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.
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> 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.
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> 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.
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> 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.