it fails to explain why or how such a transition could have come about. (If this planet is held on Atlas's shoulders, he has to stand *somewhere*; if this event is necessary because its predecessor was, the predecessor's necessity has to come about from *its* predecessor's.) The infinite regress cannot be arbitrarily terminated.

(ii) Events did not acquire the property of nomological necessity, but have always had it: from the very first moment, if the world had a temporal beginning; for all past eternity, if the world is infinitely old. The trouble with this second scenario, however, is that it conflicts with one of the principal tenets of Necessitarianism, namely, the idea that there is a very wide range of diverse – and incompatible – 'initial conditions' all individually consistent with the set of physical laws. Popper puts it this way:

> Natural necessity or impossibility ... imposes *structural* principles upon the world. But it still leaves a great deal of freedom to the more contingent singular facts – the initial conditions. (1959a, p. 430).

Popper is here using the expression "initial conditions" not as it figures in the common parlance of scientists and engineers but in a specialized, extended, cosmogonical sense. Lacking a standard term, he has appropriated this term, and consequently what he writes may appear slightly misleading. There are, of course, no *initial* (first) conditions in an infinitely-old world. And Necessitarianism does not presuppose a finitely-old world. Clearly, a theory about the modal status of physical laws must be formulated to be neutral on the empirical question as to the age of the universe. When Necessitarians speak of wide-ranging possible diversity among 'initial conditions,' they mean that, among those possible worlds (finite or infinite) that share the same nomologically necessary laws, wide variations occur from world to world in their respective singular historical facts (see Popper 1959a, pp. 433, 435). In short, Necessitarianism does *not* attribute nomological necessity to antecedent conditions.

Three possibilities, then, as to what the missing premises might be do not work. Whatever sense it is that is operative in "*a* could not have done otherwise than *P*," it is neither logical necessity or nomological necessity. That is, "*a* does *P*" is neither logically necessary nor nomologically necessary (even if it happens to follow logically from a set of premises one of which is nomologically necessary). What, then, *is* the sense of "impossibility" operative in the theory that has it that "*a* could not have done otherwise than *P*"?

Let's compare my suggested alternative with the standard view of the matter. Both theories would deduce the occurrence of *Pa* from the antecedent conditions and universal laws. The only *formal* difference between the two would lie in the fact that in one scheme the universal generalization would bear the modal property of nomological necessity, whereas in the other it would not. In both cases, the conclusions would be identical:

Regularist	*Necessitarian*
$(x)(Sx \supset Px)$	$\acute{\Box}(x)(Sx \supset Px)$
Sa	Sa
$\therefore\ Pa$	$\therefore\ Pa$

The sense in which "*Pa*" in the second case, but not in the first, "could not be otherwise" has nothing to do with anything that shows up in the formal machinery above. What makes for the impossibility in the Necessitarian's case, and lack of it in the Regularist's, has to do with the truth-conditions of the universal premises in the two arguments.

Consider, again, my choosing whether society is to use merged-gender or sex-distinct mortality tables. Suppose I have announced my decision, and the question arises of whether my uncoerced decision was truly free. Let's see how and why the answer to this question will vary according to the two competing accounts.

According to the Necessitarian account, I – obviously – could not choose or change the antecedent conditions: Whatever antecedent conditions are the causal determiners of my choosing, they are temporally prior to my deliberations; that is, they are in the past relative to the time of my deliberating and hence – at that time, the time of my deliberating – beyond my control. I cannot change the past. But neither, according to this theory, can I change (or choose) the physical laws 'governing' what subsequent effects are to follow upon (i.e., occur immediately after as a result of) such antecedent conditions. In short, there is *nothing* open to my choosing. I can choose neither the causal antecedents of my choice nor the physical laws governing the causal effects of such circumstances. In such a situation (which turns out to be *every* situation), there is nothing whatever to choose. Genuine choice, and hence free will, is an illusion.

The Regularity account concurs in only part of the Necessitarian's analysis. The Regularist agrees that one cannot undo the past and that one cannot, therefore, at the time of one's deliberating choose the antecedent conditions of one's upcoming choice.[10] But as to the second part of the argument, the Regularist disagrees. According to the Regularity account, one can (sometimes, at any rate) choose the universal law that is to apply in the case of one's choosing. One does that, not by assembling all the laws (whatever that would mean) and selecting one, but rather simply by doing what one chooses to do. The physical law follows automatically or, as I said earlier, 'semantically.' Our doing what we do 'makes' some universal proposition(s) timelessly true and others timelessly false. We did have a choice, and by exercising it we selected the covering law. There *was* something in the situation that was open to us. In short, the missing premise in the 'causal version' of the problem of free will is the claim that physical laws have autonomous truth-conditions, that their truth does not derive solely and wholly from what happens, but that whatever happens does so in accord with physical laws.

We are free to the extent that we choose the grand physical truths that subsume our behavior. Or, putting this another way, we are free to the extent that the truths describing what we do derive solely from what we do. To the extent that the true statements describing our behavior have truth-conditions logically prior to what we do, to that extent our behavior 'could not have been otherwise' than to have satisfied these descriptions. If the physical laws of this world are autonomous, we are not free; if we are free, then the physical laws are not autonomous.

[10] "Men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past." (Marx 1963, p. 15)

I want to emphasize that I am not drawing the contrast between the Autonomy and Regularity theories by saying that on the former account physical laws are ‘already true’ prior to their instances, and that on the latter account, physical laws ‘become true’ when they are (first?) instanced. This latter, Diodorean, theory has no role in these discussions. Logical priority is not temporal priority. According to both accounts, Autonomy (and hence Necessitarianism and Prescriptivism) and Regularity alike, physical laws are timelessly, or omnitemporally, true. When Necessitarians and Prescriptivists assert that a physical law has *logical* priority over an event that it governs, they do not mean (although it is true) that the law was true ‘before’ the event occurred; rather, what they are saying is that it was not the event – and others like it – that account for the truth of the law, but it is the other way around: It is because the law is true that the event (given certain antecedent conditions) occurs. The Regularist totally rejects *this* notion of logical priority.

On several critical points, the Autonomy and Regularity theories are in total agreement: (1) By hypothesis, I will choose *B*, that merged-gender mortality tables be used; (2) my choice is completely ‘determined’, that is to say, the sequence of my actions falls under, is subsumed by, one or more physical laws; and (3) those physical laws are timelessly true. The difference lies in our accounts of the nature of logical priority. Regularists insist that logical priority is just the semantic ‘truth-making’ relation: Events occur (and states obtain), and it is because these events occur (and states obtain) that certain singular and universal propositions are true. Propositions ‘take,’ as it were, their truth from what happens. Autonomists, that is, Necessitarians and Prescriptivists, have a quite different concept of logical priority. According to the common element of their theories, physical laws are true ‘logically prior’ to events; indeed, among the class of universal truths whose subjects are never, ever instanced (realized or actualized), some are true and others false. And it is because of the truth of certain of these universal propositions that the world is the way it is. According to Autonomy Theory, physical laws are true, and events – how shall we put this? – ‘conform to,’ ‘comply with,’ ‘are governed by’ these laws.

Terms such as “conformity,” “compliance,” and “governance” are anthropomorphic. Can the Autonomy Theory be couched in more neutral terms? Might it be described, less tendentiously perhaps, as the theory that events ‘accord with’ physical laws? I can imagine an Autonomist saying: “It is not that one’s behavior must *comply* with the relevant covering laws **L**; it is just that, inasmuch as **L** are the relevant covering laws, then one *will* behave in such and such a fashion.” But this defense strikes me as being founded on an equivocation on the word “will.”

“One will behave in such and such a fashion” may be used to make a prediction or to issue a command (or both). But if it is not the imperative mood that is being invoked by the Autonomist in her saying “If **L** are the relevant covering laws, then one will behave in such and such a fashion,” then nothing whatever by way of explaining the mysterious relationship between a law’s being true and an event’s occurring has been offered. If “will behave” is meant *purely* as a prediction, then the Autonomist has failed utterly to explain *why* behavior ‘accords with’ physical laws.

What lies behind the attractiveness of the view that physical laws are, if not quite logically necessary, then nomologically so, is a venerable view about the nature of logical necessity itself. For centuries, philosophers have conceived of logical necessity as imposing constraints on the world. The world *had to be* such that two plus two equals four; that God *could not but* make moving planets travel in elliptical paths or in some other way; that it *had to be the case* that if Aristotle was a philosopher and Aristotle was a Greek, then someone was both a Greek and a philosopher. The world, it seemed, could not but ‘comply’ with *these* kinds of laws.

But even here, in talking of logical necessity, conceiving of the operative relation between a law and events as that of the latter *complying* with (the dictates of?) the former, and the former as ‘imposing constraints on’ (or coercing) events, states-of-affairs, etc., is a mistake. At the very least, it is no longer the only way of viewing the relationship.

With the availability of possible world semantics, one is no longer confined to an idiom in which logical necessity is made to appear as coercion. Logical necessity may now instead be regarded as universality of truth among possible worlds. “The number of sides of a square *has* to (i.e., must) equal the number of interior angles” becomes, without a trace of residual or implied coercion: “In all possible worlds, the number of sides of a square *is* equal to the number of interior angles.”

What sanctions, if not indeed prompts, thinking of physical laws as necessary, as having autonomous truth-conditions, is the picture that also portrays logical truths as having autonomous truth-conditions, as being logically prior to events and states-of-affairs, and as setting constraints on what occurs in the world. But logical truths do not have these latter properties. Logical truths, like any others, that is, contingent truths, *take* their truth from the way the world is; they do not, as it were, *impose* their truth on the world. (See Bradley and Swartz 1979, pp. 58-62.) Consider the contingent proposition that hydrogen is more plentiful than helium. In some possible worlds, this proposition is true; in others, it is false. In every possible world, however, the truth-value of this contingent proposition is 'determined' by the way that world is; that is, those worlds in which hydrogen happens to be more plentiful than helium are worlds in which this contingent proposition is true; in all other possible worlds, this proposition is false. But now consider the results of disjoining first the one and then the other of the following two propositions to the proposition that hydrogen is more plentiful than helium.

P_i Some persons are allergic to bee stings.

P_{ii} It is not the case that hydrogen is more plentiful than helium.

The first of the two constructed disjunctive propositions, namely,

P_{iii} Hydrogen is more plentiful than helium, or some persons are allergic to bee stings

will be true in all those worlds in which hydrogen is more plentiful than helium. P_{iii} will also be true in all those possible worlds in which some persons are allergic to bee stings. Together, these two sets of possible worlds do not exhaust the entire set of possible worlds, and hence the first, P_{iii}, of these two disjunctive propositions is contingent. Now the important point is that the identical account can be given of the nature of the relationship between the truth of the second of these two disjunctions,

P_{iv} Hydrogen is more plentiful than helium, or it is not the case that hydrogen is more plentiful than helium

and the 'facts' that make it true. P_{iv} will be true in all those possible worlds in which hydrogen is more plentiful than helium, and it will also be true in all those worlds in which hydrogen is not more plentiful than helium. Unlike the preceding case, these two sets of possible worlds do exhaust the entire set of possible worlds, and hence P_{iv} is necessarily true. But the essential point is that the truth of P_{iv} 'comes about' in identically the same way as the truth of the preceding contingent proposition P_{iii}, that is, by fitting the facts. The 'direction' of logical priority does not mysteriously 'reverse itself' for the necessary truth P_{iv}. The semantic truth-making relationship still runs *from* the world *to* the proposition. The necessary truth, $P_{iv,}$ doesn't 'force,' 'coerce,' or 'constrain' the world; no more so than does the truth of the contingent disjunction, P_{iii}. The only semantic difference, then, between a contingent truth and a logically necessary truth is that the latter is true in *more* possible worlds than the former. No difference in logical priority need be posited. But if logical necessity need not be conceived to 'dictate' the form of the world, then still less should nomological necessity be conceived to have such occult powers.

The theory that physical laws take their truth from what happens rather than that events 'comply with' physical laws is often dismissed in deference to the view that one must attribute to physical laws some kind of nonlogical necessity to solve the problems of, for example, counterfactuals, vacuously true conditionals, etc. If each of these requirements can be met within the Regularity Theory, and if abandoning the Autonomy Theory solves the free-will problem, then I think one has powerful reasons for switching theories.

Neither theory – neither Regularity nor Autonomy (the latter nowadays nearly universally advanced in Necessitarian raiment rather than in its older guise within Prescriptivism) – is clearly superior on all counts. The Autonomy Theory seems to match more closely ordinary notions of physical possibility. But even on that score, it has stubborn problems epistemologically: No one has ever succeeded in adducing a satisfactory empirical test for nomicity, and indeed there seems to be excellent reason to suppose that it is impossible in principle. But the more serious defect of the Autonomy Theory is its consequence that freedom of choice is an illusion. In this latter regard, in being perfectly compatible with there being human freedom, the Regularity Theory is clearly superior.

Somewhere back a few hundred years ago, you got a crucial piece of theory upside down. You have postulated the wrong order of logical priority between events and physical laws. There are not two different orders, one between ordinary, run-of-the-mill propositions and events, and another between physical laws (and logical truths) and events. What makes the proposition that I am wearing a blue shirt true is my wearing a blue shirt. What makes the physical law (under which my choice is subsumed) true is that I choose *B*. I am wearing a blue shirt, not because the proposition that I am wearing a blue shirt is true, but because I considered, and acted upon, the facts that the shirt was clean, readily available this morning, and matches my blue trousers. Similarly, I choose *B*, not because it is true that whenever *A*, then *B*. I choose *B* because I have been requested to look into the matter of mortality tables, because I have thought about the two alternatives, and finally because *B* seems to me to be the better choice. Logical priority runs in one direction only: 'From' events (and states-of-affairs), 'to' propositions (whether they be singular or general, contingent or noncontingent). Logical priority does not mysteriously and unaccountably reverse direction – as the Autonomy Theory would have it – in the case of physical laws.

It is not too late to 'put the theory of physical laws right, but you will have to make some profound adjustments at its foundations. I commend that rethinking to you.

11

Predictability and uniformity

This chapter expands on the issues raised in the previous chapter, and it tries to meet some objections that may be brought against the theses introduced there.

In the days and weeks following his first seminar (see Chapter 10), several of the Martian's audience dropped by his office to discuss some of the points he had made. Usually these exchanges were pleasant affairs, although a few of them did degenerate into heated arguments. In any case, it was obvious that interest continued – perhaps even increased somewhat – and someone asked the Martian to give some further seminars. This time he was not nearly so reluctant, even relishing the prospect a bit. And so, a little more than one month later, he stood before his colleagues again.

THE MARTIAN'S SUBSEQUENT SEMINARS

Several of you have talked with me about the theory I was trying to advance in my seminar six weeks ago. During these conversations, I jotted down some notes, and, in reviewing them for these additional seminars, it seemed to me that your worries and interests fall principally into two areas. Let me mention them at the outset, and then I will attempt to deal with them, one today, the other tomorrow.

The first area over which many of you expressed concern involves predictability. Several of you, certainly correctly, point out that much of what we choose to do is perfectly predictable, more specifically, capable of forecast on the basis of physical laws (or scientific law – the distinction is unimportant for this particular case), and you take this to show that physical laws can themselves be known temporally prior to their instances. But if this is so, then there are good grounds for arguing that the truth-conditions of physical laws cannot (solely) reside in the events they subsume. In short, you allege that the empirical evidence of predictability confirms the Autonomy, rather than the Regularity, theory of physical laws. I will devote today's seminar to rebutting this argument.

The second point some of you urged on me was that the Principle of Determinism entails the Principle of the Uniformity of Nature, and that the latter – clearly – is inconsistent with our having done otherwise than we did. I will try to argue tomorrow that freedom to choose is not precluded by there being uniformities in Nature.

SEMINAR OF APRIL 12: PREDICTABILITY

My argument of last time was premised on the claim that the physical laws of human (and Martian) behavior take their truth from what we have done, are doing, and will do, rather than it being the other way around, that is, that we have done as we have, are doing as we do, and will do as we will do because the laws are what they are. Many of you have expressed your disagreement with this point of view, arguing that our behavior is in principle predictable and that this is so attests to the direction of logical priority[1] as running 'from' laws 'to' events:

> You do not really choose at all. Still less does your choice determine the physical laws of the world. Your so-called choice is an action wholly determined by certain antecedent conditions (your genetic makeup, the energy transmissions your body has received over the course of your lifetime, etc.) and the physical laws of this world. If we knew everything there was to know about you, the information you have received and assimilated, the minutest details of your physiology, etc., and if we knew a sufficiency of physical laws, then your behavior, your so-called choice – however opaque your motives may seem to us in our present state of ignorance – would be perfectly predictable, in theory at least, if not in actual practice.

To begin, there is a certain ambiguity here in the word "predictable." If "predictable" is taken to mean "deducible," then my action – let's leave aside for a moment the question of whether that action might appropriately be deemed a choice – *is* predictable. After all, any event, E'-at-t_n,

[1] [See "Epilog to the Martian's first seminar" in Chapter 10. –N.S.]

can be predicted (i.e., deduced) from two propositions of the form, "Whenever *E*-at-t_x, then *E'*-at-t_{x+1}" (a physical law), and "*E*-at-t_{n-1}" (a statement of antecedent conditions). One can deny that events are predictable in this *logical* sense only at the unacceptable expense of denying the validity of *modus ponens*.

But this logical version of the claim about predictability is neutral on the question as to the order of logical priority. It is only on the temporal reading of "predictable," the Laplacean epistemic version, that the claim may be brought to bear on the matter at hand. In this interpretation, "predictable" is taken to refer, as it more commonly does, to being able to say before an event occurs that it is going to occur.

What conditions must be satisfied for someone to make a successful prediction? A prediction of a future event will be deemed successful if and only if it is *true*. Thus a prediction will be deemed successful if it is true but irrational; if it is true but only a guess; if it is true and made contrary to the best evidence; if it is true but the result of a toss of dice.

We are not interested in predictions per se; our interest is directed to predictions that come about through the exercise of rationality, that is, to what may be called rational forecasts. All other foretellings will be disregarded. We exclude, too, whatever cases there may be of precognition and backward causation. Eventually, if their credentials can be established, we may wish to include these among cases of forecasts. I exclude them, not through any doctrinaire belief that they do not exist, but solely because they are, as yet, unproven to exist. And certainly, we will ignore prophecy.

What conditions must be satisfied for a successful rational forecast? Obviously, the prediction must be true. But more is needed. The prediction must issue from a rational inference either from known physical (or scientific[2]) laws and initial conditions or from 'subliminal knowledge' and observations. Admittedly, the latter characterization is vague. But it will do for our purposes. At any rate, I think it will be clear enough what I mean if I give an example. An experienced physician may be able to predict whether a patient will survive a medical crisis. Yet she does not do so by invoking any physical law or by painstakingly articulating the patient's present condition. She does so by reacting to subtle clues in the patient's appearance and

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2 As I mentioned in the introduction to today's seminar, the distinction between physical laws and scientific laws is unimportant for present purposes. I will speak just of physical laws for the remainder of today's seminar.

behavior and by having, although not necessarily being able to recount, an extensive firsthand knowledge of previous similar, relevant cases. Forecasts, then, may range from highly formalized arguments rehearsed internally (or even on paper, as in the case of weather forecasts), to the seemingly ‘intuitive’ (but misnamed) reactions of knowledgeable practitioners and experts. In any case, there are two components (besides truth) of a successful rational forecast: The forecast must ‘invoke’ universal propositions, and the forecast must call upon certain specifics of the matter at issue.

What follows from our ability to make rational forecasts? Does our ability to know of certain events, before they occur, that they will occur, imply that the universal propositions under which they fall have autonomous truth-conditions, that logical priority runs from physical laws to the events they subsume?

I want to argue that the Laplacean paradigm[3] that claims that all events are in principle rationally forecastable is false. It is false if for no other reason than that not all of our behavior is forecastable, not even ‘in principle.’ And because it is false, it provides no selective confirmation of the Autonomy Theory.

There are two reasons why our behavior is not totally forecastable. One has to do with quantum indeterminacy; the other has to do with there being future events that are the first instances of their covering laws. I mention the first of these only to put it at arm’s length.

Events at the micro or atomic level sometimes do have causal results at the macro or phenomenological level. Witness Schrodinger’s cat (1983, p. 157) or the use of a Geiger counter to guide one’s looking for minerals hidden from sight beneath the ground. In these instances, the question of whether or not a certain large-scale, publicly observable event will occur depends, in turn, critically on whether or not some microevent triggers it. But if these latter microevents are genuinely unpredictable in the way in which current-day quantum mechanics suggests, then so too will be their macroscopic effects.

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[3] "We ought to regard the present state of the universe as the effect of its anterior state and as the cause of the one which is to follow. Given for one instant an intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it – an intelligence sufficiently vast to submit these data to analysis – it would embrace in the same formula the movements of the greatest bodies of the universe and those of the lightest atom; for it, nothing would be uncertain and the future, as the past, would be present to its eyes.” (Laplace 1951, p. 4)

For present purposes, this complication is a distraction and should be ignored.[4] There are two reasons why this is so. For one, the fact of the matter is that the overwhelmingly greater part of our behavior is not infected by quantum indeterminacy. For example, a week ago the manager of my apartment building promised to repair the garage door when he returned from a trip on which he was then just about to embark. Yesterday he returned and fixed the door. The causal chain, which he had set in motion seven days earlier, lasted throughout the ensuing several days, and it would appear from the evidence that it was totally unaffected by the intrusion of quantum effects. Such sequences are common and familiar. Or consider how marvelously reliable and predictable are our computers. The probability of untoward behavior at the macro level (arising out of quantum disturbances at the micro level of their innards) has for all practical purposes been rendered zero by the sheer number of molecules making up their parts. Because of the nature of our own visual acuity, we tend to forget how truly massive, on an atomic scale, are many of the things that we cannot see with the naked eye and can observe only with optical or electron microscopes. A single nucleus of human brain cells may contain upward of 10^{12} atoms; or a transistor, invisible to unaided vision, residing on a computer microchip, may contain as many as 10^9 atoms. Granted, quantum events sometimes do make their indeterminacy felt at the macro level; but rarely in our central nervous systems or in our computers.

But even more important than the factual matter of the relative infrequency of the latter phenomenon is its logical irrelevance to our discussion. I want to argue against the Laplacean paradigm, but not because it makes the false assumption, which it does, that all physical laws are universal rather than statistical. I want to show that the Laplacean paradigm would still merit being discarded *even if there were no quantum indeterminacy whatever*.

For us to *know* beforehand, on the basis of a rational inference from a physical law, of any event whatever that it was going to occur, two conditions would have to be satisfied: (1) There would have to be a finite (and manageable) set of physical laws; and (2) each of these laws would have had to have already been instanced (so as to have been confirmed). Neither of these

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4 [Stochastic processes and statistical laws form the subject matter of the next chapter. –N.S.]

conditions can be met. The number of physical laws is indefinitely large; and, daily, physical laws that have had no previous instance are instanced for the first time.

The completion of science has been a dream since the dawn of the age of Rationalism. It is a theme that ran through the seventeenth and eighteenth centuries. It motivated the editors and contributors to the *Encyclopedia of Unified Science* in the mid-twentieth century. And it reappears more strongly than ever as the driving force behind the search for a single theory to unify all the forces uncovered by physics. Nigel Calder, in chronicling the advances in physics in the twentieth century, titled his book *The Key to the Universe*. On its first page, he has written: "The key to the universe might be a *brief* set of equations or diagrams that encompassed all the large-scale and small-scale workings of the cosmos and showed their logical connections with the character of space and time" (1979, p. 7; emphasis added).[5] And a few pages later: "Physics was always the master-science. The behavior of matter and energy, which was its theme, underlay all action in the world. In time astronomy, chemistry, geology and even biology became extensions of physics" (p. 14). The popular press, too, reinforces the belief in the deductive unity of science with their regular 'news' that a 'breakthrough' is imminent in physics that will complete Science. And physicists, like medical doctors, are often heard to remark that theirs is a profession dedicated to making themselves unnecessary: that the problems they address admit of eventual solution; indeed, that that solution is so close of late as to be virtually palpable.

This Laplacean idea that science is completable is a mistake. Inasmuch as some future human (and Martian) behavior will be the first instance of its kind or, to be more specific, the first instance of its covering physical laws, then those covering laws could not, could not even in principle, now be confirmed. Hence they could not now be known, prior to the occurrence of these future events.

No one can deny that much of our behavior *is* capable of being forecast, particularly our 'routine' behavior. That which we do regularly lends itself especially well to being forecast. Anyone who knows me knows that I regularly have a cup of coffee at mid-morning. You reliably forecast that I will tomorrow. Yet that I will hardly threatens my freedom to desist if I should

[5] [Recall the quotations from Carnap and Schlegel cited in Chapter 1, footnote 9. –N.S.]

want to. If I wanted to frustrate your prediction, I could; but I do not; indeed, I want that it be true. So you predict that tomorrow I will freely choose to drink a cup of coffee, and tomorrow I freely choose to drink the coffee.

That some event lends itself to being forecast and also is an instance of someone's exercise of her freedom is perfectly consistent. But this does not mean that *every* exercise of one's freedom is in principle capable of being forecast.

There are (at least[6]) two kinds of case of free action that are incapable of being forecast. Michael Scriven (1965) has written about one of them in detail, namely, the case of the contrapredictive, the person who sets out to frustrate the forecasts made about his behavior (my example: Eisenhower planning the invasion of Normandy). I will not pursue this case.

The other kind of case is the one mentioned in the first seminar, namely, the case of a person's being in a unique situation, for example, being the one and only person ever to choose which mortality table (merged-gender or sex-distinct) society is to adopt henceforth.

Of course every situation is, if given a complete enough description, novel; likewise, every situation is, if given a lean enough description, routine. When we come to make forecasts, we can never give 'complete' descriptions unless we describe the entire universe at that moment. Realistically and practically, we make do with 'partial' descriptions, and for many (most) forecasts these partial descriptions suffice. For example, the light switch's being flicked up is followed by the chandelier's lighting. And it matters not one whit whether the lever on the light switch is white, brown, red, or blue. Something less, indeed something *very much* less, than a complete description suffices for a successful forecast in this case.

But electrical circuits consisting of a source of electromotive potential, a light switch, and a chandelier are not entities endowed with free will. Forecasts about entities endowed with free will are more risky, not just because the number of variables and physical laws are greater, but also because some of the laws under which the behavior of the entity may be subsumed are a matter of that entity's choosing.[7]

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6 There may well be more. No other obvious cases spring to mind, however.

7 Typically, our formally crafted forecasts utilize several laws. It will simplify matters, however, if we conceive of forecasts as issuing from a single law. There is no harm in making this simplifying assumption, for any set **S** of universal propositions that, in conjunction with a set of statements of antecedent conditions, logically implies a forecast *F*, will also logically imply the existence of a single universal proposition L_i that together with the set of antecedent conditions similarly implies *F*.

Suppose that up to today I have always bought brown shoes instead of shoes of any other color. If I continue to buy brown shoes for the rest of my life, then the following proposition is a physical law: "Whenever a person having the properties ... (here one gives a unique description of me in purely descriptive terms) ... buys shoes, he buys brown shoes." Further, suppose tomorrow I need a new pair of shoes and go to a local shoe store to purchase a pair. At that moment, it is up to me to choose (although this probably will not be the intent of my choosing) how novel – as regards forecasting my choice – that situation is to be. If I choose black shoes, that situation will be more novel than it would have been had I chosen brown; the novelty of this situation will vary according to what I in fact *do*.

We look at the past behavior of things and try to formulate, using the fewest number of predicates we can get away with, universal propositions that are found empirically to provide grounds for forecast.[8] Many times, this works admirably (e.g., the case of the chandelier, the case of my drinking coffee tomorrow morning). Other cases are riskier: You predict, on the basis of my previous exceptionless behavior in this regard, that I will buy brown shoes on the next occasion of my purchasing shoes. You may well be right. If I *do* purchase brown shoes and happen to die immediately thereafter without ever having bought another pair of shoes, the universal proposition on which you based your inference would turn out to have been a physical law. If, however, I should happen to frustrate your forecast (either deliberately or unknowingly) by purchasing black shoes, that same universal proposition would turn out not to be a physical law. Either way, your forecast would have been rational. But whether you base your prediction on a physical law or on a false universal proposition lies in *my* hands. It is up to me to make that universal proposition in your inference a physical law or no law at all.

Forecasting what color shoes I will next purchase can call, at least, on some previous behavior of mine (and of some other persons as well) regarding shoe purchases. But my choosing for society between two kinds of mortality tables is without any precedent at all. Short of describing it as "a case of choosing mortality tables for society" (which description has no prior

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8 I am not suggesting that our laws are Baconian generalizations from experience, although of course some few do originate in that way. My point is one about justifying universal propositions, however we may come to entertain them in the first instance.

instance whatever), there does not seem to be any broader (less specific) description that carries with it much, if any, clue as to what I will do. Obviously, we can describe it as "a choice," or even as a "monumental choice," or as a "choice in which principles of fairness are seen to be at play," etc. But none of these plausibly provides any clue as to what I am going to decide. Suppose that once before in my life I was called upon to make a monumental decision. Suppose I was asked to choose what the punishment was to be for someone's killing all the surviving members of an endangered species. Thus there would be a physical law to the effect: "Whenever ... (uniquely individuating description of me) ... is faced with a monumental decision, *JKL*, he chooses *PQR*." If we narrow the description *JKL* so that it applies just to the case of my choosing the fit punishment in the ecological case, then we can give a fairly specific, narrow interpretation to *PQR*: namely, "that the culprit should be strung up by his/her thumbs in a public square." But if we use these interpretations of *JKL* and *PQR* respectively, then the physical law just simply does not apply to the case of my choosing which mortality table is to be used. But if, on the other hand, we broaden *JKL* so as to be general enough to include both my monumental decisions, that is, the one about the earlier ecology case and the one about the upcoming insurance case, then we are at a dead loss as to what to make of *PQR*, for we have no independent way of knowing what my second monumental decision is going to be.

We can imagine the following kind of objection.

> But couldn't one give the event you are trying to predict a broader description such that that less specific description *does* have prior instances, and thus one would have inductive warrant for the appropriate conditional statement?

The answer: No. And the reason is that the description, "chooses *B*" (i.e., "chooses that merged-gender mortality tables be used"), already is the minimum useful description. We have already 'peeled off' all the other aspects of my upcoming decision that are of no particular interest: for example, whether, when I announce that decision, I am wearing a brown suit or a blue one; whether I speak in a firm, commanding voice or a shaky, nervous one; whether I glance at my friend in the press corps or avoid her eyes; etc. In short, there just is *no* broader description of what you are trying specifically to predict. And although there are, of course, less specific descriptions that will *fit* my action, for example, "will announce his choice," these descriptions are too broad for your purposes. You are not content to predict simply that I will choose *something* or even that I will choose between two specific alternatives. You want to know specifically what that choice will be; and that is just what it is that is without prior instance.

My point about forecasting events is really quite simple: Our ability to forecast depends on there having been prior positive instances of the relevant covering law.

Most of the physical laws that are conveniently lumped together as belonging to the domain of physics have already been instanced. Thus, without there ever having been a silvery blue meteor striking Earth, we can rationally forecast the impact of one when we see a silvery blue meteor through our telescopes and plot its path as being on a collision course with Earth. In this case, the relevant laws of orbital motion are known to us, and experience has taught us that the motions of celestial wanderers are independent of their colors.

Then, too, much of our routine behavior lends itself to rational forecast. That is why we call it “routine.” There is an analytic connection between “being routine” and “being forecastable."

But these two bodies of forecastable events should not lead us to believe that all events are in principle capable of being rationally forecast. Acts of choosing – my habitual coffee drinking notwithstanding – provide countless examples of events incapable of being rationally forecast.

I am not here invoking the fallibility of inductive inference; although that is of course true, it is not my point. Rather, I am suggesting that there is nothing known prior to my choosing that merged-gender mortality tables are to be used that provides any grounds at all for rationally predicting that that will be my choice. After the fact, any number of universally true propositions describing my choice will be knowable. But none before. I am thus hardly making a skeptical point about the possibility of knowing something before it happens. On the contrary, I have already allowed that all sorts of events are knowable in advance of their occurring, even though our belief that they will occur follows in part from universal propositions not all of whose instances have occurred, that is, from universal propositions at least one of whose instances is the forecast event itself. Indeed, it should be clear that one can know some future contingents even when those propositions are not epistemically certain; even when it is logically possible that they should be false; even when it is logically possible that the universal proposition(s) figuring in their forecast ‘may be false’; etc.

Those of you who subscribe to the Laplacean paradigm may remain unconvinced. You may try to argue this way:

> The predictor wants to be able rationally to infer from knowable data the proposition "Arbiter *a* will choose merged-gender mortality tables." Why should he be unable to do this? What makes this case so different from other cases of forecast? Although the predicate "chooses for society merged-gender mortality tables" is without previous instance, the two predicates of which this is compounded, namely, "chooses for society" and "chooses merged-gender mortality tables," have each, after all, independently applied to former cases of choosing. Legislators, jurists, arbitrators, et al., have often made choices for society. And managers of various insurance companies and pension plans have chosen that their firms and plans would use merged-gender, rather than (as do other firms and plans), sex-distinct tables. Is it really impossible to find in the histories of these respective classes of decisions a pattern of behavior that would allow one rationally to predict what will be the arbiter's decision in his choosing which of the two will henceforth become the single, mandated standard?

I think it is impossible to *find* the pattern. The trouble is that there are too many data available for too few cases. Suppose there have been six occasions when the managers of insurance companies have chosen that their firms would use the merged-gender tables, and an equal number of occasions when managers of other firms have chosen the sex-distinct tables. (The exact number is of no especial moment; neither is the fact that there are equal numbers on both sides. I choose the number six only because it is convenient.) What universal propositions are we in a position to confirm? Simply, a very great number. Given the extraordinary complexity of managerial decisions of this sort – the number of factors considered by the choosers, their physiologies, their temperaments, their manners of consulting one another, their biases, their histories, their information, their ... (continue ad libitum) – there will be an indefinitely large number of confirmable universal, conditional propositions, all of which have as their consequents "chooses merged-gender mortality tables" but will differ in their antecedents. Some of these will have relatively short antecedents, that is, will be relatively broad, and others will have lengthy antecedents, that is, will be relatively specific. At the very least, one (provided determinism is true), and far more likely, a very great number, will apply to the case of my upcoming decision, and were they to be identifiable as *true* could be used successfully to predict what I will choose. But can these true propositions be identified among the myriads that, although consistent with present data, will be proved false by future events? Consistency with present data is not the same as pervasiveness, and it is evidence of pervasiveness that is needed for a rational forecast.

Suppose the six managers who chose the merged-gender tables were all college educated and more than fifty years of age; and suppose the six who chose the sex-distinct tables were all owners of sports cars and members of tennis teams. Now I happen to be less than fifty and own a sports car and am a member of a tennis team. Shall we predict that I will choose the sex-distinct tables? Before we do, we should note that the six managers who chose the merged-gender tables all are classical music devotees, whereas the six who chose the sex-distinct tables are jazz aficionados. I prefer classical music. Shall we then predict that I will choose the merged-gender tables? The universal generalizations that are compatible with our data pull us in opposite directions. We cannot rationally choose between these competing generalizations. We know that once I have made my choice some of these generalizations that are consistent with present data will not be consistent with the enlarged set of data that includes the statement as to what I choose. That is to say, some of these competing generalizations that are consistent with present data are not timelessly true; future events render them false. But, from where we stand, here and now, prior to those events, we cannot tell which of these competing hypotheses, leading to contrary predictions, are timelessly true and which are timelessly false.

It always has been thus. Francis Bacon argued that perhaps God could discern the truth from a collection of positive instances, but mortals need the winnowing device of counterexamples. As the number of variables, or factors, or predicates needed for successful prediction increase, then so too must the number of cases so that we should reasonably be able to select among competing generalizations. We already know enough about this world to know that we cannot predict human behavior on the basis of a few factors, for example, on place of birth, color of hair, weight, blood type, number of books read, etc. Human (and Martian) behavior is just too complex. Predicting it requires considering a great number of factors. But as the number of factors increase, the number of their instances decrease, often so much so that it is impossible to get a fix on which of the competing generalizations is true. Surely there must be such cases. Whether or not my example of choosing mortality tables finally is such a case is less important than that there be *some* such cases. And it is reasonable to believe that there are. There seem to be so many factors to be considered in predicting human behavior that to believe that every kind of behavior has already been instanced flies in the face of the empirical facts.

There is a final point to consider. It may occur to someone that the argument about the unpredictability of my choice may rest upon trying to predict what I will *say*, and predicting verbal behavior is notoriously difficult. One may be inclined to argue this way:

> Suppose the legislature that entrusted you with the decision furnished you with two postcards, already addressed and filled out, one for each of the two possible decisions. Your decision, as to which of the two mortality tables society is to use will be made by your picking up the one postcard on the left or the other on the right. Your action will be constituted by the physical motion of your moving your arm to the left or to the right. And surely *that* is predictable. If one describes what you are doing as 'choosing' or as a conscious action, then under that description the event may well be unpredictable; but inasmuch as what you do is also a physical movement, it must then be predictable just as are other physical movements, for example, the operation of a pop-up toaster or the turning on of a clock radio.

A retreat to mechanism or physicalism will not help. It just begs the question. For clearly I will want to argue that the movement of my arm to the left or to the right is forecastable only through the use of a universal generalization whose antecedent is a complex clause, so complex in fact as to render that generalization, like the previous ones pertaining to human action, also without inductive support. My argument for unpredictability turns on the complexity of this world and, as a consequence, on there being competing generalizations which, although consistent with available data, are inconsistent with future data. My argument does not turn on any postulated or supposed metaphysical difference whatever between conscious and unconscious behavior, nor on any difference between human (or Martian) *action* on the one hand and mechanical or physical or autonomic behavior on the other.

If all events were in principle forecastable, then one would have powerful grounds for believing that physical laws bear their truth-values autonomously. But the belief in universal forecastability is not warranted by empirical data; and if it is fostered by the Autonomy Theory itself, it can not then be used in turn to bolster that theory.

Available contemporary empirical data is a two-edged sword in this debate. Physics and chemistry have had stunning successes in predicting behavior for certain kinds of events. And generalizing from this success in the natural sciences, many persons have come to think that universal forecastability applies, in principle, within behavioral science as well, and to the case of human behavior in particular. Failures in predicting human behavior are – according to persons attracted to the Laplacean paradigm – to be explained away by our lack of imagination in creating new hypotheses, to inattentiveness to details, to failures of perception, to errors of inference, etc.; in short, in one way or another to our not selectively confirming our hypotheses by finding what is there to be found.

But the failure to predict human behavior need not be looked upon as evidence of our shortcomings in doing empirical research. For it could be that the fault lies not in us, but in Nature: that there is nothing there to be known prior to the occurrence of the event we would like to predict. As one's science passes up the ladder of evolution – looking first at atoms, then at molecules, at proteins, at protozoa, at ... (eventually) human beings (and Martians) – the laws under which behavior is subsumed become more and more complex and more and more numerous. And, thus, surely it is reasonable to assume that many of these timelessly true laws covering the latter products of evolution have no instances as yet, that their first instances will occur a minute, an hour, a year, or a millennium from now.

In summary, I am under no illusions that I have disproved Laplaceanism. I do not think it can be disproved. Or, to be more exact, those persons who do not share certain other of my beliefs are bound to regard my objections to Laplaceanism as question begging. These background beliefs are, however, very much in contention, most principally the claim that we are sometimes free to choose among genuinely alternative courses of action.

What I am doing is not so much trying to disprove Laplaceanism as to provide a viable alternative to it. Determinism – the theory that every event is a second member of a sequence that falls under a physical law – is, so far as we can tell, a reasonable hypothesis to have about this world, at least at the macroscopic level of description. But Determinism, thus explicated, is compatible with two theories: the Autonomy Theory, which gives logical priority to physical laws and sees events unfolding so as to accord with these laws; and the Regularity Theory, which assigns logical priority to events and sees physical laws as taking their truth-values from whatever happens in the world.

The Autonomy Theory is a virtual consequence of Laplaceanism. If one believes that in principle the future course of the world (again disregarding quantum effects) is forecastable, then one must believe that there really is a finite, manageable set of physical laws that when taken in conjunction with a statement describing the physical universe at any one moment of time (or on two successive moments[9]) does imply the entire future course of the universe. But even if we disregard quantum indeterminacy, there is no good reason to think that this universe is at all like this.

Unlimited forecastability of the Laplacean sort can occur only if what happens in the future is not truly 'open' as to possibilities. If everything that happens must accord with physical laws, then the fewer the number of physical laws, the fewer the possibilities open to us. For our choices to be genuine – not idle shams of 'going through the motions' and then finally opting for what was inevitable in any case – there must be many possibilities open to us, and this in turn is possible only if there are many physical laws. Freedom of action is compatible with Determinism; but it is not compatible with Laplaceanism because Laplaceanism is premised on the belief that there is a finite, manageable number of knowable physical laws. If we are free on occasion to choose among genuinely alternative courses of action, and if Determinism is true, then (1) there is no fixed upper bound on the number of physical laws, and (2) the number of instanced physical laws, and hence knowable physical laws, will steadily increase with time. If Determinism is true, and if we are free, then Laplaceanism, that is, forecastability in principle, is false.

SEMINAR OF APRIL 13: UNIFORMITY

At the time it was first mentioned,[10] I said that perhaps the most paradoxical-sounding corollary of the Regularity Theory is this:

> If a person is in a unique situation and chooses *B*, then his choosing something else that is logically inconsistent with *B*, for example, *C*, is physically impossible; nonetheless, his choosing *C* may well have been unconditionally possible.

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9 The qualification about two successive time-slices is required because of the existence of laws whose antecedents refer to the histories of situations rather than to momentary states, e.g., Steinmetz's Law of Hysteresis. (See Huntington and MacCrone 1983.)

10 [See "The Martian's first seminar" on page 127. –N.S.]

The way I suggested to remove the seeming air of contradiction is to remember "that according to the Regularity account, 'physically impossible' means nothing more or less than that such an event (e.g., choosing *C*) never, ever occurs. But ex hypothesi, this is true; for remember as well that we have ... stipulated that the situation in which the chooser opts for *B* is *unique*. It is logically impossible that he should choose both *B* and *C*; so whatever he chooses, the other would thereby become physically impossible. Still, he could choose – unconditionally – the physically impossible action if he wanted to. It is his choosing one of the two alternatives that makes the other one physically impossible. But he could choose either."

Now in our subsequent private discussions, some of you have returned to this issue and have argued that one's choosing *C* is not possible, that if a choice is genuinely determined then no other choice can occur, and that this is guaranteed by the Principle of the Uniformity of Nature. You have argued that if and only if Determinism holds, then the Principle of the Uniformity of Nature holds; they are one and the same principle.

Laplace had stated the Principle of the Uniformity of Nature in this way (although he did not give it any name whatever):

> If the present state of the universe was exactly similar to the anterior state which has produced it, it would give birth in its turn to a similar state; the succession of these states would then be eternal. (1951, p. 171)

And Mill expressed it this way:

> There are such things in Nature as parallel cases, that which happens once, will, under a sufficient degree of similarity of circumstances, happen again. (1965, p. 201)

There is one interpretation of this latter dictum that is relatively harmless. It is the one that would make of it a methodological principle counseling that one never abandon the search for similarities, in effect a truism invulnerable to refutation:

> If seemingly 'similar' events fail to have identical outcomes, then the similarity was not in fact extensive enough; there was some relevant difference that we have overlooked, and further empirical investigation will reveal it.

It is, however, another interpretation of these dicta that occasions the present inquiry.

Clearly, what is common in both Laplace's and Mill's versions of the Principle of Uniformity is the notion: "Same history, same future." It is implicit in Mill's version and explicit in Laplace's that, were the world to be 'backed up', it would have to have the same future as the one it in fact has had, that there was but one possible future for the world, given its initial state. Applying this notion to the present case, one might argue:

> Whatever led up to one's choosing *B* could not have been followed by *C*. Were the world to be brought back to its state just prior to one's choosing *B*, one would choose *B* again (and again, and again, for however many times the world were to be backed up). In this world, the state prior to *B* could only be followed by *B*, never by *C*.

We cannot, of course, conduct the experiment. We can't back up or reverse this world and approach a decision point for a second time to see whether the same outcome will occur the second time through. The best we can do is to postulate another possible world identical in its history to this world up to some time *t* and ask whether the Principle of Determinism really requires that that world have the same future, subsequent to *t*, that the actual world has. I claim that the Principle of Determinism requires no such conclusion.

The maximal amount of similarity possible, for the case under consideration, is another world, W', identical in its history to the actual world W_a up to the moment *t* but in which at *t* I choose *C*. Both are worlds in which the Principle of Determinism is true: Their respective events are members of sequences that fall under physical laws. World W', *could have been* our world, if only I had chosen *C* at *t* rather than *B*. In short, the Principle of Determinism does not entail "same history, same future," does not entail that a given history can have one and only one possible outcome. A given history cannot, of course, have more than one outcome; but which outcome it will have is not something predetermined by that history. True enough, the future of that world is logically implied by the description of its history together with that world's physical laws. But, to repeat, there is no predestination in any of this provided those laws take their truth from what has happened, is happening, and is going to happen, and not from some other source. Provided the laws are not autonomously true, that is, are not logically prior to their instances, there is no predestination: Nothing 'compels' or 'requires' events to occur. In a categorical sense, within empirically discovered limits, we are free to choose from among a set of genuinely alternative actions. How *much* we can choose, and what is outside our sphere of choosing, is something we *discover* about this world; it is a contingent matter knowable only a posteriori. But the crucial point is that there are some, at least, genuine choices open to us.

The Principle of Determinism and the Principle of the Uniformity of Nature are *different* principles; the latter is a stronger principle in that it implies the former. The Principle of Determinism does not imply the Principle of the Uniformity of Nature (no more so than that it implies forecastability in principle). (Note that the Principle of the Uniformity of Nature is often stated counterfactually. Recall, for example, Laplace's statement quoted a moment ago. The Principle of Determinism states merely that events fall under universal laws. It does not state that events can have only one possible outcome.)

A further difference between the Principle of Determinism and the Principles of Uniformity lies in the fact that *being determined* and *being uniform* are different concepts. This can be seen by noting that the two fall under quite different determinables. *Being determined* allows of only two different values: Either a situation (event, etc.) is determined, or it is not. But *being uniform* admits of degrees: One situation may be more, or less, uniform than another.

Many different analyses of "uniformity" can be given. But one is appropriate for present purposes, and it is a comparative concept; not a classificatory or a quantitative one[11]:

> A world W_1 will be said to be more uniform with respect to the occurrence of an event-kind e than another world W_2 if a set of minimum conditions sufficient in W_1 for the occurrence of an event of kind e constitutes a proper subset of a set of minimum conditions sufficient in W_2 for the occurrence of an event of kind e.

Intuitively, this means that it is easier (ontologically speaking) to bring about an event of kind e in W_1 than in W_2: Fewer conditions must be satisfied in W_1 to bring about events of kind e. But note, W_1 and W_2 may both be perfectly deterministic worlds.

Allow me a few illustrations. Consider, first, what happens when one plays a flame on the surfaces of various objects in this world. Some objects will ignite; others not. Whether they do or not depends on a variety of factors, including their chemical compositions, their abilities to conduct heat rapidly away from the point of application, etc. But in some possible worlds, fewer

11 For more on these three types of concept, see Carnap 1962, pp. xv-xix, 8-15.

conditions for igniting must be satisfied than in this world. We can imagine a world, for example, in which the thermal conductivity of the object has no role in whether or not it ignites. In that world, the ignition of objects would be more uniform than in this. Similarly, we can describe a possible world in which all metals have the same electrode potential. Such a world is more uniform, as regards electrode potential, than a universe (such as this one) in which the electrode potential varies from metal to metal. A universe in which all round things are hot and all square things are cold is more uniform, as regards the relation between shape and temperature, than a universe (such as this one) in which some but not all round things are hot and some but not all square things are cold.[12] And of course, on the other side of the coin, a universe in which the various isotopes (atomic weights 192, 194, 195, 196, and 198) of platinum (atomic number 78) are yellow, blue, green, blue, and red, respectively, is *less* uniform (as regards the color of platinum) than a universe (such as ours) in which all isotopes of platinum are silver colored.

Obviously, just about all (perhaps all) connected event-kinds in this world are both less uniform than they logically could have been and – equally – more uniform than they could have been. How *much* uniformity there is in a world,[13] and how it distributes itself over the class of connected event-kinds, will vary from possible world to possible world.

Certainly, there are uniformities in this world. But the crucial question concerns the degree of uniformity and whether the uniformity is of such a degree as to threaten free will. It is at this conceptual juncture that the question has become confounded by confusing it with the question about physical determinism.

> One of the main motives in the rebellion against determinism, not only on the part of ordinary people but also of modern philosophers who have been most vigorously opposed to the determinist position ... [is] ... the desire for freshness, novelty, genuine creation – in short, an open rather than a closed universe. ... even a good year – had we to live it over again with every detail fixed beforehand – would stifle us with boredom: our food would taste dull to our palate, our most spontaneous talk sound as uninspired as the playback of a tape-recorded conversation, and our words of love would sound hollow because we should know beforehand the precise moment of fatigue when they would expire. (Barrett 1958, p. 31)

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[12] Indeed, this case comprises a limiting case of the explication being considered, since there seems to be no connection between shape and temperature in this world.

[13] An unexplicated, intuitive concept of the ‘amount’ of uniformity is adequate for present concerns.

There is a curious inconsistency in Barrett's scenario: We are asked to imagine living a good year "over again with every detail fixed beforehand" and are told that were we to do so we would be "stifled with boredom." But unless we were stifled with boredom the first time around, we could not be stifled with boredom the second time around, not if – as he says – the second time around every detail is 'fixed' (i.e., a repeat of the first time around). For if we were not stifled the first time around, then, were we to repeat exactly *that* experience, logically we could not be stifled the next time around either. Obviously, Barrett has something much less than total or exact repetition in mind. He imagines, rather, repeating an experience but *knowing* it to be a repetition; and *that* might well be boring. I am not quite convinced, however, that it certainly will be boring. I remember hearing many years ago a performance of Bach's "Third Sonata for Unaccompanied Violin" that was utterly sublime. I would not mind in the least, indeed would welcome, a repeat of *that* experience. In any case, I think the thrust of Barrett's statement is real enough, and if it is not altogether a perfect piece of psychologizing, it is, nonetheless, probably not too far off the mark.

But what if experiences were repeated exactly, complete with all of one's feelings of anticipation, deliberation, expectancy, and concern? In such circumstances, could our actions be said to be free?

Imagine, if you will, a possible world – mercifully unlike this. one – where daily, throughout all eternity, every man at 7:32 P.M. closes his evening paper, folds it into thirds, clears his throat, and then challenges his wife (every man has exactly one wife to whom he is wedded forever) to a game of chess. Every day, he thinks carefully for a moment and then makes the same opening gambit, and his wife responds with one and only one defense, which soon changes to the offense, with her placing his king in checkmate in thirty-two moves completed at precisely 8:47 P.M. Gruesome world, isn't it? One only a Martian mathematician, those reputedly most regular of creatures, could relish.

My visceral feeling, my prephilosophical, untutored intuitions tell me that the unfortunate denizens of that repetitive world neither exercise free will nor even for that matter *have* free will, that any seeming 'deliberation' they go through prior to 'choosing' to play chess is illusory, a counterfeit of the real thing.

Can I do better than to call upon these emotional reactions, reactions that, possibly, some of you do not share? Could it be that there is really nothing more wrong with such a world than that I find the prospects of living in it odious? Is it really, as I allege, devoid of free will? Couldn't one challenge my claim by arguing:

> There might, after all, be free will in that world. Perhaps all the benighted folk in it carefully, deliberately, choose to play chess. They did not, and do not, *have* to; but they *choose* to. By the free exercise of their wills, they choose, day after day, to lead lives of a repetitive sort. They could do otherwise, if they should want to; but they do not want to.

Surely, one thing I cannot say in rebuttal is that these chess players are driven by determinism, or must act out their dreary lives in accord with powerful physical laws of their world. I do not want to give such an account for *any* possible world, it being totally antithetical to my analysis of physical law. Rather, my rebuttal must take quite another form.

Let's approach this problem in a two-step process. Let's begin, not with the more difficult problem of whether there is, or might be, free will in such a repetitive world, but with the easier problem of whether there is any *evidence* of the exercise of free will.

We can imagine our pairs of chess players having the following conversation after their matches:

He: Why did you move your Queen's Knight to QB4?

She: I anticipated that your attention was directed to your setting up the Baron Scarpia Gambit, and I figured you would not notice that I was implementing Boskovshy's Ploy. It was taking a bit of a chance I know, but I counted on your being distracted, and I chose to go ahead with it.

He: Bad luck. If I had chosen instead the Stonewall Maneuver, as I was seriously considering, you never would have been able to get the upper hand.

From Olympian heights, eavesdropping on this possible world for the first time, we would probably be inclined to take this conversation at face value and consider that it provides evidence that the speakers are creatures endowed with free will. But when we notice that they have the identical conversation on the following day, and again the day after, and still again on the fourth day, indeed on every day, their words sound empty, as they would in our watching a play being acted for the umpteenth time. The more often the speakers recite these lines, the more they come to resemble Walt Disney's automatons (trademark: "animatronics").

Introspective feelings of freedom, public avowals of freedom, and the like are all defeasible evidence of true freedom. Other kinds of evidence can prompt us to discount such prima facie evidence. Compulsions, for example, may go unrecognized by their owners; drug induced behavior, such as the startling effects (megalomania) of cortisone, may be completely unrecognized by their exhibitors; etc. And so it is with the repetitive world we are considering. The avowals of freedom on the part of its inhabitants do not ring true. Indeed, the continual repeating of their avowals eventually is construed as evidence against the very thing being claimed: "Methinks the man doth protest too much." Their claims come to take on the aspect of self-frustrating or self-refuting reports. Apart from their avowals, which we would be inclined to dismiss, nothing whatsoever suggests that anyone acts freely in that world. All the evidence of that world suggests that the persons therein do not exercise any free will.

We now come to the second stage of my rebuttal.

If we agree that there is no good evidence that the persons in the repetitive world are exercising their free will, couldn't someone nonetheless argue that they *might* be?

> Nothing that happens in the repetitive world suggests that the persons in it are exercising any freedom. But then again nothing suggests that they are not. It is possible, it is certainly consistent with the evidence, that they *are* exercising their free will.

This defense is problematic on several counts. First of all, I think that total lack of evidence *for* something (e.g., the exercise of free will) ought to be taken as evidence that that thing does not exist. But this is, admittedly, merely a methodological principle to guide our apportioning rational belief. It hardly clinches the matter metaphysically speaking. But still, it should put us on our guard, for it suggests a second point.

Suppose one were to allow that this repetitive world really, contrary to the evidence, was one in which the inhabitants did exercise their free will. How – we now ask – would such a world differ from a world identical in all appearances but in which the inhabitants did *not* exercise their free will?

In other words, if the exercise of free will does not ultimately come down to exhibiting certain kinds of behavior, in what then does it consist? We can imagine someone who wants to defend the position that the repetitive chess players might really be exercising free will, saying:

> The husband was exercising his free will because, as he said, he seriously considered the Stonewall Maneuver, but *chose* not to pursue it. He could have done it if he had wanted to; but he simply did not want to. In some other possible world, very like his own, he did invoke that maneuver, however.

This will not do, and the reason why lies in the fact that the alleged difference between the repetitive world in which a person does exercise his free will and a repetitive world in which that person does not exercise his free will is no distinction at all. That that person does something different in some *third* possible world, totally fails to distinguish between those two possible worlds in which the chess players act absolutely identically but for one difference: In one they are exercising their free will and in the other not. And if one tries to say that this third possible world, the one in which the chess player does implement the Stonewall Maneuver, is accessible from the former but not from the latter of the two otherwise indistinguishable worlds, we are at a loss to understand what difference this talk of accessibility is supposed to denote. Indeed, it is nothing other than the very difference one is intent to explicate masquerading in the elaborate costume of the possible-worlds idiom.

Beware. The question at issue is not whether there is some possible world 'very like' the repetitive world, but in which the husband's actions do issue from the exercise of his free will; but rather, whether, under the specialized kinds of circumstances described (unrelieved repetition), his actions could be said to be free. The question is not, then, whether there is some possible world in which the man's actions (described as simply "foregoing the Stonewall Maneuver") are free – of course there *is* such a world; but whether there is a possible world in which *both* his actions are free *and* his behavior perpetually repeats. Although I would want to insist on a positive answer to the first question, I am equally inclined to answer in the negative to the second.

It would be natural for you to construe my remarks as evidence of a certain verificationist tendency on my part, and I am not altogether sure that at root they might not be. But if they do issue from that source, they do not do so in quite the straightforward way you might at first assume.

My inclination, as you have seen, is to say that the repetitive world I have described is one in which the inhabitants are not exercising free will. And you might assume that I reach this conclusion on the basis of there being no evidence for their exercising their free will. But, you might object, they really might be exercising their free will, even in the absence of there being any evidence:

> Consider a possible world in which there are invisible elves who manage always to escape our detection. We would be inclined to say such elves do not exist. But they really do. Lack of evidence for a contingent existent is logically consistent with that thing's existence. Lack of evidence for a thing's existence can be taken as good reason to disbelieve that that thing exists; but it cannot be taken as proof of that thing's nonexistence.

As natural a rebuttal to my position as this objection is, it does not quite hit the mark, for there is one all-important disanalogy with the situation as I am imagining it. You see, in the world where there exist xenophobic elves who forever elude our observation, we can imagine someone or something else detecting their existence. Presumably, the elves themselves know they exist; so too does a god whose powers of observation surpass yours and mine. More exactly, what sets the elf-inhabited world apart from the repetitive world I earlier described is that there is something *more* to be *observed* in the elf-inhabited world. There is a 'detectable' fact of the matter, which somebody or other, not you or me, could learn. In the repetitive world, there is no such 'additional' fact. I take myself to have given you the entire relevant data base. The problem with the repetitive world lies not with our lacking a further fact, but with our interpreting the facts as we have them. As I am imagining it, not even a god of superior powers of observation would be any better off than we in deciding whether these chess-playing couples are exercising free will. The problem is a *conceptual*, not a scientific or epistemological, one. I cannot believe that what accounts for the difference between the exercise of free will in a 'spontaneous' game of chess and the lack of free will in a daily game of chess comes down to something we could hope to find in the situation itself, either in, for example, the brain-states of the actors or in the immediate externals.

It seems to me that, of two similarly appearing games of chess, one occurring in a world where chess games are pretty irregular, and one occurring in a world where chess games are as regular as the decimal expansion of 5/33 (i.e., 0**.**151515151515 …), the former game might well and truly be deemed to issue from the exercise of one's free will, whereas the latter would never be so.[14]

The difference has to do with the very fact of repetition. Highly repetitive acts, even when accompanied by avowals that they issue from the free exercise of one's will, seem – just by the fact alone of their repetitiveness – not to be free. (Recall Barrett's sentiments, quoted earlier in this seminar.) Indeed, they seem to have lost entirely the very things that mark freedom: spontaneity; the ability to learn from past experience (especially from mistakes); the ability, and the occasional implementation of that ability, to change or modify behavior; etc.

What this latest thesis ultimately comes down to is this: One lacks free will if one never does anything differently. Sometime or other, having free will has to show up in doing something novel. Let me put it this way: spontaneity, novelty, and the like are not symptoms of having free will; they comprise some of the criteria.[15]

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[14] Were Kant's daily walks – year in and year out – free choices? I am disinclined to think so. This is not, however, to suggest that they were compulsions. They were probably just a habit, which is not to say that he could not have chosen otherwise. Possibly, they were so much of a routine that he didn't choose at all to walk; he just did it.

[15] I can anticipate a certain objection. In a modern classic, "Time Without Change," Shoemaker (1969) showed how one can have evidence of a passage of time in which there is no change; a fortiori, it is possible that there should be a time with no change. I can imagine someone arguing, along similar lines, that there could be free will in the absence of anyone's ever doing something novel.

Like this would-be objector, I, too, want to invoke Shoemaker's paper and adapt its ingenious technique. For I think it bears out my point, not my opponent's. The analogy must be carried through fully, however.

What Shoemaker's argument showed was not that all eternity could pass without change, but only that some period of time – embedded in a longer time – could pass without change. He showed, that is, that some periods of time could be unaccompanied by change; he did not and – I venture an opinion – could not show that all of time could be unaccompanied by change. And it is just this contrast between 'some period of time' and 'all of history' that I want to analogize with the case of free will. I have no quarrel with it being hypothesized that persons 'have free will' even when they might not be doing something novel; but I do balk at attributing free will to persons none of whom *ever* does anything novel. I am no more prepared to allow the latter than I am to allow that there might be an eternity in which nothing ever changes. In what sense can "eternity" apply to changelessness? In no intelligible sense, I aver.

What has to be true of a world so that someone therein has free will? It seems to me, for the reasons just given, that it will not do to say that someone who always acts in the most regular fashion 'could' do something differently. This bare, unrealized *de re* possibility does not distinguish that world from an otherwise identical one in which no one has free will.

For it to be *possible* in world *W* that someone have free will, it is necessary that someone or other in *W do* something novel. (Note the parallelism with the case of there being a river of Coca-Cola. According to the Regularity account, in world *W* there is a physical possibility of there being a river of Coca-Cola only if in *W* there is at some time or other and at some place or other a river of Coca-Cola.) For there to be free will in a world, it is not enough that someone *could do* something different from what he usually does, if he wanted to; it must be that somebody wants to and *does*.

Of course, it is logically impossible that anyone should both do something and do that very thing differently. And it is a vacuous claim to say that somebody does something differently from what he might have done. I mean that someone does something differently from what somebody else, or he himself on a different occasion, has done, is doing, or will do. Really, my point can be put pretty straightforwardly: The existence of freedom requires that there *be* novelty in a world.

If the existence of free will is to depend on the existence of novelty, we can rightly demand an explication of the concept of novelty. What does 'doing something novel (/new)' *mean*?

Since I am trying to make having free will a metaphysical matter, it cannot be made to depend on psychological criteria of unexpectedness, for example. Certainly, an event may be 'novel' in that it was unexpected; but that someone does something unexpected need not be evidence of her having exercised her free will; the unexpectedness may reflect nothing more than our inattention to what was going on and to what might reasonably have been forecast.

Can 'novelty,' understood to be a metaphysical category, even occur in a deterministic world? Can an event be both determined *and* novel?

The concept of novelty appropriate for our purposes has already been illustrated in our earlier case of my choosing which shoes to purchase. Recall that we supposed that I had an unbroken history of always buying brown shoes. Were this behavior to continue, the universal generalization, $\mathbf{U}_l$, under which my shoe purchasings would fall would be: "Whenever ... (uniquely individuating description of me) ... in situation *GHI* buys shoes, he buys brown shoes." But suppose that tomorrow I do something 'novel': I buy black shoes. Thus $\mathbf{U}_l$ cannot be the physical law covering tomorrow's purchase or, for that matter, any of my previous purchases. The description *GHI*, because of my 'novel' behavior tomorrow, turns out to be too broad, too inclusive. We must add some *differentia*, *X*, to the specification. *Two* laws – instead of the false $\mathbf{U}_1$ – it would now appear, cover my shoe purchasing behavior: one, $\mathbf{L}_1$, whose antecedent condition contains the term "*GHI* and *X*" and whose consequent is "buys brown shoes"; and the other, $\mathbf{L}_2$, whose antecedent contains the term "*GHI* and **~***X*" and whose consequent is "buys black shoes." By my breaking a pattern of behavior, I have made the world *less uniform* (in the sense previously explained) than it would have been.

Novelty, clearly, can occur in a fully deterministic world. It consists in lessening the uniformity of that world from what it would have been.

In part, in considerable part, what makes the actual world such an *interesting* place to live is that we ourselves, and our fellows, are forever doing new, novel things (i.e., are forever doing things that lessen the uniformity of the world).

A belief in the existence of free will is not threatened by a belief in determinism, that is, the belief that events may be subsumed under physical laws. What does pose a threat to our belief in free will is the idea that determinism carries in its train the doctrine of limited variety,[16] or excessive uniformity, or, putting this still another way, the doctrine that there are ultimately only a few physical laws. What we need, to have free will, is not that our actions should not be subsumable under physical law, but rather that there should be a very great number of physical laws. The freer we are, the more physical laws there are; the less free we are, the fewer physical laws there are.

A world in which there is too much uniformity is a world uncongenial to freedom; so too is a world with too little. But both worlds, at opposite ends of the scale of uniformity, may be fully deterministic worlds. Determinism per se poses no threat to freedom. Certain kinds of deterministic worlds are inhospitable to freedom; but not all.

All too often, discussions about the possibility of free will concentrate attention on the impediments to freedom, for example, on being drugged, hypnotized, mentally ill, physically constrained, etc. But a look at the positive necessary conditions rather than the inhibiting

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[16] Discussions of uniformity, variety, and novelty seem to be somewhat out of fashion of late. Some philosophers, e.g., Mill, Keynes, and Carnap, used to talk about these concepts, but these discussions no longer seem topical. They should be. Clarification of these concepts is fundamental to the understanding of the concepts of physical law, determinism, forecastability, and the like.

conditions reveals just how fragile freedom is: The existence and exercise of one's freedom requires a very special kind of world.

What are some of these positive necessary conditions? I hardly know them all; I do not even know whether I know most. But I can specify as least some.

First of all, the world must be reasonably uniform. One must be able to learn from past experiences. One must be able reasonably to anticipate the probable consequences of one's actions, and, unless one can do this a priori (and that seems pretty unlikely for any world fairly similar to this), one must depend on past experience as a guide to the future.

One must be able to make valid inferences pretty regularly. One must be able to select relevant data. One must have a fairly good memory. And one must be able to imagine alternative (possible but not undertaken) courses of action.

Persons who have argued that freedom is impossible if determinism *is* true have probably thought that determinism implies a stifling uniformity. Those who have argued that freedom is impossible if determinism is *not* true have doubtless seen that freedom requires that there be appreciable uniformity and have probably thought that the existence of this degree of uniformity requires that the world be deterministic.

Both sides are correct in their respective views about uniformity: Too much uniformity is inimical to freedom; too little is likewise. And both are incorrect as regards the relation between uniformity and determinism.

Determinism is compatible with both high and low uniformity. Whether a world is congenial to freedom does not depend on that world's being determined, but on the degree of uniformity obtaining in that world.

That Determinism be *false* is not a necessary condition for the existence of free will. But neither does the existence of free will require that Determinism be *true*. Free will exists both in possible worlds that are fully determined and in possible worlds that are not. Only in those worlds in which few or no events are physically determined, that is, in which there is little or no uniformity whatever (i.e., a truly chaotic world), and in those worlds in which all or most events are eternally repeated, that is, in which uniformity is close to or at its maximum, is there no possibility for free will. In short, that free will exists is logically independent of the truth of the Principle of Determinism.

PART III

The theory extended

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12

Statistical laws

One of the necessary conditions (see Chapter 2) for physical lawfulness is disjunctive, namely, a physical law must be either a universal proposition or a statistical one.

Up to this point, we have not examined statistical laws, but have instead concentrated our attention on universal ones. The neglect has been deliberate. Various writers have tried to solve the free-will problem by denying Determinism, that is, by denying that all states and events can be subsumed (as second members of pairs or sequences) under *universal* physical laws. Some have argued that the world is indeterminate at its very foundation – for example, at the subatomic level, where only statistical laws prevail – and hence that free will is possible. Others place the indeterminacy at the very highest level of Nature's organization, in the central nervous systems of human beings. Here, in the uppermost reaches of the natural order, a special category of causation, *agency*, displaces mere 'brute' causation. Viewed from the standpoint of physics and chemistry, whatever is happening at this rarefied level cannot be deterministic, but only statistical at best.

I have postponed examining statistical laws until now because I have wanted to keep some important issues distinct. I have tried to show, in the previous two chapters, that determinism and free will are compatible, that one need not postulate a breakdown of determinism to accommodate free will. I have tried to show that the problem of free will comes about through a mistaken conception of what physical laws are; the solution to the problem does not require abandoning Determinism, but neither does it require embracing Determinism.

Freed of the enticement of warranting indeterminism to solve the free-will problem, we can now go about investigating the matter of probabilistic laws in a dispassionate way. At the very least, the solutions to the weighty problems of free will and moral responsibility will not hang in the balance.

The Copenhagen interpretation (1927) of quantum mechanics (see Hanson 1967, pp. 43-4, 46-8) historically served as the catalyst for the contemporary debate about the status of statistical laws. That the debate should derive its principal impetus from physics is unfortunate from the point of view of intellectual history. For it bolsters the belief that the natural sciences are somehow more fundamental than the social sciences and that the ‘true’ nature of physical laws is to be learned from what physics and chemistry reveal, rather than from such sciences as economics or sociology. Certainly, the view still prevails that the ‘laws’ of sociology are but the logical consequences of the ‘fundamental’ laws of physics and chemistry. Such a view carries the corollary that, were the ‘laws’ of sociology, economics, and so on to be statistical rather than universal, this fact would not be decisive, or even for that matter particularly relevant, in answering the question of whether any ‘real’ physical laws are statistical or whether all physical laws are – without exception – universal. ‘Real’ laws, in this view, are the preserve of physics, and it is to physics and physics alone that one must turn to answer the question of whether any ‘real’ laws are statistical.

This way of approaching the question of whether physical laws can be statistical makes it look as if what were at issue were an empirical question, as if it were a matter to be settled in the physicists’ laboratories whether physical laws might have a certain property. But surely this is a mistake. To proceed in the manner imagined, one would have to have an *independent* way of recognizing what a physical law is, and then one would check to see whether any members of this class were statistical rather than universal. We have only to put the matter this way to see immediately that the question is not empirical but conceptual. It falls to us to *decide* whether, and if so under what circumstances, we might want to allow that a statistical proposition is to be regarded as a physical law. Certainly, it is an empirical matter to discover which of a certain class of contrary propositions, of potential laws, is *in fact* a law; but to decide what the criteria are by which a proposition comes to be in this class of candidates for lawfulness is a conceptual problem.

What ‘laws’ certain sciences – for example, sociology, economics, pharmacology, linguistics – adduce are nearly always statistical. Is this because the ‘real’ laws are universal, but incapable of explicit formulation, perhaps because of the enormous numbers of variables, the unethicalness of performing controlled social-scientific experiments, prohibitions of cost, irreproducibility of initial conditions, etc.? Or might it be that the ‘real’ underlying laws of social events are genuinely statistical?

If some physical laws are statistical, then it logically follows that some statistical propositions are physical laws. I want to go considerably further. I want, now, to argue that not just some, but *all* statistical propositions that satisfy all the other requirements for physical lawfulness – being true, contingent, conditional, and purely descriptive in their nonlogical and nonmathematical terms – are physical laws.

Virtually all chemists and physicists have reconciled themselves – even if originally rather grudgingly – to acknowledging the legitimate claims of lawfulness among some statistical generalizations. Few would deny, for example, that the half-life of lead-214 (Pb^{214}) is 26.8 min. Freely paraphrased, this law states that, in a 'large sample' of lead-214, very nearly one-half the total number of lead-214 atoms will spontaneously decay in any 26.8 min. period.

But could such lawful status ever be extended to the kinds of facts compiled by political pollsters, economists, efficiency experts, etc.? Could it be a physical law that 38% of fishermen who own their own boats have on board a ship-to-shore radio; or that 12.2% of all paper clips end up being used for something other than clipping together sheets of paper?

On the face of it, it looks implausible to argue that all true statistical propositions that are contingent, conditional, and whose predicate terms are purely descriptive are physical laws. But then again, it was also initially implausible to make the same claim for the corresponding class of universal propositions. And yet, as we have seen, there are positive grounds for promoting the latter case; and we will find, equally, that there are positive grounds for the case of the statistical generalizations, that is, that there is no distinction to be made between 'genuine' (i.e., nomological) statistical laws and mere 'accidental' statistical truths.

Before we can make the case for there being no difference between nomological and accidental statistical generalizations, we must first see why the very concept of statistical law itself has been thought to be problematic and why historically it was resisted.

Chief among the obstacles to admitting that there could be any statistical propositions that are physical laws – let alone allowing that they all should be – is a deep-seated puzzlement as to how an ensemble could adjust itself to comply with a statistical law. The Necessitarian view that would have it that events 'adjust' themselves to 'accord' with physical laws is very deeply ingrained. As the heirs to this idea that has been promoted throughout most of the history of modern science, many philosophers and scientists find it 'natural.' They find no problem in all members of an ensemble behaving in one certain way, for example, that all silver objects tarnish in an atmosphere of hydrogen sulfide. Exceptionless behavior, in accord with a universal law, seems not in need of explanation, concern, or worry. If every member of a class is driven by a nomological necessity, then it is little wonder that they all should behave in the identical fashion. But let only some members behave in a certain way, and the lack of unanimity seems incredible. How can the members of a class adjust themselves in accord with the dictates of a statistical law?

Blind obedience to a universal law (a silver ingot tarnishing, for example) can proceed in a state of total ignorance of what others are doing. But acting individually in such a way as to assure that a statistical law describing collective behavior is observed (a lead-214 atom decaying) would seem to require information (knowledge?) of what one's fellows are doing. Yet rarely do the members of ensembles take votes and designate which ones among them will undergo the requisite changes. Penguins may gang up to push some hapless member of the rookery off the cliffs into the sea below to test for leopard seals and other predators. But radioactive atoms of lead-214 do not elect victims to be cast out from among their members. And individual coins in a series of coin flippings do not keep a watchful eye on the gyrations of their squat cylindrical colleagues and adjust their own alignments in the gravitational field accordingly.

This metaphysical problem is profound. If information is not being passed back and forth among the mindless members of a series of coin flippings, or between the insensate atoms in a sample of lead-214, *how can we account for the permanence of the statistical regularity we find true of the behavior of the ensemble*? How is the Necessitarian to conceive of a series, class, sequence, etc., to be governed by a nomological statistical law? How do classes, sequences, etc., manage to comport with their governing laws? What metaphysical 'mechanism' are we to posit at play here?

The Necessitarian has three possible kinds of theory available to him to explain such phenomena.

1. The Necessitarian could argue that there are no genuine statistical laws. He could argue that the world is wholly determined; or, if it is not, then the only aspects of the world that are law-governed are those governed by universal physical laws. According to this account, although there may be statistical truths, *none* of them are *laws*.

2. Alternatively, the Necessitarian could allow that there are statistical laws; that nomological, statistical connections should obtain between *sequences* of paired events (e.g., coin flippings and getting heads) and between a *series* of states (e.g., between males having XYY chromosomes and their being more than normally aggressive).

3. Or, finally, the Necessitarian could argue as immediately above, except that he would interpret the statistical measures as nomologically necessary propensities of *individual* pairs of events and of *individual* pairs of states.

The first of these alternatives should not prove particularly attractive to a Necessitarian. Quantum mechanics has too thoroughly established itself for one to argue now that no physical laws are statistical. Even if what are presently taken to be laws in quantum mechanics should be superseded, there is little reason to think that their successors will be any the less statistical in nature.

The second of the two alternatives seems to be the preferred one, but it has considerable metaphysical difficulties. It is one thing to advance a theory that would make the connection nomological between, for example, introducing a flame into a tank containing 2 moles of hydrogen and 1 of oxygen and the subsequent explosion; and quite another to advance a theory that would make the statistical connection nomological between the several flippings of a coin and its coming up heads (roughly) 50% of the time. The connection between introducing the flame into the tank and the subsequent explosion is a connection between two *events*, and events are spatiotemporal items (at least we can say when and where they occurred). But the series of coin flippings and the series of heads are not events but *sequences* of events. They are a different ontological category from their members. It seems odd to advance a theory that assigns nomological connectedness not only to individual events but to *sequences* of events. We may wonder at a world in which the events of a sequence are not law-governed, but the sequence itself is.[1] Although this is hardly a conclusive argument against this latter point of view, it does underscore its peculiarity.

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[1] There may be another problem with allowing that sequences of events might be governed by physical laws. E.g., some series of coin flippings extend far into the future. If, however, there are ‘too many’ heads in the initial segment, there may be insufficient opportunity in the latter part to ‘correct’ the imbalance. If, then, a long series of coin flippings, extending well into the future, is now to satisfy some statistical law, the early part of that series, i.e., now, long before the completion of the series, will have to be so comporting itself as to make it all turn out ‘right.’ If there happens to be a preponderance of heads lying at the end of the series, in the future, the series will even now have to be compensating for that perturbation. This sounds awfully like backward, or time-reversed, causation.

The third alternative is to make the statistical regularity of the whole series or sequence an outgrowth of a nomological, stochastic propensity of the individual members of that series or sequence. According to this theory, the nomological necessity that attaches to statistical laws may be thought to reflect a diminished (or fractional) necessity that obtains between events and their consequences and between certain pairs of states, but that does not obtain between *series* of event-pairs and *sequences* of paired states.

Popper, whom we have seen (in Chapters 6, 10, and 11) is a prominent advocate of the Necessitarian Theory, has abandoned the Frequency Theory of Probability and embraced this third alternative. In the first (German) edition of *The Logic of Scientific Discovery* (1934), he spoke "disparagingly" (his own characterization) of

> the metaphysical idea that ... nature is more or less 'determined' (or 'undetermined'); so that the success (or failure) of predictions is to be explained not by the laws from which they are deduced, but over and above this by the fact that nature is actually constituted (or not constituted) according to these [indeterministic] laws. (1959a, p. 212; parenthetical gloss added)

But, in the English edition of 1959, Popper repudiates his earlier point of view:

> This … characterization [presently] fits perfectly my own views which I now submit ... under the name of 'the propensity interpretation of probability.' (1959a, p. 212, note *4; parenthetical gloss added)

As Popper's views about nomicity, provoked by Kneale, changed in his writings from those of Regularity to Necessitarianism, there was an accompanying change in his views of objective probability from the Frequency Theory to a Propensity Theory.[2] In his latest theory, the objective relative frequency of the sequence is now taken to be evidence of an objective, stochastic disposition of the experimental setup:

> We can consider the propensities as physically real. They are *relational* properties of the experimental set-up. For example, the propensity ¼ *is not a property of our loaded die*. This can be seen at once if we consider that in a very weak gravitational field, the load will have little effect – the propensity of throwing a 6 may decrease from ¼ [i.e., what it would be for the loaded die under normal gravitational conditions] to very nearly ⅙. In a

[2] "Propensity theory" is a generic name, not a proper name. See Giere 1977, pp. 42-5.

> strong gravitational field, the load will be more effective and the same die will exhibit a propensity of ⅓ or ½. The tendency or disposition or propensity is therefore, ... a relational property of the experimental set-up. (1962b, p. 68; parenthetical gloss added)

(“Experimental set-up” ought not to be read too literally in this context. For it is clear that Popper intends that sequences such as horse races ought, too, to be considered ‘experimental set-ups.’ See, for example, Popper 1959b, p. 29.)

In this view, if it is a physical law that, under circumstances **C**, 72.3% of *G*s are *H*s, then, under circumstances **C**, each actual individual *G* that is not already an *H* has a propensity of strength 0.723 to break out into actual *H*-ness.

Although Popper’s Propensity Theory has won few adherents, he has, I think, seen correctly the consequences of his, and others’, metaphysical Necessitarianism. A Propensity Theory of the Popperian sort is the natural consequence of that view of Nature that would have events occurring ‘in accord with’ physical laws. If universal laws impose a natural (nomological) necessity, then statistical laws must impose a statistical analog of this necessity. Just as, in the former view, electrons would be thought to have a metaphysical necessity (strength 1.000) to have a mass of 9.107×10^{-28}g, so, in the latter view, would lead-214 atoms have a metaphysical propensity (strength 0.500) to decay in the next 26.8 min.

According to the Regularity Theory, in contrast, there is no mystery as to what ‘mechanism’ (or concealed necessity) might be at work that would bring it about that the individual members of a series or sequence so comport themselves as to satisfy a statistical law true of the ensemble. There is no need to solve this problem because the Regularity Theory rejects its presupposition. Individual events no more accord with statistical laws than they do with universal ones. Once again, the claim is that logical priority (see Chapter 10) runs in the other direction: It is because things behave as they do that the laws, statistical or universal, are as they are. And once again, according to this analysis, there is no distinction to be made between accidental truths and nomological ones.

The form of the Necessitarian’s initial objection is, by now, perfectly obvious:

> Suppose it were true that 78.35% of all fifth-graders love chocolate ice cream. This surely could not be a physical law. Such a proposition could only be descriptive. It tells us how the world is; but surely not how it must be. There is no necessity in 78.35% of all

> fifth-graders loving chocolate ice cream; they just *do*. If it were a physical law that 78.35% of all fifth-graders love chocolate ice cream, then fifth-graders would have to love chocolate ice cream in this percentage.

The counterargument exactly parallels the Regularist's argument against the standard Necessitarian argument:

> Laws do not compel. Thus 78.35% of fifth-graders would no more be compelled, would no more *have* to love chocolate ice cream than would 100% if it were a physical law that *all* fifth-graders love chocolate ice cream. Laws are true in virtue of the singular facts; it is not the other way around.

But, at the next stage, the debate becomes more substantial. For the Necessitarian will explain why and how statistical truths might be sorted into laws and mere accidental truths:

> Certain statistical truths are nomological, whereas others are not; that is, these latter may be regarded as accidental or 'merely' descriptive. There are two indicators of the difference.
>
> One is that, in the case of laws, the connection is pervasive or 'stubborn' (just as in the case of universal laws); that is, a genuine statistical law remains fixed in numerical value through a great change in experimental set-up, that is, is relatively immune to interference.
>
> The other is that the relative frequency holds not only for the entire sequence [or 'in the long (or completed) run'], but also for segments or sections of the total sequence; that is, the relative frequency is regularly exhibited in some 'short runs' as well. For example, a well-balanced coin's coming up heads 50% of the time is something which (so far as we can tell) is true not only of very long sequences, but seems to be true as well of shorter sequences, for example, of trials of a hundred flippings and of trials of a thousand. The ice cream case is not like this. We can expect that fifth-graders' preferences for chocolate ice cream might differ markedly from time to time, place to place, season to season, culture to culture, etc. Obviously, *some* figure or other must be true for *all* fifth-graders; and for the sake of argument we assume that it is 78.35%. But it could have been *any* figure. Whatever figure it turns out to be clearly is *just* an artifact of the singular facts of the case; that is, it is *merely* descriptive of the history of ice cream preferences. The figure of 50% for coin flippings is different, however. It tells us not only how coins have behaved; it tells us how they must, and (counterfactually) how other coins that have not been flipped would behave if they were to be.

The Necessitarian's argument, however, fails to have the intended effect on the Regularist, for the Regularist again fails to see the difference the Necessitarian sees:

> Regarding the first point: Coin flippings turning up heads are no more nor any less immune to outside influence than fifth-graders choosing chocolate ice cream. Neither is any more or less a pervasive feature of the world. Coin flippings can be influenced by weighting the coin, by switching on an electromagnetic field triggered by a television camera focused on the coin, by gusts of wind, etc. Fifth-graders' choosing chocolate ice cream can be influenced by advertising, by the choice of their peers, by threats, etc.
>
> Regarding the second point: No one has ever succeeded in producing a nonarbitrary, rational, justifiable algorithm for determining for various categories of events what constitutes a 'long run' and what a 'short run.' If in some particular sample of fifth-graders the actual percentage that prefers chocolate ice cream is not especially close to the figure of 78.35%, we need have no more concern about this departure from the overall figure than we would if in some particular sample of, let's say, four coin flippings the actual number of heads were 100%, rather than 50%. It may take more samplings of fifth-graders to get a 'fix' on the 'final' value, but that is just a difference of degree from the case of the coin flippings. It hardly seems to constitute any *metaphysical* difference whatsoever.

The Regularist can hardly but argue that all true statistical generalizations that satisfy all the other criteria for lawfulness are physical laws. If there is nothing to mark a significant difference between members of the similarly constituted set of universal propositions – nothing, that is, that sorts them into disjoint classes of laws and nonlaws – then it would be exceedingly odd if there were such a sorting property among statistical generalizations. Symmetry of reasoning demands that if all contingently true, conditional, universal propositions having purely descriptive terms are physical laws, then all similarly characterized statistical propositions are as well.

In any but the most contrived possible worlds, there will be – according to the Regularity Theory – both universal and statistical physical laws. Indeed, in any world in which there are any *universal* laws that are not convertible, that is, whose antecedents and consequents cannot be interchanged so as to produce a true proposition, there will be statistical laws. Consider, for example, a world in which there are exactly 100 items: 20 red circles; 30 blue squares; and 50 blue triangles. There would then be the following universal laws true of that world:

All circles are red
All red things are circles
All squares are blue
All triangles are blue

The first and second of these laws are convertible; but the third and fourth are not, and they give rise to the following two statistical laws[3]:

37.5% of blue things are squares
62.5% of blue things are triangles

Suppose now we were to devise a metaphysics for that impoverished world. Shall we puzzle ourselves over what metaphysical 'mechanism' could possibly account for 62.5% of the blue items in that world adjusting themselves so as to comply with the inviolable law that 62.5% of the blue things in that world are triangles? Of course not. The physical law is what it is because the blue things are as they are; not conversely. Whatever the singular facts had been of that world, the laws would have 'adjusted themselves' accordingly.

Once necessity has been expunged from the analysis of physical law, statistical laws are on the identical metaphysical footing with universal ones: Neither 'coerces'; the former does not coerce universally, and the latter does not coerce stochastically. They differ only in the degree of

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3 The example chosen is one in which the descriptive terms in all of the universal laws are so-called 'count nouns.' The case is somewhat more complicated, and interesting, when one introduces 'mass nouns,' e.g., "Nitric acid dissolves tin." Here one can generate two quite different sorts of converted propositions. On the one hand, we can generate converted propositions in which the descriptive terms refer to numbers of *kinds* of things, rather than to the numbers of individuals of those kinds. For this first case, the converted law will be understood to be, "There is one chance in *m* (i.e., $^1/m \times 100\%$) of a substance that dissolves tin being nitric acid," or, somewhat more colloquially, "There are *m* different kinds of substance that dissolve tin, and nitric acid is one of these." On the other hand, one can generate converted propositions in which the descriptive terms refer to individual samples of tin and nitric acid respectively, e.g., "There is an *n*% probability, for any (individual piece of) tin that dissolves, that that piece dissolves in (a sample of) nitric acid." It should be clear that the values of *m* and *n* bear no special relationship one to another; and will vary, as well, for the corresponding statistical laws for every other pair of substances.

connectedness they state to hold between two classes of events, states, etc .[4] Some sequences of event-kinds are found to fall under universal laws; others under statistical ones. Divorced from the Necessitarian Theory, universal laws and statistical ones are both metaphysically benign. Neither requires the postulating of occult necessities, neither universal ones in the former case nor stochastic ones in the latter.

Just as in the case of universal laws, we will want to make a distinction between physical statistical laws on the one hand and scientific statistical laws on the other. The scientific statistical laws of the social scientist are typically the product of sampling. As such, their probability values are *estimates* of the true numerical values, and only rarely, we suppose, will these estimates turn out – fortuitously – to be *exact*. Those unknown propositions, which sport the true values, are the physical laws grounding the scientific laws, the workaday proxies, of the social scientists. But unlike the case of a false universal scientific law going proxy for a true physical law, scientific statistical laws are more intimately allied to physical laws. The difference is that false universal scientific laws differ from the true physical laws in omitting some further descriptive term(s); they are simplifications, and they simplify by failing to take account of all relevant factors. But scientific statistical laws, by their very nature, are not simplifications; they can depart from the truth – provided there is a truth – *only* by a numerical factor. As a result, we often have competing statistical laws.[5] But, almost by way of compensation, we are afforded a

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4 According to the Regularity Theory, much of the motivation for postulating propensities is lost. Since, according to this theory, sequences and series do not 'comply' with statistical laws (since of course nothing whatsoever 'complies' with physical laws) there is no especial need to invent occult fractional necessities to account for the individual behavior exhibited by the members of the sequence. Should a Regularist wish to posit propensities, she would have no need to make of them statistical analogs of nomological necessities. For a Regularist, a propensity need be construed as nothing more than a mathematical construction, not unlike the 'average person.' If 62.5% of *A*s are *B*s, then the Regularist can construe "Each individual *A*'s 'propensity' to be a *B* is of strength 0.625" as elliptical for the statistical claim about the entire class of *A*s.

5 I.e., it may be true that m% of *A*s are *H*s; that n% of *B*s are *H*s; that $m \neq n$; and that some particular item, j, is both an *A* and a *B*. What probability shall we assign to j's being an *H*? According to the frequency theory, the various measures of the probability of j's being an *H* will depend (objectively) on the specification of the reference class to which j is assigned.

According to the Propensity Theory, however – if I understand Popper correctly – there will be one, single, objective propensity of j's being an *H*. I do not, however, find in his explanations of his theory how this one, single figure is *[footnote 5 continued on page 182]*

class of scientific laws that are near perfect representations of physical laws, and this being so allows us to examine, even more clearly than in the case of universal laws, the modality of physical laws.

Often the social sciences, because of their inability to adduce universal laws, have been regarded as poor relations of the natural sciences. Perhaps this attitude is a product of the historical order of precedence. If it is, then it is a profound mistake. For when one reflects on the history of the evolution of the natural and social sciences, there does not seem to be any special historical reason for the one to precede the other. Laplace's probability theory seems not to have waited upon Newton's invention of the calculus, etc.; and it could have been invented by a clever mathematician a thousand years earlier. If it had, the course of history might have been very different, with the result that, in later generations, when a handful of universal laws came to be discovered in physics and chemistry, these latter laws would have occasioned hardly a stir but would have been assimilated merely as laws with extreme probability values, 1.00 and 0.00.

It is difficult, given our history, to put ourselves in the frame of mind I have latterly described, but I think it does greater justice to Nature (i.e., the nature of the world) than does the metaphysical view that has been shaped by the historical accident of the natural sciences having antedated the social sciences. In spite of my early training as a physicist, I have come to think that the emerging metaphysics of contemporary social sciences more aptly fits the world than does the traditional metaphysics of the natural sciences.

It is a profound metaphysical error to dismiss, as sometimes happens, the work of – choosing but one example – actuaries, saying of their statistical generalizations that they are 'merely descriptive', that such empirically derived data, since they often are not underpinned by theory, do not truly capture lawful connections. The error is revealed by the fact that these actuarial laws

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[cont.] to be calculated. Since he identifies propensities with 'occult forces', and allows that in a horse race there is a propensity for a horse's winning the race, one must suppose that in each horse there are as many occult forces operating together as there are objective statistical truths of the form, "*n*% of horses having property *P* in circumstances *C* win a horse race." There seems to me to be no particular limit on the number of such truths, with varying values of *n* and interpretations for *P* and *C*. In short – again, if I have understood Popper correctly – there doesn't seem to be any end to the number of propensities collectively operative in any one case of something's happening. This sort of Necessitarianism seems metaphysically excessive.

are epistemically powerful: They can be used to predict the behavior of classes and can be used, too, to explain. Reliance on statistical generalizations is as much a feature of modern society as reliance on universal generalizations. Engineers plot the probability of car accidents as a function of traffic volume, weather conditions, the class of road, etc. Insurance companies plot the probability of car accidents against drivers' ages, sex, and drinking habits. Quality-control engineers calculate the mean time between failures (TBF) for every manner of mechanical and electrical device, from camera shutters to fluorescent lights. Dairy producers measure and inform consumers of the shelf life of perishable foods. Physicians can calculate the incidence of Down's syndrome in a population; they can even calculate it more finely, as a function of the mothers' ages.

In few, or none, of these cases and in countless others besides is there much temptation to *explain* the observed statistical regularity as evidence of an underlying metaphysical, or nomological, necessity. "There is no necessity," I think most of us would be inclined to say, "that there be *n* number of automobile accidents per million miles driven. This is just the way the world happens to be. The statistical law is descriptive." To be sure, the Necessitarian's idiom may still persist in our manner of *describing* these sorts of cases; for example, we may find ourselves tempted to say such things as, "Telephoning behavior on Christmas Day accords with certain statistical laws." Nonetheless, I think that if we were pressed to explain what we mean by "accord" for such laws, we would likely (!) say that these statistical laws are merely descriptive and carry no nomological weight, for example, that persons do not *have* to telephone in these numbers, they just *do*. If I am right, then we may very well be in a historical transition period between two metaphysical paradigms, and the recognition of, and increasingly daily use of, statistical laws may be moving us away from Necessitarianism toward Regularity. Indeed, I suspect that with regard to most statistical laws, many of us are already, if unknowingly, Regularists.

If necessity can be dispensed with in the case of statistical laws, it can perfectly as well be dispensed with in the case of universal laws. If statistical laws can be used – as they are – to explain, control, and predict the world without attributing to them a nomological necessity, then universal laws can, and I would add *ought*, to be similarly regarded as descriptive of the world and not as coercive. (Recall the quotations from Popper, Swinburn, etc. in Chapter 10.)

There is nothing in physics that makes it any more scientific than sociology, economics, linguistics, etc. And indeed, when physics comes to subsume the behavior of ensembles (whether of stars, atoms in a crystal, or molecules of a gas) under scientific laws, these laws are invariably statistical. Statistical laws are not merely the ‘second-best’ laws of the social scientist; they are the greater part of the laws of the world and are spread superabundantly across all sciences.

Does the coexistence of universal and statistical laws entail that the world is, ultimately, indeterministic?

Such a conclusion does not follow, although of course it may be true. Having statistical laws true of a world does not by itself make a world an indeterministic one. An indeterministic world, recall (Chapter 2, Section titled “The Principle of Determinism”), is one in which not every event is subsumable as a second member of a pair (or sequence) falling under a universal physical law. And thus it remains an entirely open question as to whether the individual members that make up some series, sequence, or ensemble are determined. I might program a computer with a complex algorithm to produce a series of digits whose pattern is seemingly random. The entire sequence will satisfy probabilistic laws (e.g., “The digit ‘7’ occurs with a relative frequency of 0.10”), but each member of the sequence may be perfectly determined. And indeed the entire sequence can be generated and replicated by anyone who learns the algorithm. But coin flippings may not be like this; and even if the individual members of the sequence are determined, there may not be any compact or ‘simple’ law that subsumes the entire sequence. The entire sequence itself may fall under no more simple law than the conjunction of all the laws that cover each of its many members.

But these kinds of differences should be regarded as devoid of metaphysical interest or consequence. It is only by giving physical laws occult properties that any such differences matter in one’s world view.

I have argued earlier that the truth or falsity of the Principle of Determinism ought not to cause us much worry. Whether that principle is true or false, we are still going to be left with virtually all our philosophical and metaphysical problems intact, indeed virtually untouched.

Often, our interests are directed to classes of events rather than to individual events. Insurance companies are not immoral in failing to want to know exactly who among their clients will die in the next year and who will live. International relief agencies do not have to know who, exactly, will need food and clothing; they need to know only (roughly) how many will and of those what percentage are children. Car companies need not know whether *you* will buy a new car next month, but only how many persons will, to plan their production schedules. Forestry officials do not need to know precisely where lightning will strike, but only what the chances are of its striking in an inaccessible region and with what probable frequency. And so on. As our interests move to predicting and explaining group behavior, our reliance on statistical laws correspondingly increases. But as our familiarity with such laws grows, the vestiges of Necessitarianism may fall away. We come to understand that general *descriptions* of the world are powerful tools for explanation, prediction, and control. And there seems to be little need to invest these descriptions with occult properties.

In summary, on a variety of points, statistical generalizations merit being accorded the status of physical laws. Principal among these is the fact that in all respects, save their being nonuniversal, they have the same metaphysical properties as universal laws. Moreover, admitting them to equal status alongside universal laws in our world view does not commit us to indeterminism. It does, however, argue that those sciences that adduce only statistical laws are no further removed from 'reality' than those that succeed in adducing universal laws. Finally, by adopting a comprehensive Regularist view, in which neither universal nor statistical laws dictate to reality, we can complete the program of dissociation from an integral set of metaphysical arcana. For, along with coercive necessities, world-potentialities, autonomous truth-conditions, and impotent wills, we may now also dispense with stochastic propensities interpreted to be fractional necessities.

13

Counterfactuals, numerical laws, and necessity-in-praxis

Had this essay been intended as an encyclopedic treatment of the analysis of physical laws, it would have had to touch upon many more topics. It was not my purpose, however, as I explained in the preface, to say everything that could be said, nor even everything that should be said. What I set out to do was to examine the differences between two theories. And I followed my own interests, with the result that some often-examined issues were relatively unexamined. I will, then, by way of concluding, examine three of these issues and offer a few brief comments.

I have, at several points in this book, discussed counterfactual conditionals. But I would like now to make a final observation about this class of propositions.

Suppose (adapting a famous example) that all the coins that ever were, are, or will be in my daughter Diane's piggy bank are copper pennies, and suppose that this bank has an individuating description, *XYZ*, in purely descriptive terms. Thus the universal generalization, that all the coins in an *XYZ* piggy bank are copper, is true. What, then, of the truth-value of the counterfactual conditional, "If a coin were to be added to an *XYZ* piggy bank, it would be copper"? The received answer is, "The counterfactual conditional is false, and this for the reason that the universal conditional is an accidental, not nomological, truth."

Regularists will reject the reason given for this latter answer. For a Regularist, there is no difference between accidental and nomological truths. But suppose a Regularist wants to agree that the suppositional conditional, namely, "If a coin were to be added to an *XYZ* piggy bank, it would be copper," is false. How shall he justify his choosing this truth-value?

I think that the warrant for that particular answer is easier than it is usually portrayed to be. The Regularist says that the counterfactual is false simply because not all piggy banks contain only copper coins. But why invoke a truth about *all* piggy banks rather than about the restricted class of *XYZ* piggy banks?

The proper answer to *this* latter question is, I admit, very difficult to formulate. But I do not have to be able to give it to be fairly sure that the immediately preceding justification for the Regularist's choice is right. Indeed, I am certain that it is this latter fact, about *all* piggy banks, that Necessitarians also really appeal to when *they* deny the truth of the counterfactual conditional.

I propose an experiment. Ask a Necessitarian *why* it is false that, were a coin to be introduced into an *XYZ* piggy bank (which never contains anything but pennies), that coin would be copper. At first, the answer might be: "Because although it may be true, it is not *nomologically* true that all coins in an *XYZ* piggy bank are copper." Persist. Ask now *why* he thinks the universally true proposition about *XYZ* piggy banks is not nomologically true. Now the answer will be: "Because not all piggy banks contain copper coins; some contain other kinds of coins as well: nickel, silver, aluminum, gold, etc." But having eventually arrived at this claim about other piggy banks, it seems to me that the Necessitarian's intermediary stage of invoking a nomological necessity (or rather the fact of the absence of such a necessity) is, if not gratuitous, at least dispensable. For the latter claim, about other piggy banks, could have served directly rather than mediately as the explanation of the falsity of the counterfactual conditional.

Appearances to the contrary, this argument just given does not depend on the relation between explanans and explanandum being transitive. The statement "*p* explains *q*" (where *p* and *q* stand for propositions) is a nontransitive relation. The argument is *not*:

> "Not all piggy banks contain copper coins" explains "it is not nomologically true that all coins in an *XYZ* piggy bank are copper"; and hence, by transitivity, the former universal proposition explains why the counterfactual about *this* silver dime is false.

No, my point is that the apparently mediating claim about nomicity is elliptical for the denial of the nonmodal universal generalization. The falsity of the universal generalization explains the truth-value of the counterfactual directly. The introduction of the concept of nomicity is superfluous. Perhaps the concept of nomicity here plays some pragmatic role in discourse; but to admit this is not to be committed to saying that the necessity invoked need be thought to represent an ontological feature of the world.

The Necessitarian's test for nomicity, which would have it that only nomologically, but not accidentally, true universal generalizations will support a singular counterfactual proposition, seems not to work at all for the alleged parallel distinction between nomological statistical laws and accidentally true statistical generalizations. Consider the probabilistic counterfactual conditional, "If this film frame were in the world's most expensive camera, it would probably contain a latent image of a flyby picture of the surface of Venus." What grounds the truth of this probabilistic singular counterfactual? A statistical generalization of this sort: "Most of the film frames in the world's most expensive camera contain latent images of flyby pictures of the surface of Venus." Here it would seem that the statistical generalization invoked is, according to Necessitarian criteria, merely accidental. Yet this 'accidental' generalization *does* seem to support a probabilistic singular counterfactual.

There is a variety of responses the Necessitarian can make to this case, all of them, however, inimical to his position. He could try, for example, to argue (i) that no statistical propositions are physical laws. But – as I argued in Chapter 12 – quantum mechanics, at the very least, advances strong evidence that some are. Or he could argue (ii) that, inasmuch as the statistical generalization in this instance does warrant a singular counterfactual conditional, that generalization is a physical law (and is thus according to his account nomological). The trouble with this response, however, is that the generalization about the world's most expensive camera seems to share all relevant properties with those universal propositions that Necessitarians have held up as examples of merely true, accidental generalizations, for example, "All moas die before the age of fifty"; "All the screws in Jones's car are rusty"; etc. If he is not, then, to have to retract all his former examples, it would seem that the Necessitarian cannot deny that the generalization about the world's most expensive camera is merely accidental. Or finally, he might try to argue (iii) that in this example the statistical generalization (since it *is* merely accidental) does not in fact warrant the singular counterfactual. But here the reply is that the warranting relation in this case is as strong as in other examples usually adduced in these discussions. To deny it in this instance would be suspiciously ad hoc.

The upshot is that the Necessitarian's test using counterfactuals to distinguish between nomicity and accidentalness does not work. And the reason why, I suggest, is that it attempts to make a distinction where in fact there is none. There is no distinction because there are no nomological necessities: neither universal ones nor statistical ones.

Let's now turn to a second issue.

Sometimes Necessitarians have objected to the Regularity Theory on the grounds that the theory is unable to accommodate *numerical* physical laws. It is pointed out, truly, that not all – indeed very few – scientific laws are of the conditional form, $(x)(Sx \supset Px)$. Most scientific laws are, rather, propositions about relations between mathematical quantities, and, inasmuch as the class of scientific laws is a surrogate for the class of physical laws, the latter may also be supposed to be comprised of a vast number of numerical formulas. These latter physical laws are propositions about relations between mathematical quantities, and their variables range over a nondenumerably infinite domain of real, and sometimes imaginary, numbers. Propositions taking their truth from *actual* occurrences – the challenge goes – could never begin to cope with such domains. At best, physical laws, construed as statements about what actually happens, could be true for only a minute number of values encompassed by any one physical law. Necessitarianism is then offered as the corrective. (See Pap 1962, pp. 303-5.)

The correction is not needed. Regularity has no trouble on this score. One does not have to 'strengthen' the mode of truth of numerical laws. Suppose we construe numerical laws as compendia of an infinite number of singular statements (indeed, such a view is the favored contemporary explication of the mathematical concept of "function"), where the constants and variables in these statements stand for numbers and physical quantities. Suppose, for the moment, just to have an easy example, that Ohm's Law, that is,

P14 $IR = E$

were true. (*I* stands for the value of the current; *R* for the value of the resistance; and *E* for the value of the voltage.) The singular expansion (suitably defined) of this law comprises a nondenumerable infinity of propositions including, for example,

P15 *5.7893 amperes* × *45.2349 ohms = 261,878.40657 volts*

Now let's suppose, further, (probably not too unrealistically) that these particular values never are (at any time) instanced in the current, resistance, and voltage, respectively, of any actual electrical circuit.' What follows? Would the truth of this latter fact (i.e., the absence of instances) 'make' Ohm's Law false?

Hardly. Construed as a material conditional, *P15* would read thus:

P16 *If the current in an electrical circuit is 5.7893 amperes and the resistance is 45,234.9 ohms, then the voltage is 261,878.40657 volts*

P16, it is clear, is *true* if no circuit has a current of 5.7893 amperes, or if no circuit has a resistance of 45,234.9 ohms, or if no circuit instances both these values.

If anything, having noninstanced values of its variables enhances the probability of a numerical proposition's being true. But of course having noninstanced values does not guarantee the truth of a numerical proposition unless *all* its numerical variables go wanting for lack of an instance. One need not fear for Ohm's Law on this latter count. It is hardly vacuously true. Millions upon millions of its variables are instanced daily on this planet, blanketed as it is with electronic devices.

Consider, now, what would happen on this analysis to a 'pretender'-law. Suppose someone were to hypothesize (contrary to what we are here assuming to be true) that the relationship between current, resistance, and voltage is not as stated in Ohm's Law, but is rather as stated in Liar's Law, namely,

P17 $IR = 2E$

The singular expansion of this 'pretender'-law would include

P18 *5.7893 amperes* $\times$ *45,234.9 ohms = 2* $\times$ *130,939.203285 volts*

Presuming, as above, that no circuit instances both these first two values, *P18*, like *P15*, will turn out to be true. But this does not mean that the 'pretender'-law, *P17*, also turns out to be true. *P18* is merely one among an infinite number of necessary but insufficient conditions for the truth of *P17*. And some of these other conditionals in the singular expansion of *P17*, rather than being vacuously true, will (assuming it is Ohm's Law that is *true*) be determinately false. In short,

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1 Should anyone think that these values might realistically be actually instanced, then construct a new example by increasing each of these figures by a factor of 10^{18}, 10^{21}, and 10^{39}, respectively. One will not find these latter values in this world.

having 'gaps' in the data base (i.e., not having actual instances for every logically possible solution of the numerical equation) does not mean we are saddled with Liar's Law.[2]

But gaps do present other problems. For any distribution, whatsoever, of graph points, provided that distribution is finite or denumerable, there will, theoretically, be an infinite number of *different* equations (curves) all fitting this set of points *perfectly*. If our data base is not mathematically continuous – and how could it be? – there will be an infinite number of different numerical laws all subsuming those data. No matter how many would-be 'laws' (curves) are (timelessly) eliminated by our future fillings-in of more and more gaps, (timelessly) there will always be an infinite number of different (i.e., logically nonequivalent) physical laws, each subsuming the totality of the actual past, present, and future gappy data.[3]

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[2] I have just given "data base" a specialized definition. Here and below, by "data" I do *not* mean "data gathered"; I mean, rather, "the *actual* instances (whether known or unknown) of the logically possible solutions to a physical law." I.e., "data" designates an ontological, not an epistemological, category. I regret having to distort the standard meaning of a common term, but I do not know of any other term that precisely embodies the sense I need here.

[3] Serendipitously, just a few weeks after I had written the above paragraph, my daughter came to me with a problem she was having in her junior high school math book (Sobel and Maletsky, 1974, p. 72). The students had been given the task of finding 'the' formula that fills the gaps in the following mapping:

x	y		z
3,	4	$\mapsto$	5
6,	8	$\mapsto$	10
9,	12	$\mapsto$	15
5,	12	?	?
16,	12	?	?
20,	15	?	?
8,	15	?	?

Diane could not figure out why the book gives as the 'official' answer "$z = \sqrt{x^2 + y^2}$" when she found another formula that equally well fit perfectly the first three (completed) entries in the table. Indeed, in just a few minutes, she and I found three solutions, all in some sense simpler than the official one:

$z = 2y - x$
$z = 3x - y$
$z = 5(y - x)$ *[footnote 3 continued on p. 192]*

Is the situation tolerable? We know what many persons have said about this plethora of equations all fitting the data: “Truth is simple; whichever of these is simplest, that is the true one.” And, “Necessity is reflected in the ease with which the proposition may be incorporated into the corpus of science.”

The reply is that these latter kinds of answers are misdirected. What persons who invoke *simplicity* as a criterion of acceptability are doing is not proposing a metaphysical test for nomicity, but a methodological rule for getting on with the job of predicting, explaining, and controlling the world.

Admittedly, this view – that all equations that fit the data, however different they may be from one another in their predictions of (timelessly) uninstanced values, are all laws – is at odds with the established view. Indeed, even most Regularists, too, probably believe that there is but *one* law, however complicated, that describes, for example, the interrelationship among the values of current, resistance, and voltage in all electrical circuits. But I think the Regularity Theory demands, and I cannot see that there would be any theoretical problems whatever in allowing, that there are as many laws as there are true propositions, each of which subsumes all the actual data, past, present, and future. Goodness knows we would not want to cite some of these laws in our day-to-day designing of electrical circuits – some of these laws are horrendously complicated, running on to miles of paper were we to try to express them in ordinary-sized type, for example – but they are laws nonetheless. Again, my point is the earlier one, that physical laws, construed as true descriptions of the singular facts of the world, must be distinguished from what are *used* as laws in scientific practice. (Also see Cartwright 1980b.)

One can imagine that a Necessitarian will want to bestow special status on one alone of these many equations, each of which fits the data:

> One of these propositions is necessary: It alone would fit all those possible data that are never actualized. Were the gaps to be filled in, all but one of these equations would be eliminated, and that one is the nomologically necessary one.

[cont.] Obviously, each of these latter formulas gives quite different sets of values for the completion of the third (*z*) column.

The relevance, to my discussion above, of this exercise is clear: There is no such thing as a unique curve fitting any finite set of points. As to the opinion one should form of my daughter’s mathematics text, decorum forbids an explicit suggestion.

The Regularist replies:

> Let me try one last time to challenge your views. Clearly, you seem to think that one alone among this vast set of nonequivalent equations, all of which fit the gappy data, is nomologically necessary. It is that one that would be true if all the gaps were to be filled in.
>
> But nomological necessity is not a determinate property of any member of this set. For there are as many ways to fill in the gaps as there are nonequivalent equations fitting the *actual* data. Every one, every last one, of all that infinite number of equations turns out in some possible world or other to be *the* one that fits the filled gaps. That is, every possible way of filling those gaps is realized in some possible world or other. And because those gaps, ex hypothesi, are not filled in this world, no determinate sense can be made of the supposition that this world is exactly one of those worlds and not another. Indeed, the one thing we must say is that this world is none of them. This world is not a world in which there is a single mathematical solution to the actual data.
>
> Each world in which the data are complete, that is, without gaps, is blessed with a single law subsuming those data. But this world is not so blessed; and we just have to put up with having many logically nonequivalent laws all subsuming the same data.
>
> To attribute nomological necessity to a proposition in this world is to suppose that certain propositions have a determinate property that, logically, they could not have. And to attribute nomological necessity to a proposition in a world blessed with gapless data is to say nothing more or less than in that world no other nonequivalent proposition subsumes those data.

The Necessitarian counterargues:

> I am glad you have invoked talk of possible worlds. My point can be put very nicely in terms of possible worlds. As you say, in this world the data base is gappy. There is an infinity of different possible ways those gaps might be filled in.
>
> But of course, in other possible worlds, these different possible ways are realized. In some possible worlds, the gaps are (partially or wholly) filled in one way, and in other possible worlds, the gaps are (partially or wholly) filled in other ways. Some of these nonactual possible worlds will be *physically accessible* from the actual world, others not. Consider the set of all those possible worlds that are physically accessible from this world. It is an infinite set. In each of these worlds (apart from the one in which the data base is completely filled in), there will be many, presumably infinitely many, formulas subsuming that world's own gappy data base. But there will be one formula, and one formula alone, *common* to all these worlds. And it is *that* unique formula that is the one that is nomologically necessary in this, the actual, world.

The Regularist has his last say in the matter:

> Talk of physical accessibility does not illuminate the matter in the slightest. It may give us a powerful heuristic method by which to conceive of these matters, but really it is just a translation, not an analysis, of the concepts at play here. Unless physical accessibility is to be some sort of intuitively comprehended primitive, *it* will have to be defined in terms of physical possibility, physical necessity, and the like. Or will it have to be defined in terms of nomological necessity? Either way, it will not ultimately solve the problems we have been addressing. It will only transubstantiate them.
>
> Here in the actual world, we have, as it were, an embarrassment of riches: An infinity of nonequivalent formulas all subsume the gappy data base. We Regularists (some of us anyway) are content to accord to all these formulas the status of lawfulness. You want to single out one, known or unknown, as being ‘the’ physical law. It is that one alone, that, *were* the gappy data base to be filled in, would subsume all the instanced values. Clearly, this is what your possible-worlds story is designed to do; to give us a way of specifying truth-conditions for this latter counterfactual conditional.
>
> But there is no good reason, whatever, to think that there is any one such favored solution. Why not simply allow that all formulas that fit the actual data are physical laws? Talk of physical accessibility and the like, although captivating, does not advance our ability one iota to distinguish one formula from another. It is a metaphysical distinction with absolutely no empirical manifestation. If it exists, it cannot – by its very nature – ever reveal itself to us empirically.
>
> Some persons have suggested that the mark of this nomological necessity is simplicity: that the one formula that is simplest, among all those that subsume the actual (gappy) data, is the one that is nomologically necessary.
>
> The trouble with this notion is that, again, it fails to provide a decision procedure. “Simplest” is not a well-defined notion. Then, too, when in our actual practice we have chosen, using some convenient if somewhat arbitrary notion of “simplest,” among a few ready-at-hand alternative formulas, it must be emphasized that these choices are not even between *true* statements. Virtually without exception, the various statements that get called “laws” in science are known to be false. Hence, they cannot be nomologically necessary. If simplicity were the hallmark of nomological necessity, again, we would have no idea when a statement satisfied that condition.
>
> Ordinary practice knowingly selects false propositions as workaday laws. It can hardly, then, be trusted to provide a guide to selecting one genuine nomological from

> among an infinite host of other true statements. Indeed, even if all these true statements were – per impossible – to be known, we might still much prefer to *use* a false approximation than to be saddled with the burden of calculating with a nomological of complexity beyond practical utility. That is, even if nomological statements could be recognized, we might not want to use or invoke them in our doing science. They might be too complicated for our purposes.
>
> In short, we are unable to analyze the concept of "nomological necessity," we have no way of recognizing nomologicals, and we probably would not want to use them if they *could* be recognized. Why, then, persist in the dogmatic, useless belief that they exist? The notion is at once idle and mischievous. Why not, finally, abandon it?

Although this latter exchange will close the discussion of numerical laws, it does not constitute quite the last word in the debate. In its course, this latest dialog has made reference to the practice of science. Might it be there, in what scientists do, rather than in what they examine, that one might find nomicity? One Necessitarian, Rescher, believes so.

In Chapter 6, we saw how Rescher argues that nomological necessity can never be "extracted from the evidence," that is, can never be revealed experimentally. Yet he remains sanguine about attributing nomological necessity to certain propositions. The passage quoted in Chapter 6 continues:

> Lawfulness is not found in or extracted from the evidence, it is superadded to it. *Lawfulness is a matter of imputation*. ... Men impute lawfulness to certain generalizations by according to them a particular role in the epistemological scheme of things, being prepared to use them in special ways in inferential contexts ...
>
> Lawfulness is not a matter of what the generalizations [*sic*] *says*, but a matter of *how it is to be used*. By being prepared to put it to certain kinds of uses in modal and hypothetical contexts, it is *we*, the users, who accord to a generalization its lawful status thus endowing it with nomological necessity and hypothetical force. Lawfulness is thus not a matter of the assertive content of a generalization, but of its epistemic status, as determined by the ways in which it is deployed in its applications. (Rescher 1970, p. 107)

The necessity Rescher would accord to physical laws is neither metaphysical nor linguistic, but epistemological. It arises out of the role physical laws play in our schemes of explanation. Much earlier in the same book, Rescher calls this property of physical laws their "coherence," but by the use of that term he does not mean simply *consistency* with one another or indeed even with the whole of the scientific corpus. Rather, he means the term to designate something stronger, what he also calls "integration into the body of scientific knowledge" (p. 16), that is, mutual support through interlocking deductive and inductive relationships. In short, "coherence" (in his specialized use), "lawfulness," "nomicity," and "integration" are all correlative terms. They connote a pragmatic aspect of select generalizations, an epistemic-cum-explanatory role in the scientific enterprise.

Rescher is certainly right in pointing out that what get used as laws by scientists in their giving of scientific explanations tend not to be 'isolated' propositions but those that 'fit' into larger schemes of theories. But the question we must ask is whether the distinction among universal and statistical generalizations – between those that get used as laws and those that do not – is the same distinction as that between nomicity and accidentalness. The answer will have to be: No. For when we examine Rescher's necessity-through-use, we find that it bears little resemblance to the traditional Necessitarian's nomological necessity and is ill-suited to offer the solutions Necessitarians have perennially demanded of nomological necessity.

The first, but by no means least, problem in Rescher's proposal to identify nomicity with elevated epistemic status in the scientific corpus is that nomicity has always been conceived to be a timeless property of propositions. In contrast, the body of scientific laws, that is, those propositions used by practicing scientists as laws, varies from time to time and, to a lesser degree, from place to place. Is nomicity thus to change, too, from time to time and place to place? Rescher is silent on this point. His theory seems geared to a static science rather than a dynamic one. But science is not fixed.

A nomicity that changes from time to time and place to place is totally unacceptable according to traditional Necessitarian accounts. After all, the nomological necessity of copper's conducting electricity is not supposed to be something that first occurred in the eighteenth century when conductivity was discovered. Copper is the sort of stuff that, if it conducts electricity necessarily, has *always* done so. But if the class of nomologicals is not to change in lockstep with the evolution of scientific practice, can we construct a timeless nomicity out of the flux of practice? The prospects are minimal. It will not do, for example, simply to say that a proposition is nomologically necessary if it is ever (in the past, present, or future) used as a scientific law and is not nomologically necessary if it is never so used or if it is firmly rejected as a law. The trouble is obvious: Many propositions that at one time are firmly entrenched as scientific laws (e.g., all flammable material contains phlogiston; all planets travel in circular orbits; electromagnetic radiation is a transverse wave propagated in a medium) are later just as firmly and resolutely regarded as nonlaws. A given proposition, then, might (timelessly) have contradictory properties, namely, being nomologically necessary and being not nomologically necessary. To construct a consistent, nonarbitrary theory of timeless nomicity, one would have to invoke a Science Completed. But were we to do that, we should never – because we cannot foretell the remote future developments of science – be able reasonably to regard ourselves as knowing of any proposition that it is nomologically necessary.

The difficulty with grounding a timeless necessity in the flux of practice is hardly the end of troubles. A second, no less serious, difficulty arises.

Can a nomological necessity, conceived to be an epistemological feature of propositions, assume the role that has traditionally been regarded as the preserve of an ontological necessity? Rescher writes as if it could:

> To explain a fact scientifically is thus to adduce reasons to show why *this* fact obtains rather than some one among its possible alternatives. This requires going beyond establishing that the fact *is* actually the case to showing that (in some sense) it *had to* be the case – that it was *necessary* and inevitable, that it should be so – or at least *probable* and “to be expected.”
>
> ... Scientific explanation proceeds by *subsumption under laws*, by placing the item to be explained as a somehow special case within a framework of generalizations that are taken to state how things must operate within a certain range of phenomena (1970, p. 11)

Note the admixture in this passage of psychological terms and metaphysical ones: On the one hand, “to be expected”; on the other, “had to be the case,” “inevitable,” and “must operate.”

It may be plausible to argue that the epistemic necessity of the generalizations we actually use in giving explanations accounts for our psychological expectations. To say that all *A*s are *B*s is epistemically necessary may be just another way of saying that a person who *knows* that this proposition is ‘integrated’ into the fabric of science *expects* all *A*s to be *B*s. Epistemic necessity and psychological expectation may well be closely allied. (Perhaps the connection is even analytic.) But psychological expectation is not metaphysical necessity. The shift between “to be expected” and “inevitable” is not, in this context, merely a shift between two psychological terms, but is also a shift between a psychological term and a metaphysical one. Throughout, the two categories – the psychological and the metaphysical – are confounded.

“Nomological necessity” or “theoretic coherence” in Rescher’s view arises out of the conscious, deliberate, rational practice of scientists. However he might choose eventually to explicate this notion, it is clear that it will have to be a relation one of whose terms will designate a set of persons, whether individual scientists, groups of them, or perhaps the entire scientific community. In any event, this explication of nomicity will have as a consequence that to attribute nomicity to a proposition is, at least in part, to say something about *us*. (Or, if not literally to *say* something about us, then at least to presuppose that our existence should *figure* somehow among the truth-conditions of that proposition’s being nomological.) Few Necessitarians have ever thought that the necessity of physical laws is a fact (however partial) about *us*. Consider Rescher’s own example: “All elms ... must shed their leaves in the fall” 1970; p. 11). Only Idealists and Pragmatists would think that this proposition was ‘about’ us as well as elms. Virtually everyone else would think that this proposition is not about us at all, but only about elms, leaves, autumnal days, and exfoliation.

Rescher is himself aware of the Idealist aspects of his theory and is forthright about them (Rescher 1970, section titled “Lawfulness as Mind-Dependent,” pp. 113-21):

1. The natural world comprises only the actual. This world does not contain a region where nonexistent or unactualized possibilities somehow “exist. “ Unactualized hypothetical possibilities do not exist in the world of objective reality at all.[4]

2. Nor do unactualized possibilities somehow exist in some Platonic realm of world-independent reality.

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4 Contrast with von Wright: [*p* (a generic state of affairs) may be] “A potency or latent possibility of the world” (1977, p. 20). This later quotation, recall, was examined in the section titled “Actualized and unactualized dispositions” in Chapter 8.

> 3. The very foundation for the distinction between something actual and something merely hypothetically possible is lacking in a "mindless" world. Unactualized hypothetical possibilities can be said to "exist" only insofar as they are *conceived* or *thought of* or *hypothesized*, and the like. For such a possibility to be (*esse*) is to be conceived (*concipiendi*). (pp. 118-19)

Rescher obviously shares with the Regularist the inability to 'locate' nomological necessity *in re*. But, unlike the Regularist, he is not prepared to abandon the notion that physical laws are nomologically necessary. And thus he 'locates' the necessity in *us*.

> A [universal] generalization like "All cats are vertebrates (i.e. have backbones)" *if not taken to formulate a law* makes a claim whose correctness is doubtless unaffected if we postulate a mindless universe. But if the [universal] generalization is construed in a lawful sense, as asserting that cats *have to* have backbones, with some sort of nomic necessity the story is quite different. For lawfulness "lies in the eyes of the beholder," since the lawfulness of a [universal] generalization consists in its being treated and classified and used in a certain way. (1970; p. 116. Glosses added)

Could nomicity thus explicated, lying "in the eyes of the beholder," possibly do what Rescher requires of nomicity? Could it, for example, account for the modal aspect of the 'having to' in "all cats *have to* have backbones"?

The suggestion strikes us as implausible. All cats, to the best of our knowledge, have backbones. But whether they do or not has nothing to do with us, not even with our engaging in scientific research and theory construction. Although we may discover this fact about cats, surely it was 'there' antecedently to be discovered. Why should the case be any different when it comes to ascertain whether cats *have to* have backbones? Why should this be a question requiring for its answer a fact about us? Surely – like their having backbones – their *having to* have backbones, if indeed it is a fact at all, is a fact about cats, not about us.

According to Rescher, in this world, cats do *have to* have backbones. But that is because *we* have done some science. In another possible world, as like this world as is consistent with no one's having got around to looking at feline anatomy, cats, although just like actual cats in that they all *do* possess backbones, do not *have to*. In not having to have spines, Rescher's fictional cats would be like Popper's actual moas who, Popper tells us, did not *have to* die before the age of fifty (see Popper 1959a, pp. 427-8). But Popper, although himself like Rescher a Necessitarian, would hardly want to explain the moas' escape from necessity as having anything to do with paleontologists coming on the New Zealand scene lately and making (or failing to make as the case may be) theoretical claims about fossil remains. Popper, we may be sure, would be loath to make each moa's premature, nonnecessary demise (and each cat's not having to have a backbone) a fact about what *we* have failed to do.

There probably is no argument that is finally decisive against the extraordinarily strange consequences of Rescher's theory. And the reason is that there is probably no finally conclusive argument against Idealism itself. If one is going to identify truth with consistency, for example, or nomological necessity with 'most favored status' among consistent propositions, one *can* insulate such theories from refutation. It is much harder, however, to argue plausibly that such notions solve traditional problems. On two counts – in its view of a static science and its concomitant difficulty in explicating a timeless nomicity; and in its identification of metaphysical necessity with epistemological necessity and its concomitant implausibility in making nomological necessity an artifact of our actions – Rescher's theory seems only to aggravate the traditional problems, not solve them.

There is a third difficulty as well. And although relatively minor, it bears remarking. Rescher does not observe the twofold distinction I have insisted upon between 'real' laws and the instrumental 'laws' actually used in the day-to-day practice of science. By failing to observe this distinction, he creates still another impediment to the acceptance of his theory. For he makes truth a necessary condition of nomicity. But although truth characterizes 'real' laws, it does not characterize many of the 'laws' used by scientists. These latter propositions, as I have said (Chapter 1), are virtually all false. Thus almost none of what scientists use as laws would turn out to be nomological. But if one were to relax Rescher's necessary condition of truth, one would have the paradoxical consequence that just about every proposition that is nomologically necessary is false. Statistically, nomological necessity would be more a companion property of falsity than of truth.

I agree with Rescher that nomicity cannot be located *in re*. Where I differ is in believing that nomicity must, then, be located somewhere else. If it is true that all elm trees shed their leaves, then *this* tree sheds its leaves because it is an elm tree. We do not have to attribute nomological necessity to this just-invoked universal generalization to ground the explanatory relation. It suffices that all elm trees shed their leaves. My finger hurts because I cut it, and because cuts usually (/always) hurt. One understands this, an explanation has been given, without strengthening the generalization with a species of necessity. One need not think of cuts as 'necessarily' hurting to understand that cuts (in general) hurt and that this one (in particular) hurts.

I have concluded with this theory of necessity-through-use because I think it is important to see how much this recent attempt at rehabilitation diverges from traditional Necessitarian accounts. There is, certainly, some fundamentally correct insight in Rescher's enterprise: What gets used as laws has much to do with such matters as simplicity, fruitfulness, and degree of integration with other claims (theories, hypotheses, assumptions). Very few of the infinity of universal and statistical generalizations prove interesting or useful. Most, even those that are true, are epistemic deadwood. [Utility increases with large extension and small intension. It is much more useful to be told that all metals conduct electricity than to be told (only) that aluminum conducts electricity; although the latter is in its turn more useful than to be told that a cube of aluminum measuring 1.34 cm along each edge and having a temperature of 42° C conducts electricity.] But standing high on the scale of utility and being used as a scientific law is not the same as being nomologically necessary. Traditionally, Necessitarians have invoked nomic necessity to explain why the world not just is, but has to be, the way it is. This kind of necessity cannot – in spite of Rescher's claims – arise as an artifact (epiphenomenon?) of the way we *do* science. Elm trees lose their leaves. Either they 'merely do' (i.e., they do), or they 'have to' (i.e., they must). But *if* they must, they must because of some way the world is; not because of something you or I, or the community of botanists, do by grouping various propositions into cohesive, mutually supporting, wholes. If Necessitarianism is to be advanced, at least let it be on ontological, not epistemological, grounds. Better yet, one should approach that theory with extreme wariness.

Postscript: cosmic coincidences

At one time in the history of Western thought, it seemed mysterious that the world could 'get' from one instant of time to the next. Persistence in time was something in need of explanation. How could mere inactive matter existing *now* bring it about that matter should exist after now? The existence of matter seemed to require an active agent, and that matter-now should 'give rise' to matter-later seemed incomprehensible. Matter-now seemed no more capable of creating matter-later than matter was capable of creating itself in the first place. And thus God, a necessary being, was seen as the active creator, not just in having brought the world into being in the first instance but in re-creating (i.e., conserving, sustaining) the universe from moment to moment.

Today, few persons would be moved by such a (transcendental) argument: The Thomistic presupposition that prompts it has fallen by the wayside. It is not so much that our science has changed (although, of course, if *has* changed, enormously and profoundly), but more that our metaphysics has changed. The existence of matter is not now quite the mystery it once was. Persons today are far more prepared to allow that matter should have existed for all eternity; equally, they entertain with equanimity the hypotheses occasionally advanced by scientists that particles of matter either 'spontaneously' appear in the world or 'coalesce' out of energy. In any event, the problem of how matter manages to keep itself in existence, how it 'gets from' now to later, just simply is a dead letter today. Indeed, the very question, and its answer, have been turned about. For it is fashionable today to *define* endurance in terms of a succession of 'instantaneous time-slices': "What it *means* for an object x to endure from t_1 to t_2 is (roughly) that there should exist a series of objects very similar to x along a continuous spatial path connecting t_1 and t_2." Whether by convention, by neglect, or by fashion, or perhaps because we have grown tired of asking a question for which there seems to be no rational answer, we no longer ask what it is that brings it about that there is such a series, what it is about matter that allows matter existing at one instant to be succeeded by matter existing at a latter instant. We have reached the point where we want to say: "That's just the way the world is. Matter-now is succeeded by matter-later." We feel no need to postulate necessary creators, occult powers, or mysterious creative (or conservationist) forces in this case.

And so it should be, too, with lawfulness. There is no more nomological necessity in some sample of water having a vapor pressure of 41.8 Torr at 35° C than there is in the fact that the chipped teacup on my desk should be succeeded by a chipped teacup. The latter sequence-kind (chipped teacups-now giving rise to chipped teacups-later) is hardly a necessary feature of this world; it is just the way this world *is*. But if we have been able to dispense with the awful mystery of the endurance of teacups, then might we not – equally – be able to dispense with the invented mystery of nomicity?

On a lovely fall afternoon recently, I was driving north along Gaglardi Way approaching the intersection with the Lougheed Highway. Five red cars, of various manufacture, were lined up in a row on Lougheed stopped at the red light. When they eventually drove off, they did not seem to be traveling in a convoy (three of the five turned left), and I was quite prepared to consider the congregation of five red cars as nothing more than an eye-catching coincidence.

But although five red cars assembled in one spot might be dismissed as a mere coincidence, ten such would strain one's credulity mightily.[1] And no one would be prepared to allow that a column of cars, a thousandfold in length, all red, could be a coincidence. Large-scale coincidences cry out for explanations that reveal the contrivance, planning, or deliberation behind the phenomenon. (Of course, if *all* cars were red, there would be nothing remarkable about there being an unrelieved monotony of hue in a column of 1,000 cars. But then the reason why all cars should be red would need explaining. It was, of course, no coincidence that all early Model T Fords were black: They were black because Henry Ford ordained that they should be.)

There are probably more than 10^{60} electrons in the universe, and all of them, we may suppose, have precisely the same electrical charge. Now although I am prepared to allow that five red cars in a row might be dismissed as a coincidence, can I allow that 10^{60} items with precisely the same electrical charge is likewise a coincidence?

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[1] The improbability increase exponentially.

Modern microphysics tries to explain away this last seeming coincidence: Electrons all bear the same charge because they are constituted of subparticles *x* and *y*, and all *x*s and *y*s have properties φ and ψ, respectively. And the incipient coincidence of all *x*s and *y*s having properties φ and ψ, respectively, is explained by discovering some further subsubparticles, *u* and *v*, all having properties F' and F'', respectively. But this regress cannot go on forever; it has to stop *somewhere.* Then what do we do?

One thing we might do is swallow deeply and then say, "Well, that's just the way the world is. All these untold billions upon billions of sub- ... -subparticles all share the same properties, F_1, ... F_2; and nothing, nothing at all, accounts for this fact."

Faced with the prospect of having to say this, many persons find the sheer *contingency* of the actual world utterly fantastic: "If it wasn't God (a super Henry Ford) who designed all this and saw to it that all these countless particles are qualitatively identical, then *something* has to account for it. That 10^{60} things should all be alike in their properties cannot *rationally* be deemed 'just a coincidence.'"

Having abandoned God, the next best thing to do is to invoke a depersonalized necessity: "Ultimate particles bear identical properties because *they have to*." This claim certainly has the form of a claim that would lessen the degree of contingency.

This 'having-to' just posited cannot, of course, be a *logical* 'having-to.' (That brand of rationalism is, I take it, permanently dead.) It must then be some weaker species, some nomological necessity. But does postulating nomological necessity to explain-away what would otherwise quite literally be a cosmic coincidence really help?

At some point, we have our backs to the wall. It seems to me reasonable to think the wall to be at the point where we say, "Well, these countless particles all have the same properties because that's just the way this world is." Others prefer to think of the wall as being one step further removed: "The world is the way it is because it has to be."[2] Frankly, I just cannot convince myself that this world *has to be* this way; it just *is*.

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[2] In saying this, these persons do *not* mean: "It has to be that the world is the way it is." This latter proposition is a *logical* truth.

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