In 1766, a mathematics professor, Johann Daniel Titius, pointed out that the distances of the planetary orbits from the sun fall into a simple pattern. If the distance between the sun and Saturn’s orbit is divided into 100 equal units, then Mercury’s orbit is 4 of those units from the sun, Venus 4+3, Earth 4+6, and Mars 4+12. As far as Titius knew, there was a gap at 4+24 units, but Jupiter is at 4+48 and Saturn, of course, is at 4+96 units. This numerical progression doesn’t reflect the distances perfectly. How accurate it is depends on such things as what point of the planet’s orbit (closest, farthest, or average from the sun) is chosen. What is of interest to us is the debate that emerged: Bode, von Zach, Wurm, and others promoted the principle. Their position was substantiated by the discovery of Uranus at approximately 4+192 units and the discovery of the asteroid Ceres (taken to be a minor planet) at 4+24 units. Critics of the principle included Gauss, Lalande, Delambre, and Laplace. They are reported to have called it a “mere game with numbers”. (See Jaki 1972 for further discussion.)

What was this controversy about? What exactly was at issue? One reasonable understanding of this episode in the history of astronomy, it that these scientists disagreed about whether Titius had discovered a law of nature. Science includes many principles that were once thought to be laws and others that still are thought to be laws. Famous examples include Newton’s law of gravitation, his three laws of motion, the ideal gas laws, Einstein’s principle that no signals travel faster than light, Mendel’s laws, and the laws of supply and demand. In essence, the controversy was whether Titius’s principle was on a par with, say, Newton’s laws.

Laws of nature are not just important to scientists. They are also a matter of great interest to
us metaphysicians. We aren’t so much concerned with discovering laws. We are not in the business of figuring out what the laws are. We leave that to the scientists. Metaphysicians care about what it is to be a law, about lawhood, about whatever it is that is the essential difference between something’s being a law of nature and something’s not being a law of nature. The notion of a law is clearly a part of our common-sense conceptual framework and it is also clearly a part of our scientific conceptual framework. So it is job of the metaphysician to understand lawhood better, just like it is the metaphysician’s job to understand better what the mind is, what causation is, what free will is or what identity is. There is another important reason why metaphysicians investigate lawhood: Lawhood is critical to the standard formulation of determinism and is thought to be a key to understanding the counterfactual conditional and causation. As a result, lawhood is also central to the philosophical puzzles that arise about free will and about mental causation. As metaphysicians, we do need to ask: What is it to be a law?

1. Common Ground

There is some agreement among philosophers about the nature of laws of nature. Let us begin with a look at three standard assumptions. Like many things in philosophy, there is far from perfect agreement on these matters. There is enough, however, to lay the groundwork appropriate for a careful look at our topic.
a. Truth

Despite its accuracy about Ceres and the seven major planets nearest to the sun, the numerical progression proposed by Titius clearly is not in line with the orbital distances of Neptune and Pluto. The Titius principle (in its 1766 formulation and other improved formulations) was jettisoned after Neptune was discovered in 1846. Astronomers judged it not to be a law. Why? Obviously, this judgment was made because, in order for something to be a law of nature, it must be true. The determination of Neptune’s orbital distance from the sun showed the Titius principle to be false.

Be careful: The postulate that all laws are true can lead to some confusion. Strictly speaking, many things that are called ‘laws’, like Newton’s so-called law of gravitation, are not really laws. Relativity theory has shown Newton’s gravitational principle to be only a very good approximation. Titius’s progression is another good example. It is usually referred to as ‘Bode’s law’—Bode was its best known proponent—or ‘the Titius-Bode law’ even though it is not true. Do not be misled by these familiar ways of referring to the principles in question.

b. Generality

Something else seems important about the examples of laws of nature provided so far. They all are generalizations. They all make a claim to the effect that things have a certain property, usually a certain conditional property. For example, that no signals travel faster than light says about every individual thing in our universe that if it is a signal then it only travels at speeds less than or equal
to the speed of light. The Titius-Bode law says about every individual thing that if it is a planet orbiting the sun, then its orbital distance from the sun falls in the progression described above. Note that we are reluctant to accept anything but general propositions as laws. For instance, it would be strange to think that some singular fact (e.g., that the Earth has mass $5.98 \times 10^{24}$ kilograms) could be a law of nature, no matter how interesting or scientifically important it might be.

As was the case with the idea that truth is a necessary condition of lawhood, we urge you to be careful about the postulate that generality is too. In taking laws to be generalizations, we are not thereby denying that laws sometimes refer to specific objects, times, or places. (Generalizations referring to specific physical objects will be discussed in the Section 2.) Nor do we thereby deny either that there might be certain probabilistic laws or even what philosophers sometimes call *ceteris paribus* laws. The generalizations that all uranium atoms have a half-life of 1500 years or that all silver atoms exposed to a nonhomogeneous magnetic field have a 50% chance of having spin up are perfectly good candidates to be laws of nature. They are generalizations despite including an element of probability. Similarly, if it is true that, *ceteris paribus* (i.e., other things being equal), price is inversely proportional to supply, we do not intend anything we have said to disqualify this (hedged) generalization from being a law.

c. Contingency

Metaphysicians have generally held that some contingently true propositions could be laws of nature. For example, any possible world that as a matter of law obeys the general principles of Newtonian
physics is a world in which Newton’s first law of motion—the generalizations that all inertial bodies have no acceleration—is true. A possible world containing accelerating inertial bodies is a world in which Newton’s first is false. In fact, many have maintained that contingency is a necessary condition of being a law of nature. Mathematical principles, like one stating the commutative property of addition, are thought to be disqualified from being a law of nature because they are necessarily true. While it is much more controversial than our previous two postulates, we will also adopt the stance that all laws are contingent. So, our third postulate is that it is necessary condition of being a law that a proposition be contingent.¹

2. A Regularity Account of Lawhood

That all laws are true, contingent, and general inspires one simplistic but instructive attempt to say what lawhood is. The thought is that by taking these three necessary conditions and conjoining them we would get a necessary and sufficient condition:

¹Some metaphysicians known as necessitarians hold that no laws of nature are contingent. (For example, see Shoemaker 1980 and 1998.) They often argue that their position is a consequence of the correct theory of the individuation of properties. Roughly, they maintain that mass just would not be the property it is unless it had the causal powers it does, and hence obeyed the laws that it does. Though the issue cannot be decided here, we see little to recommend the necessitarian position. We find it plausible that our concept of mass could be exemplified and be subject to different laws, say ones with only slightly different constants.
P is a law of nature if and only if P is a contingently true generalization.

Sometimes called a *regularity account* because according to it laws are just (contingent) regularities, this analysis does make some true pronouncements. For example, according to our regularity account, it is a law that no signals travel faster than light. Still, the proposal faces at least three serious sorts of problems. A careful look at these problems will give us a better appreciation of how daunting the challenge is that metaphysicians face in their attempts to understand better what it is to be a law of nature.

First, there are many contingently true *restricted* generalizations that are not laws. These generalizations are restricted in virtue of referring to particular physical objects. Examples include that all rocks in this box contain iron, that all the screws in Smith’s car are rusty, and that all the apples in the refrigerator are yellow. Though these might all be true, none of them are laws. Even assuming they are all true, they seem much too accidental. A piece of pure quartz in the box, a stainless steel screw in Smith’s car, a Ruby Red in the refrigerator—these are all things that readily could have happened and each would have made one of the stated generalizations false. There is nothing fundamental about the way nature works that fixes the truth of any of these generalizations. It does not help to add a necessary condition to our regularity account requiring that laws not be restricted. The problem with such a necessary condition is that there are generalizations that could express laws that are restricted. Galileo’s law of free fall is the generalization that, *on Earth*, free-falling bodies accelerate at a rate of 9.8 meters per second squared. This generalization refers to Earth and yet it could be a law. The Titius-Bode law refers to the sun but it was not for this reason that doubts were raised about its lawhood.
Second, there are many contingently true generalizations that are not about anything in our universe: all unicorns are slow, all plaid pandas weigh exactly five kilograms, et cetera. These are usually called *vacuously true generalizations*. They have the form that all Fs are Gs and what makes them vacuously true is that there are no Fs. It may seem a little odd to even count these generalizations as true, but they are true.\(^2\) The problem for our regularity account is that, though true, they are not laws. This account counts them as laws, but really they are too accidental. Even if there were a plaid panda, there is no reason to think that it would weigh exactly five kilograms. If there were a unicorn, there is no guarantee that it would be slow. Demanding that a law of nature not be vacuously true would not solve the problem. There are vacuously true generalizations that are not accidentally true, even some that scientists have accepted as laws. Newton’s first law of motion is a good example. If our universe were Newtonian, it would be a law that all inertial bodies have no acceleration even though there would be no inertial bodies.

Though a lot of energy has been expended on the problems of vacuously true generalizations and of restricted generalizations, there is a third problem for our regularity account that is more vexing: There are contingently true generalizations that fail to be laws that make no mention of any particular physical object and that are also not vacuously true. Consider the unrestricted and nonvacuous generalization that all gold spheres are less than one mile in diameter. There have never been any gold spheres greater than a mile in diameter and in all likelihood there never will be.

\(^2\)The easiest way to see this is to recognize the equivalence between generalizations of the form ‘all Fs are Gs’ and generalizations of the form ‘No F is not G’. For example, the proposition that all signals don’t travel faster than light is equivalent to the proposition that no signals travel faster than light. Similarly, that all unicorns are slow is equivalent to no unicorns are fast. Notice that there is nothing odd about taking this latter proposition to be true. It is just so much common sense that no unicorns are fast.
Nevertheless, even assuming there never will be gold spheres that big, this is still not a law. Again, it is just too accidental. If we were curious and persistent enough, we could just gather that much gold together and and create a one-mile-in-diameter gold sphere.

The perplexing nature of this final puzzle for our regularity account is clearly revealed when the gold-sphere generalization is paired with a remarkably similar generalization about uranium spheres:

All gold spheres are less than a mile in diameter.

All uranium spheres are less than a mile in diameter.

Though the former is not a law, the latter arguably is. The latter is not nearly so accidental as the first, since uranium’s critical mass is such as to guarantee that such a large sphere will never exist (van Fraassen 1989, 27). What makes the difference? What makes the former an accidental generalization and the latter a law? These are hard questions.

Despite the limitations of our regularity account and (hopefully) because we have sketched what those limitations are, we suspect that you may already have a better idea of what lawhood is. What seems to be missing from the regularity account is some kind of requirement ensuring that laws not be accidentally true, something to ensure that they would remain true under a range of merely possible or counterfactual alternatives. This is precisely the sort of thing that seems to have bothered the critics of the Titius-Bode law when they accused it of being a mere game with numbers. With there being only a handful of known planets in our solar system at the time, it was hardly surprising that someone could cook up a neat progression that picked out the orbital distances reasonably well,
and the critics seemed well aware that there was more to being a law than just getting the distances right. They knew it was important that the progression hold up even if certain possibilities came to pass (e.g., if there were other planets). Understandably, the critics just didn’t see any good reason to think that it would.

What if we were to try to revise the regularity account to reflect these plausible thoughts about the importance of being nonaccidental? What if being a law amounts to holding up under a certain range of possibilities? Consider the following counterfactual analysis of lawhood:

P is a law if and only if P is a contingently true generalization that would remain true under a range of counterfactual alternatives.

Setting aside natural concerns about whether just any range of counterfactual alternatives would do, this analysis holds some promise. For example, since the generalization that all the screws in Smith’s car are rusty would not be true if there were a stainless steel screw holding the radiator to the chassis, this account might appropriately disqualify this restricted generalization from being a law. Similarly, since the generalization that all plaid pandas weigh 5 kilograms would not be true if some poor adult panda had its fur dyed plaid, this vacuously true generalization is also correctly disqualified by the counterfactual account. In contrast, we would fully expect a law like Newton’s first law of motion to hold up under these and many other counterfactual possibilities. Whether the Titius principle was a law would have turned on whether it would maintain its plausibility under various counterfactual possibilities.

Nevertheless, most philosophers would be disappointed if this counterfactual account was
all that could be said about lawhood. The leading philosophical accounts of the counterfactual conditional invoke lawhood and so there is a significant threat of circularity here. The fear is that we would have explained lawhood in terms of the counterfactual conditional and then turned around and explained the counterfactual conditional in terms of lawhood—not a satisfying state of affairs for a responsible philosopher looking for illumination about both counterfactuals and laws. At its root, the problem is that lawhood and the counterfactual conditional are too similar for an account of lawhood in terms of the counterfactual to be very informative. What philosophers have wanted (and what some would say they really need) is an account of lawhood that doesn’t appeal to the counterfactual conditional or any other concepts that are too similar to lawhood. These concepts are sometimes called nomic concepts and are thought to include the concepts of causation, explanation, and dispositions as well as the counterfactual conditional. Philosophers have wanted to give a thoroughly nonnomic account of what it is to be a law.

3. The Systems Approach and the Universals Approach

There are two very popular ways that metaphysicians have tried to give an analysis of lawhood without invoking any nomic terms. The first is the systems approach advocated by David Lewis (1976, 1983, 1986). The second is the universals approach advocated by David Armstrong (1978, 1983). In this section, we will consider some attractive features of these philosophical routes to understanding lawhood. In Sections 4 and 5, we will discuss some underdetermination examples that will clearly reveal some potential weaknesses.
a. Lewis on Laws

The kind of system that is important to the systems approach is a *deductive system*. A deductive system is a set of axioms, really just any set of propositions. The logical consequences of the axioms are known as the theorems of the system.

Deductive systems may have many different properties. Truth (all true axioms) is one straightforward one. Simplicity and strength are other examples, though they are not nearly so straightforward. Strength has to do with something like how interesting or applicable the theorems of the system are. Simplicity has to do with things like how many axioms there are and how complicated they are. Strength and simplicity compete. It is easy to make a system stronger by sacrificing simplicity: include all the truths as axioms. It is easy to make a system simple by sacrificing strength: have just the axiom that $2 + 2 = 4$.

According to Lewis, the laws of nature are the contingent generalizations that belong to all the true deductive systems with a best combination of simplicity and strength. So, for example, the thought is that it is a law that all uranium spheres are less than a mile in diameter because it is, arguably, part of the best deductive systems; quantum theory is an excellent theory of our universe and is arguably part of all the best systems, and it is plausible to think that quantum theory plus truths describing the nature of uranium would logically entail that there are no uranium spheres of that size. It is doubtful that the generalization that all gold spheres are less than a mile in diameter would be part of the best systems. It could be added as an axiom to any system, but not without sacrificing something in terms of simplicity.
Many features of the systems approach are appealing. For one thing, it appears prepared to deal with the challenge posed by vacuous laws. With the systems approach, there is no exclusion of vacuously true generalizations from the realm of laws, and yet only those vacuously true generalizations that belong to the best systems qualify. For another thing, the systems approach appears prepared to deal with restricted generalizations. The best systems could include some particular facts, say, about the mass of Earth, and so it could turn out that the theorems of all the best systems include a generalization like Galileo’s free-fall law; yet the best systems are not likely to include some particulars facts about, say, Smith’s car. Furthermore, it is reasonable to think that one goal of scientific theorizing is the formulation of true theories that are well balanced in terms of their simplicity and strength. So, the systems approach in addition to all its other attractions seems to underwrite the truism that an aim of science is the discovery of laws of nature.

One last aspect of the systems view that is appealing to many (though not all) is that it is in keeping with broadly Humean constraints on an account of lawhood. Hume was the great denier of necessary connections in nature. If $e$ caused $f$, then, for Hume, there is not any kind of necessitation relation in nature that is the causation. For Hume, if they were anything at all, causal connections had to be nothing more than constructs out of other simpler concepts given to us directly in perceptual sensations. Contemporary Humeans pretty much believe the same thing about lawful connections. If there is some kind of law about signals and a maximum velocity, then there is not any kind of lawful connection or relation in nature linking signalhood with that velocity. For Humeans, signalhood doesn’t necessitate anything in any interesting sense. The regularity account of Section 2 is a good example of a Humean account. If it were correct, then lawhood would be a construct out truth and a couple of arguably logical features: contingency and generality. The systems approach
is also a Humean approach; lawhood is just a construct of certain deductive relations, and certain considerations about simplicity, strength and best balance. If the systems approach is correct, then there doesn’t have to be any mysterious necessitation relations in nature in order for there to be laws of nature.

b. Armstrong on Laws

In the late 1970's, there emerged competition for the systems approach. Led by David Armstrong (1978, 1983), the main rival to the systems approach appeals to a universal to distinguish laws from nonlaws. Here is one of Armstrong’s concise statements of the framework characteristic of the universals approach:

> Suppose it to be a law that Fs are Gs. F-ness and G-ness are taken to be universals.
>
>A certain relation, a relation of non-logical or contingent necessitation, holds between F-ness and G-ness. This state of affairs may be symbolized as ‘N(F,G)’ (1983, 85).

As does the systems approach, this framework holds a great deal of promise. Maybe the difference between the uranium-spheres generalization and the gold-spheres generalization is that being uranium does necessitate being less than one mile in diameter, but being gold does not. It could be that being a screw in Smith’s car does not stand in the necessitation relation N to rust though being a free-falling body does stand in this relation to a 9.8-m/s/s acceleration. Being inertial may
necessitate zero acceleration, but being a unicorn not necessitate being slow. Some universalists also think that the framework supports the idea that laws can play a special explanatory role in inductive inferences, since a law is not just a universal generalization, but is an entirely different creature—a relation holding between two other universals. (See Section 5.)

Armstrong’s account is intended as an account of lawhood that does not use any nomic terms. ‘N’ is intended as a name for a relation in the world. The idea is that there is a law that Fs are Gs just when F-ness and G-ness stand in N. N is not an abbreviation for some nomic concept. It refers directly to a certain entity in the world. What is somewhat remarkable is how diametrically opposed the universals approach is to the systems approach despite the fact that both approaches seek a nonnomic characterization of what it is to be a law. For universalists like Armstrong, a contingent necessitation relation in nature is exactly what makes the difference between a law and an accident. In virtue of its appeal to a lawmaking universal, an element of necessitation, a lawful connection in nature, holding between the lawfully related properties, this is a decidedly not a Humean solution to the problem of laws.

4. Laws and Supervenience

Rather than trying to detail all the critical issues that divide the systems approach and the universals approach, we will do better to focus our attention on one crucial issue. The issue concerns supervenience. It concerns whether Humean considerations really determine what the laws are. There are some important examples that appear to show that they do not. The examples affect philosophers
in remarkably different ways. Some take the examples at face value and are moved to abandon Humean analyses of lawhood in favor of a universals analysis or for another (sometimes extreme) alternative theory. For others, the examples lead them to strengthen their commitment to the systems approach or some other Humean analysis.

Michael Tooley (1977) ingeniously asks us to suppose that there are ten different kinds of fundamental particles. With this supposition, it turns out that there are fifty-five possible kinds of two-particle interactions. Suppose also that fifty-four of these kinds of interactions have been studied and fifty-four corresponding laws have been proposed and thoroughly tested. What has not been studied at all is any interactions between the last two kinds of particles, which Tooley arbitrarily labels as ‘X’ and ‘Y’ particles. There have been plenty of the first fifty-four kinds of interactions, but not a single interaction of the fifty-fifth kind; X and Y particles have never crossed paths. Furthermore, these X-Y interactions will never be studied because conditions are such that these two kinds of particles never will interact.

One thing that is ingenious about this example is that, at least at first glance, it seems that there could well be a law about X-Y interactions. After all, in the example, scientists have already discovered laws for all of the other fifty-four kinds of interactions. Indeed, it is even true that nine of these laws are about X particles and that nine are about Y particles. So, there is some reason to think that there is also a law about what happens when X and Y particles get together, despite the fact that they never will. (Such a law would have to be a vacuously true law but we have already seen that this is no barrier to lawhood.) Another thing that is ingenious about Tooley’s example is that it seems that many, many different X-Y interaction laws are perfectly consistent with all the events that might take place during the complete history of this universe—past, present, and future. Even given
the complete history of this universe, the complete actual sequence of events and any other considerations a Humean might think important, there could be a law that, when X particles and Y particles interact, some P event occurs. But, then again, even given the complete history of this universe adding in whatever other Humean considerations you like, there could be a law that, when X particles and Y particles interact, some Q event occurs, where P events and Q events are very different, incompatible kinds of events.

This underdetermination or nonsupervenience suggested by Tooley’s example might not be restricted to his example. If the complete history of his ten-particle world doesn’t determine whether it is lawfully or accidentally true that X-Y interactions lead to P events, then maybe other histories leave the status of their laws unfixed too. Consider the possibility that there is a single physical object traveling through otherwise empty space at a constant velocity, of, say, one meter per second. It seems that this might just be a very barren Newtonian universe in which it is true that all bodies have a velocity of one meter per second, but where that is not a law of nature; it just so happens that there is nothing to alter its motion. But, one has to admit that it might also be the case that this world is not Newtonian and that it is a law that all bodies travel at one meter per second; it could be that this generalization is no coincidence and would have held true even if there were other bodies slamming into the moving object. Furthermore, we should consider our own situation. Maybe lawful underdetermination is actual. It can seem that our complete history is consistent with its being a law that all gold spheres are less than a mile in diameter. Even though we will never gather that much gold, maybe it is true that, if we were to, then the gold would start to decay or explode or disappear. Similarly, it can seem that our complete history is consistent with it being a remarkable accident that no signals travel faster than light. Maybe we will just never be smart enough to generate the
conditions under which a signal would travel much, much faster than light. Prima facie, this is perfectly consistent with the goings on in our world. The lawfulness of our laws seems like something the actual course of events doesn’t determine.

Tooley takes his example to make a case against Humean attempts to solve the problem of laws. (He favors a universals approach.) One can begin to see why he thinks that by considering what our regularity account from Section 2 says about his ten particle world.

When X and Y particles interact, a P event occurs.

When X and Y particles interact, a Q event occurs.

Our regularity account says about Tooley’s example that both of these X-Y generalizations are laws. But that is impossible because P events and Q events are incompatible. It cannot be true that, if there were an X-Y interaction, then both a P event and a Q event would occur. This problem for the regularity account is a consequence of the fact that the considerations appealed to in that account do not differentiate between these two generalizations. Because the two X-Y generalizations are both true contingent generalizations, they both get counted as laws. The trouble does not stop there for Humeans; the systems approach does not appear to be in much better shape than our regularity account. For not only do the two key X-Y generalizations not differ as regards to their logical form, their contingency, or their truth, they also don’t differ as regards their simplicity or their strength. Evidently, either they both would belong to all the best systems or neither would. It seems to be quite unreasonable to expect that all the best systems would include one of these generalizations and not the other.
In contrast, the universalist approach seems to be in better shape. In virtue of its appeal to facts about universals, it opens up the possibility that there is something that grounds the lawhood of exactly one of the generalizations. For all that it that has been said, it might be the case that being an X-Y interaction necessitates a P event though being an X-Y interaction does not necessitate a Q event. It could also go the other way: being an X-Y interaction might necessitate that a Q event occur but not necessitate that a P event occur. Indeed, that is what Tooley thinks ultimately determines what the laws really are in his example. The other underdetermination examples are dealt with in the same way: Wondering what determines whether it is a law in the single body example that all bodies have a velocity of one meter per second? For Tooley, it just depends on what the necessitation relation relates. Why is it not a law in our world that all gold spheres are less than a mile in diameter? According to Tooley, it is because being a gold sphere doesn’t stand in the necessitation relation to being less than a mile in diameter.

Many philosophers are not prepared to draw the conclusions drawn by Tooley. For example, even though he is quite prepared to believe in universals and in their importance to an account of laws, Armstrong is troubled by the idea that there could be an uninstantiated universal like being an X-Y interaction floating about doing any necessitating of anything! Furthermore, Tooley’s example exposes a void in the universalist approach, at least insofar as that view has been presented here. It is awfully convenient for Tooley that the universals line up so nicely in the Plato’s Heaven of the underdetermination examples, doling out lawfulness to exactly the generalizations that are really laws. But, why should we believe that they really do line up so nicely? What do we really know about this necessitation relation, besides its name? What relation is it? This is the first of the two problems Bas van Fraassen calls the identification problem and the inference problem (1989, 96).
Basically, there needs to be a specification of what the lawmaking relation is (the identification problem). Then, there needs to be a determination of whether it is suited to the task (the inference problem): Does N’s holding between F and G entail that Fs are Gs? Do laws really turn out not to supervene on the Humean facts in the way Tooley says they do? Do universalist laws hold up under a range of counterfactual alternatives?

For these sorts of reasons, the underdetermination examples often generate a kind of anxiety that pushes some philosophers back to Humeanism. In Section 5 we will consider the epistemological worry generated by these examples. Basically, Humeans must contend that these so-called possible worlds are not really possible. But before looking at the epistemological issues about laws, let us briefly report a very different reaction some philosophers have to the nonsupervenience cases; the fall out examples has been a range of sometimes extreme philosophical stances that go way beyond the issues dividing Lewis and Armstrong. The stance we will describe is to adopt some form of antirealism. Some go so far as to hold that there are no laws. For example, van Fraassen develops this view at length in his *Laws and Symmetries*. He finds support for this in the problems facing certain accounts of lawhood (e.g., Lewis’s and Armstrong’s), and the perceived failure of philosophers to describe an adequate epistemology that permits rational belief in laws. Other philosophers (e.g., Ward 2002) adopt a subtly different sort of antirealism. Though they will utter sentences like ‘It is a law that no signals travel faster than light’, they are antirealists in virtue of thinking that such sentences are not (purely) fact stating. Whether this Einsteinian generalization is a law is not a fact about the universe; it is not something out there waiting to be discovered. Rather lawhood sentences project a certain attitude (in addition to belief) about the contained generalizations.
5. Induction and Skepticism

Nelson Goodman thought that the difference between laws of nature and accidental truths was linked inextricably with the problem of induction. In his “The New Riddle of Induction” (1983, [first published 1954], 73), he says,

Only a statement that is lawlike—regardless of its truth or falsity or its scientific importance—is capable of receiving confirmation from an instance of it; accidental statements are not.

Lawlikeness is whatever property a generalization needs, aside from truth, in order to be a law. Apparently, Goodman’s claim is that, if a generalization is accidentally true (and so not lawlike), then an instance of the generalization does not confirm—is no evidence—that the generalization is true. That may be an overly strong interpretation; it may be that he is only claiming that a single instance of a generalization that is not lawlike never provides enough evidence to justify believing that the generalization is true. On either interpretation, the idea is that the generalizations that are not lawlike are bound to be too accidental for one instance to indicate their truth. They might still be true, but just one instance doesn’t decide their truth. Finding one rusty screw in Smith’s car shouldn’t lead us to believe that all that all the screws in Smith’s car are rusty. That first screw may have been a fluke.

Goodman’s idea is not without problems. Suppose I will throw a brand new die twice and
then destroy it. Also suppose that I am interested in whether it will come up six both times it is
tossed. I throw it the first time and it does land six. Notice that this single instance has increased
dramatically the probability that it is true that this die will land heads on every toss. Before the first
toss that probability was, 1/36 or about 3%. Now that the first toss has landed as a six that probability
has gone up to 1/6 or about 17%. This suggests that the strong interpretation of Goodman’s claim
is mistaken; my observation of one instance of the generalization that this die will always land heads
has provided some evidence for this generalization. A variation of this case makes trouble for the
weaker interpretation of Goodman’s claim: Suppose I know that the die will only be tossed once
before it is destroyed and then see it land six. The probability that the die will always land six
increases from about 17% to 100%! It has provided so much evidence that evidently we would be
justified in believing that this die will always land six.

It is standard to respond to such examples by suggesting that what does require lawlikeness
is confirmation of the generalization’s unexamined instances. If this is correct, what matters in our
first example is whether the first toss increases the probability that the second toss will land six. And,
of course, it does not. The probability of the second toss landing six is 1/6 before the first toss is
made, and this probability is still 1/6 after the first toss is made. In our second example, it is also true
(trivially so) that the probability of the generalization holding for unexamined instances is not
raised; there are no unexamined instances. In the second case, there has been an exhaustive
examination of the instances.

Unfortunately, there are other problems. Some of these may seem kind of trivial but we
should always remember that philosophers like to get at the strict and literal truth, and these other
problems at least strongly indicate that the followers of Goodman really have their work cut out for
them. The biggest problem is that background beliefs can really mess things up. We have already seen evidence of this in the prior examples where our prior knowledge that the die would only be tossed once or twice played a major role. The role of background beliefs, however, could have been more dramatic. Suppose you know that Sam always sorts his coins by what pocket they are in and that he has lots of coins in every pocket. Sam shows you one of the coins from his left front pants pocket and you see that it is a nickel. Evidently, this instance of the generalization that all the coins in Sam’s left front pocket are nickels has confirmed this generalization. Given your background knowledge, you seem perfectly justified in believing that this generalization is true even though it is not lawlike.

That is hardly the only problem facing Goodman’s proposed connection between lawhood and induction. Here is another that may have already occurred to you. We all know that all gold spheres are less than a mile in diameter—always have been and always will be. But, how could we know this if Goodman is on the right track? That generalization is true and not a law of nature. So, it is not lawlike but evidently it is something that is very well confirmed. There will in the future be gold spheres that are currently unexamined instances. We have very good reason to believe that they will be less than a mile in diameter.

Sometimes the idea that laws have a special role to play in induction serves as the starting point for a criticism of Humean analyses. Fred Dretske (1977, 261-262) and Armstrong (1983, 52-59) adopt a view about induction on which it involves an inference to the best explanation. On its simplest construal, their model describes a pattern that begins with an observation of instances of a generalization, includes an inference to the corresponding law (this is the inference to the best explanation), and concludes with an inference to the generalization itself or to some conclusion about
its unobserved instances. The complaint lodged against Humeans is that, on their view of what laws are, laws are not suited to explain their instances and so cannot sustain the required inference to the best explanation. After all, if laws are generalizations and so are summaries of their instances, then they can’t explain their instances. Does the fact that all Fs are Gs explain why this F is a G? It is hard to see how it could because that this F is G is part of what makes it true that all Fs are Gs. So, much in the spirit of Goodman, some philosophers maintain that the role of laws in induction is so important that it indicates what the laws must be like. Otherwise, at least according to Dretske and Armstrong, inductive skepticism threatens Humeanism.

Dretske’s and Armstrong’s argument is, perhaps, a little quick. They rely on a model of induction that threatens to overintellectualize inductive reasoning. It certainly cannot be the case that, whenever anyone reasons inductively, they form a belief that something is a law of nature. Isn’t it only the very best scientists that have very well confirmed beliefs about what the laws are? So, what work is the model of inductive reasoning supposed to be doing, if it is not providing a constraint on ordinary rational inductive inferences? What’s more, it is important to keep in mind that someone might maintain that all laws are generalizations without holding that all generalizations are laws. If so, they might also adopt a model of inductive inference similar to Dretske’s and Armstrong’s where a hypothesis to the effect that it is a law that all Fs are Gs is introduced to explain the examined positive instances; the universal generalization, that all Fs are Gs, needn’t be the thing doing the explaining. With a suitably rich conception of lawhood, one could accept their model of induction, accept that all laws are universal generalizations, and yet still avoid the trap leading to inductive skepticism. What the conception of lawhood is will be crucial to whether Humeans ultimately can use this maneuver to sidestep the skeptical trap.
In sharp contrast with Armstrong’s and Dretske’s claims, Humeans argue that those who reject supervenience—including philosophers like Armstrong and Dretske—are the ones plagued with skepticism. In our discussion of supervenience, we mentioned the idea that the actual world might match up with some other possible world’s complete history of events despite the fact that the other world had different laws. It is this possibility that generates the most serious skeptical challenge. That is, the skeptical worry about nonsupervenience takes its strongest form when we suppose that the Humean facts of the actual world do not determine what generalizations are laws.

So, let us take this idea seriously. Let us suppose that the actual course of events does not determine whether it is a law that all gold spheres are less than a mile in diameter. If this matters is left underdetermined, then how can we be sure, how can we know that it is only an accident that all gold spheres are less than a mile in diameter? How can we know it is not a law that no signals travel faster than light? The available evidence, limited as it is to the Humean facts, does not favor one of these hypotheses over the other.

It is important to remember that, at least sometimes, we can’t know what the laws are. Tooley’s underdetermination case provides a straightforward example. There really doesn’t seem to be any evidence in Tooley’s world as to what the law governing X-Y particle interactions actually says. In all likelihood, no one in this world would be in a position to know what all the laws are. This semi-skeptical conclusion, however, should not worry Tooley or anyone prepared to reject Humeanism. It is very obvious that there are a great many ways a world could be such that the scientists of that world will not discover every fact. For example, suppose scientists want to know what happens on a certain date at a certain time as a result of a specific chancy astronomical process. They know that the result will be a quick flash of light, but they do not know what its intensity will
be. They are paying close attention as the time approaches. When the time comes, the source supplying their instruments with electricity goes out, and they do not measure the intensity of the light. As a result, they can never know its intensity. This “skeptical” consequence is not the least bit worrisome; it accurately describes the situation these scientists are in. Just so, it seems that is an appropriate and unremarkable “skeptical” consequence that scientists wouldn’t know the nature of the X-Y law in Tooley’s example..

Another important point to keep in mind: Epistemological questions have been known to befuddle metaphysical issues. Berkeley's idealism is a well-known example. Faced with Descartes's skeptical investigations, Berkeley advanced a metaphysical position giving us easy access to the external world. Our perceptions, apparently, constitute the basis of our knowledge of the external world; Berkeley's metaphysics has it that our perceptions (along with God's) are what make it the case that facts about the external world obtain. Much later, for similar reasons, phenomenalists sought a reduction of physical object propositions to pure appearance propositions. In the same spirit, the epistemological importance of behavior to our beliefs about other minds led behaviorists to seek an analysis of mental concepts in purely behavioral terms. Engrossed by epistemological worries, the search for epistemologically oriented analyses of this sort takes on an aura of legitimacy. Yet the history of philosophy teaches us that epistemology can be a bad guide to metaphysics. This, fortunately, has been recognized with regard to the problem of the external world and the problem of other minds. Impressed by the failings of idealist, phenomenalist, and behaviorist analyses, the sensible philosopher rejects Berkeley’s idealism, phenomenalism, and behaviorism. Let’s face it: The Humean has to make it very clear that he is not making the same mistakes made by the phenomenalists and the behaviorists.
When considering any epistemological questions about the nature of lawhood, we should also keep in mind that the history of philosophy is full of important and frustrating skeptical arguments that can seem to show we don’t know much of anything. Contemporary versions of the skeptical concern about laws tend to take the form of something like a relevant alternatives attack. If I am at the zoo in front of a cage labeled ‘Zebra’ and see, standing in front of me, a four-legged striped mammal that I take to be a zebra, a friend might still give me some pause by claiming that I don’t know that it is not a mule cleverly disguised to look like a zebra. Since a cleverly disguised mule would look just like the animal before me and the sign would still be there and so on, it can seem that I do not know it is not a mule and so also that I don’t know it is a zebra. It seems that in pointing out that it might be a law and not an accident that all gold spheres are less than a mile in diameter, the Humean is engaged in some sort of similar activity. As important as this kind of skeptical reasoning is for philosophical investigation, it seems doubtful that it should have any consequences for how lawhood should be analyzed or whether supervenience holds; the reasoning is as compelling about zebrahood as it is about lawhood.

Nevertheless, the Humean skeptical worry should not be ignored. It certainly would be troublesome if it turned out that we can never know what the laws are! If a position on lawhood, be it the rejection of supervenience or something else, has the consequence that no one ever knows that any proposition is a law, then the defender of that position should be concerned. The metaphysician’s motivation for engaging in an investigation of laws stems in part from the seeming truism that scientists do try to discover laws. If it should turn out that the scientists who debated the lawfulness of the Titius-Bode law or any other law-seeking scientists were engaged in an activity bound not to result in knowledge of what the laws are, then metaphysics would have led us to an unintuitive and
unenviable take on the nature of the world.

Cited References


