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Postgraduate/Distance Learning Assignment coversheet & feedback form

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For completion by the student:

Student Name:

Derek Linney

Module code:

HPPH7010

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R.R.R. 2218467 →

Module tutor:

RH

Assignment due date:

If your module has multiple submissions please indicate which piece of work this is.

1st ☐ 2nd ☒ 3rd ☐ 4th ☐ 5th ☐ 6th ☐

I confirm that this is my original work and that I have adhered to the University policy on plagiarism.

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Assignment Mark

1st Marker's Provisional mark

80

2nd Marker's/Moderator's provisional mark

Agreed Internal Mark:

External Examiner's mark (if relevant)

Final Mark

NB. All marks are provisional until confirmed by the Final Examination Board.

This is an excellent piece of work that focuses on the task set whilst

For completion by Marker 1:

Comments: showing in-depth & wide scholarship of the topic, linking issues in philosophy of Science with the problem of induction as Hume sees it. This is some need to draw on Hume's claims a little more, utilising the primary reading for Hume, but, as it stands, you've demonstrated a systematic, critical & sophisticated understanding of the topic. It is enjoyable to read too, with the presentation of ideas & arguments being clear, accessible & thorough.

Marker's signature:

Date:

For completion by Marker 2/Moderator:

Comments:

Marker's Signature:

Date:

AGREED INTERNAL MARK (where necessary):

Comment on process on arriving at agreed mark:

External Examiner's comments (if relevant)

External Examiner's Signature:

Date:

Q3. Can scientists prove that a formulation of a law of nature is true? Provide reasons / support for your answer and discuss with reference to the problem of induction.

✓ This essay provides a brief overview of what constitutes a *law of nature*; including aspects such as regularity, generality, and invariance and whether a law is necessary or contingent. It then discusses how scientific theories address laws of nature; whether they simply describe (formulate) the effects of the law or offer an explanation of the cause(s) of the law – i.e., whether they are essentially epistemological or ontological in content. The question as to whether a formulation of a law can be proven is addressed with specific reference to the problems of inductive reasoning. It considers two primary varieties of scientific theories, those that are mathematically/formulaically describable and those that are statistical laws; it considers the nature of proof in each case. The problem of *ceteris paribus* conditions, implicit in most scientific theories, is discussed with reference to the challenge this poses for proving those theorems. The essay considers three specific examples of laws of nature and the scientific theories surrounding them: the Newtonian theory of gravity, the Pauli Exclusion Principle, and the Mendelian theory of genetics. While concluding that absolute proof is not possible as a result of the problems posed by induction, scientific theories can achieve a high degree of practical reliability particularly within the limits imposed by the resolution and scope of the available scientific tools and experimental techniques.

What does or does not constitute a law of nature is, in general, easily intuitively recognised by scientists but formulating a definition poses a difficult challenge for philosophy.¹ The two main approaches are firstly that laws of nature are contingent and are recognised by regularities of behaviour that occur together and in a fixed sequence without necessarily assigning a specific causal relationship, and the alternative approach which holds that the laws are necessary, and they constrain nature to behave as prescribed by the rules.² General to both views is that laws:

- a) describe regular patterns of behaviour of nature rather than being one-off behavioural instances
- b) are general in their applicability – for example, the law applies to a wide category of objects: apples, oranges, rocks etc. and there aren't separate laws for apples and oranges
- c) are invariant of time and location – they are the same in all locations and at different times.

¹ John T. Roberts, "Laws of Nature," in *The Oxford Handbook of Philosophy of Science* (Oxford University Press, 2016), p.340.

² Roberts, in *The Oxford Handbook of Philosophy of Science*, p.345. ✓

Most definitions of laws include an additional condition:

- d) they support counterfactual reasoning. For example, I can state that were I at the moment holding an apple in my hand and let go of it then it would fall to the ground under the force of gravity.

A scientific theory of a law of nature needs to encompass the above conditions to be regarded as a "good" scientific theory of that law. For example, one of the great strengths of the Newtonian theory of gravity is its generality: it applies equally to the apple dropping from the tree to the behaviour of the planets orbiting the sun. While the laws themselves may be considered to be either contingent or necessary, it should be noted that the inferences of induction (see later) as used in scientific theories are intrinsically not necessary but contingent.³

Clearly, any sceptical theory of knowledge would automatically preclude the ability to prove a scientific theory; a non-realist view of the world would also negate the ability of scientific theory to provably describe a law of nature. This essay therefore presumes a realist view in order to afford a discussion of the extent to which a scientific theory can be proven to describe a law of nature. There is, even in a realist view of the world, a question as to whether laws of nature exist at all or, whether, what we call a law of nature is a mental construct resulting from an inherent tendency to look for patterns in the world.⁴ In this case, the existence of a theory (scientific or otherwise – e.g. a folk theory) could be regarded as a prerequisite for the existence of a law of nature. Dretske, however, refutes this and says that "the existence of laws does not wait our identification of them".⁵ An illustration of the role of the mind in looking for regularities in nature is given by a sequence of coin tosses that turns up 20 x heads; we infer that this sequence is unlikely to occur with a fair coin and is likely the result of bias in the coin; whereas if the sequence HTTTHHTHHTTHTHTTHT turns up we accept this as a random result and that the coin is fair. In fact, with a fair coin, the latter sequence is no more nor no less likely than the 20 x heads; but we detect a pattern, a regularity in 20 x heads, that we don't see in the other sequence.

Some scientific theories are limited to describing, often in mathematical terms, the effects resulting from a set of initial conditions. Effectively they only describe or formulate the effects of an assumed causal relationship. Newton's law of gravity describes the force acting between bodies that have mass and his laws of motion describe the acceleration that a body will experience when acted upon by such a force. Newton makes no attempt to explain what gravity actually is or what causes the force of attraction; he simply quantifies it. By contrast, some theories attempt to explain the mechanism(s)

³ Jan Sprenger, "Confirmation and Induction" in *The Oxford Handbook of Philosophy of Science* (Oxford University Press, 2016). p.185.

⁴ See John Earman, "Laws of Nature," in *Philosophy of Science*, ed. Yuri Balashov and Alex Rosenberg (London: Routledge, 2002).

⁵ Fred I. Dretske, "Laws of Nature," *Philosophy of Science* 44, no. 2 (1977). p. 262.

behind the perceived causal effect. For example, Einstein, partly because he was uncomfortable with the implied action at a distance aspect of Newtonian gravity, formulated the theory of General Relativity which theorises that the apparent force of gravity is caused by a deformation of space-time in the region of a body of non-zero mass, thus eliminating action at a distance. Of course, the explanation, like all reductionist arguments has to stop somewhere, and how the mass actually deforms space-time is not explained.⁶ Dretske argues that not only are laws of nature necessary - "they tell us what must happen, not merely what has and will happen ..." - but they must also include some explanatory power in order to distinguish them from the more general category of universal truths.⁷

There is a line of thought that the laws of nature should not be considered individually but are part of a system of laws working together.⁸ A candidate for being considered as a law of nature should fit into this system if it is to be accepted. Further, laws should "belong to the deductive system with the best combination of simplicity and strength".⁹ Under this approach, "one goal of scientists theorizing is the formulation of true theories that are well balanced in terms of their simplicity and strength".¹⁰ Hossenfelder however, believes that modern theoretical physics is being led astray by the concentration on simplicity and the effective use of 'beauty' to decide amongst competing theories of particle physics.¹¹

✓ The requirement for a theory to describe the generality of a law of nature poses one of the challenges to the proof of a theory; experiments and observations are necessarily limited in the number and type of object or behaviour that can be observed and it is therefore an article of faith, rather than proof, that the results would apply equally to other, unobserved, or inaccessible objects and behaviour. As an example, it is not clear whether the widely accepted scientific laws of physics hold in all locations, such as within black holes, or across all times, such as in the first few moments of time after the assumed 'big bang' origin of the universe.

As the accuracy and resolution of scientific instruments, such as the telescope or microscope, have improved over time then previously accepted scientific theories have had to be revised or rejected following measured behaviours incompatible with these theories. At best, one is rationally only able to say that 'subject to the limits of experimental accuracy' then a particular theory corresponds, or explains, a particular law of nature.

⁶ See for example: John Gribbin, *Science, a History, 1543-2001* (London ; New York: Allen Lane, 2002). p.595.

⁷ Dretske, pp.262-263.

⁸ John W. Carroll. "Laws of Nature", *The Stanford Encyclopedia of Philosophy* (Winter 2020 Edition), <https://plato.stanford.edu/archives/win2020/entries/laws-of-nature/>, 2020. p.4.

⁹ David Lewis quoted in Carroll, p.4.

¹⁰ Carroll, p.5.

¹¹ Sabine Hossenfelder, *Lost in Math : How Beauty Leads Physics Astray* (New York: Basic Books, 2018).

Deductive logic proceeds from premises through a logical process to deduce a conclusion. Provided the logic of the argument is valid then the truth of the premises ensures the truth of the conclusion. In inductive logic a conclusion is inferred from a set of data: observations, measurements etc..¹² Unlike deductive logic which can lead to a proven conclusion, inductive logic provides, at best, only support to the inferred conclusion. Francis Bacon, in *Novum Organon*, was the first to articulate the role of inductive reasoning in science; he proposed a process of eliminative induction – an empirical approach whereby potential causes of an effect can be eliminated by identifying situations where the effect occurs, but the proposed cause was not present.¹³ Descartes proposed a similar approach in *Discours de la Methode*. Neither, however, proposed any justification for the inferences from inductive reasoning.

Very good examples

David Hume was the first philosopher to fully explore induction and its problems and, in *An Enquiry Concerning Human Understanding*, articulated the problem of induction as “it is not reasoning which engages us to suppose the past resembling the future”: that is, it is not rational to be certain that what has held in the past will continue to hold in the future.¹⁴ The need for an empirical approach in science, using inductive inference, arises from the fact that causal relationships cannot be inferred *a priori* but only from experience. Despite many efforts to refute Hume’s statement of the problem of induction, no satisfactory counterargument has been totally successful although some approaches try to limit the implied scepticism.¹⁵ Sprenger puts it as “it is well acknowledged that no purely epistemic, noncircular justification for induction can be given.”¹⁶ Attempts to circumvent induction by an appeal to the success of theories that have always in the past predicted future events accurately does not overcome the problem of induction since the logic of such an argument is itself inductive.

While most scientific theories are based directly upon inductive logic - a series of observations and measurements either lead to a formulation of a theory or a hypothesised theory is supported by observations – there are some scientific theories that are deductive in nature, but the premises, other scientific theories, on which they are based ultimately themselves rely upon inductive logic. Hence, all scientific, as opposed to mathematical or logical theories, are therefore ultimately inductive. This means it can never be absolutely proved that their formulation accurately describes a law of nature.

The challenge that induction poses is that there is no rationally supportable argument that proves that a theory that is valid today, or for all of known history, will continue to be valid tomorrow. However, at the root of this is that one cannot rationally maintain that it is inevitable that a law of nature will continue

¹² James Hawthorne. "Inductive Logic", *The Stanford Encyclopedia of Philosophy* (Spring 2021 Edition), <https://plato.stanford.edu/entries/logic-inductive/>, 2021.

¹³ Sprenger.p.185-6.

¹⁴ David Hume, and P. J. R. Millican, *An Enquiry Concerning Human Understanding*, Oxford World's Classics (Oxford ; New York: Oxford University Press., 2007). Sect IV. Part II [23].

¹⁵ Leah Henderson. "The Problem of Induction", *The Stanford Encyclopedia of Philosophy* (Winter 2022 Edition), <https://plato.stanford.edu/entries/induction-problem/#LiviInduSkep>, 2022.

¹⁶ Sprenger.p.206.

to hold tomorrow, whether or not we have a scientific theory of that law. While we cannot have an absolute proof of the theory, we can have a very high degree of belief that, unless nature itself changes, then the theory will continue to apply. Similarly, while we assume that nature is homogeneous across location and time, we cannot prove this given that the application of inductive logic limits our ability to extrapolate results into unobserved or unobservable locations. Even if one appeals to the regularity of nature precluding a change in the fundamental laws of nature one is still ultimately prone to uncertainty in inductive reasoning: hypothetically, for example, it could be that a constant, such as G in the theory of gravity, changes regularly every 10,000 years and we simply haven't been observing it long enough to be able to exclude the possibility of an imminent change; the change would not represent a failure of regularity.

✓ Popper rejects the view that scientific theories are derived by a process of inductive logic, arguing instead that scientific theories are hypothesised, and that deductive logic is then applied to the theory to generate predictions¹⁷. These predictions can then be investigated by looking for corroborative evidence or conducting experiments. However, he further states that the primary goal is to find evidence of refutation in order to falsify the theory. If there is no process or result that could falsify a theory, then he maintains that the theory is pseudo-science and not science. While ostensibly avoiding the problems of induction, as Popper believes, his approach doesn't avoid the issue of whether a theory can be proved since he explicitly states that a scientific theory can only be refuted and not proved.

One can ask whether the assumed invariant nature of laws of nature as contained within the formulation of scientific theories is a reasonable assumption. It is not inconceivable, for example, that the gravitational constant embedded in Newton's law of gravity, could change subtly over long periods of time or be different in different parts of the universe. Indeed, while that law, suitably adjusted for general relativity, explains the motions of the nearby, in cosmological terms, bodies in space there is an interesting issue when observing the movement of distant galaxies. Their movement doesn't correspond to what we would expect. The cosmologist's response is to believe that gravity, as a law of nature, is indeed invariant and therefore, in order to explain the observed movements of the galaxies, she invokes the existence of vast quantities of dark matter (unobservable matter but with mass) in the universe.¹⁸ By contrast, there are some assumed laws of nature whose invariant nature does seem to be absolute with regard to space and time. Consider, for example, the Pauli Exclusion Principle which postulates that electrons (indeed all fermions) of the same spin cannot occupy the same energy levels in an atom.¹⁹ If this principle didn't hold then white dwarf stars would not exist, they would collapse into black holes, the conduction of electricity would cease and chemistry as we know it would cease. It seems, therefore,

¹⁷ Karl R. Popper, *Conjectures and Refutations : The Growth of Scientific Knowledge*, 3rd ed. (London: Routledge, 2002). pp 69-72.

¹⁸ CERN, "Dark Matter," <https://home.cern/science/physics/dark-matter> (2022).

¹⁹ Britannica, "Pauli Exclusion Principle," *Encyclopedia Britannica* (2022).

highly unlikely, though not impossible, that this principle would suddenly cease tomorrow or not hold even in some unobserved sector of the cosmos.

There are many laws of nature, especially in the biological sciences, that are statistical in nature. Experimental 'proofs' of theories in these cases are therefore inherently statistical. As such they can never achieve absolute proof nor are they susceptible to refutation by counter examples; even Popper maintains that statistical inferences are not falsifiable.²⁰ More examples may improve the accuracy of the theory but with diminishing returns once the pattern is established. Mendelian theories of genetics predict the occurrence of physical characteristics in the offspring of parents with specific characteristics. The results are statistical probabilities for the inheritance of genetic traits from different allele (genes) - dominant, co-dominant, or recessive - each of which exhibit different distribution patterns in offspring. Mendel himself conducted thousands of crossbreeding experiments with over 28,000 plants and applied statistical techniques to establish his theories.²¹ Suppose one examined 100 offspring of parents with specific genetic traits and expected, on the basis of Mendelian theory, that 25% of the offspring would inherit a specific characteristic. If one found that only 5%, or even none, of the offspring had the characteristic being investigated then it would, *ceteris paribus*, throw severe doubt about the veracity of the theory but it would not, however, absolutely refute it.

As well as the issue of it being impossible to absolutely prove statistical theories, there is also an induction problem with such theories. It is conceptually conceivable that the rules could be other than they are and indeed that they may indeed change with time. Gender birth ratios, for example, do vary in different environmental conditions and could not be considered a law of nature. Until recently it was thought that gender conception ratios were also skewed towards the male gender and were variable. Recent research has, however, suggested that gender conception ratios are even between male and female and this could be classified as a regularity and potential law.²² Separating out factors external to the theory in question is particularly difficult in biological theories.²³

When assessing observations as evidential support in statistical theories one has to take into account that a direct (causal) relationship cannot be established of the form "all Fs are G" since there will be instances where the relationship doesn't hold. One therefore needs to take an alternative approach such as a statistical-relevance (SR) analysis of the form that an event C explains the occurrence of an event

²⁰ Karl R. Popper, *The Logic of Scientific Discovery*, 2nd ed. (London: Hutchinson, 1968). p.197.

²¹ Gribbin. p.540.

²² Steven Hecht Orzack et al., "Human Sex Ratio from Conception to Birth," *Proceedings of the National Academy of Sciences - PNAS* 112, no. 16 (2015).

²³ Alexander Rosenberg, *Philosophy of Science : A Contemporary Introduction*, 2nd ed., Routledge Contemporary Introductions to Philosophy (New York ; London: Routledge, 2005). p.52. Also, See *ceteris paribus* conditions later in this essay.

E if the probability of 'E given C' is greater than the probability of 'E' on its own.²⁴ Such Bayesian theories of probability lend weight to the idea that additional data as evidence does increase the probability of the accuracy of a scientific theory although this is disputed.²⁵ While Bayesian theories provide an alternative to hypothetico-deductive (H-D) methods they remain inductive.²⁶ An alternative statistical approach to that of Bayesian analysis of confirmation is *frequentist inference*. The basis of frequentist inference is to use hypothesis testing, technically it is normally null hypothesis significance tests (NHST) that are analysed, using statistical methods to determine distribution curves and specifically p-values (the observed significance level).²⁷ These approaches are standard in, for example, drug effectiveness trials: the null hypothesis is that there is no difference in outcomes between the drug being tested and a placebo and the analysis attempts to show the null hypothesis can be rejected with confidence. Adherents of the frequentist approach suggest that they are more replicable and objective than Bayesian approaches.²⁸ However, the p-values still only provide substantial evidence against the null hypothesis; they are intrinsically inductive and hence fall short of absolute proof.

Most, if not all, scientific theories contain an implicit or explicit *ceteris paribus* condition, i.e., 'other things being equal'.²⁹ Individual theories formulate the rules by which the world behaves but only in respect of a limited, often singular, isolated set of parameters. The theory of gravitation describes the attraction between bodies in the absence of other forces, such as electrical charge, magnetic fields, or the weak and strong nuclear forces. The first Newtonian law of motion is that "if a body is at rest or moving at a constant speed in a straight line, it will remain at rest or keep moving in a straight line at constant speed unless it is acted upon by a force" when, in practice, no such body exists since all bodies in the universe are subject to some forces.³⁰ The problem of *ceteris paribus* conditions is illustrated by classic physics textbook questions such as: calculate, using Newtonian Mechanics, the motion of a perfectly spherical ball rolling down a frictionless ramp in a vacuum and in the absence of any

²⁴ $\text{prob}(E|C) > \text{prob}(E)$. One also has to rule out other factors H: C explains E if (i) $\text{prob}(E|C) > \text{prob}(E)$ and (ii) $\text{prob}(E|C \& H) = \text{prob}(E|H)$. Psillos attributes this approach to Salmon. Stathis Psillos, *Causation & Explanation, Central Problems of Philosophy* (Montreal ; Ithaca N.Y.: McGill-Queen's University Press, 2002). pp. 252-6.

²⁵ For the two sides of the debate see: Patrick Maher, "Probability Captures the Logic of Scientific Confirmation," in *Contemporary Debates in the Philosophy of Science*, ed. Christopher Hitchcock (Oxford: Blackwell, 2004). and Kevin T. Kelly, and Clark Glymour, "Why Probability Does Not Capture the Logic of Scientific Justification," in *Contemporary Debates in the Philosophy of Science*, ed. Christopher Hitchcock (Oxford: Blackwell, 2004).

²⁶ Wesley Salmon, "Bayes's Theorem and the History of Science," in *Philosophy of Science*, ed. Yuri Balashov and Alex Rosenberg (London: Routledge, 2002).

²⁷ Sprenger. pp.203-5.

²⁸ Sprenger. P.204.

²⁹ Rosenberg. pp.51-2.

³⁰ Britannica, "Newton's Laws of Motion," *Encyclopedia Britannica* (2022).

perturbations. The general form of the *ceteris paribus* clause can, somewhat derogatively, be described as leading to the assertion that "All Fs are G, except those that aren't".³¹

While scientific experiments can be designed to reduce extraneous effects to a minimum or to compensate for such effects then this renders all evidence for a theory as ultimately limited. In the results of well conducted experiments the findings will not be provided as absolute but as, typically, within a margin of error: often a 'confidence interval'. While philosophers may be correct in saying that repeated experiments do nothing to address the problem of induction – a million experiments giving a positive result don't prove that the result will hold tomorrow – what is true is that repeated experiments can improve the accuracy or veracity of the results – for example, narrowing the confidence interval or extending the range of circumstances in which the results are expected to hold.³²

There is a further challenge to the veracity of scientific theories: that of underdetermination. From any set of observations or experimental data it is possible to construct multiple, indeed, an infinite number of, scientific theories that are consistent with that data.³³ The inductive process of science theories can be likened to having a piece of graph paper with a finite number of data points located on it; it is possible to draw an infinite number of different curves that pass through the points on the graph.³⁴ While further experiments or observations (effectively additional points on the graph) may enable some of these to be refuted there will always remain potentially competing theories. Sometimes, as with Schrödinger's wave mechanics theory and Heisenberg's matrix mechanics theory in quantum mechanics, the theories can be shown to be equivalent and to make the same predictions while using different mathematical techniques.³⁵ While shown to be epistemologically equivalent in their consistency with the data and their predictive capacity, the two quantum mechanics theories embodied different ontological views of the underlying reality. However, reconciliation of different theories is the exception rather than the rule and there will, according to most philosophers, always be an indefinite number of epistemologically equivalent theories that are consistent with the data. Laudan and Leplin dispute this and maintain that specific theories can be isolated which uniquely correspond to the data.³⁶ Salmon attributes the underdetermination of theories by the data as a consequence of the H-D method of science and suggests that Bayesian techniques provide a way of selecting preferred theories.³⁷

³¹ Roberts, in *The Oxford Handbook of Philosophy of Science*, p.341.

³² For example, G the Gravitational constant has been measured with improving accuracy over the last five decades as measurement technologies and techniques have improved.

³³ Salmon, in *Philosophy of Science*, p.392.

³⁴ Salmon, in *Philosophy of Science*, p.393.

³⁵ Slobodan Perovic, "Why Were Matrix Mechanics and Wave Mechanics Considered Equivalent?," *Studies in History and Philosophy of Modern Physics* 39, no. 2 (2008).

³⁶ Larry Laudan, and Jarrett Leplin, "Empirical Equivalence and Underdetermination," in *Philosophy of Science*, ed. Yuri Balashov and Alex Rosenberg (London: Routledge, 2002).

³⁷ Salmon, in *Philosophy of Science*.

It is often reported that scientific theories are changed either by experiment, improved measurements, or, according to Kuhn, by paradigm shifts.³⁸ There is a tendency for scientists to remain within a specific paradigm even when experimental or observational data suggests a problem with a theory and only abandon it for a new paradigm when the weight of evidence is overwhelming or there is a new theory that offers not only significantly better fit to the data but also potentially better explanations and/or predictions. The impression given is that theories have been shown to be false and this can be used to discredit the veracity of scientific theories in general. Whilst there are examples, such as the phlogiston theory, that have been shown to be simply false, many theories are superseded by more accurate theories but the original remains, within the limits of applicability or scale, valid as a practical approximation. While Newtonian mechanics has not, in theory terms, survived the arrival of the theories of special and general relativity the theories have nonetheless been of supreme utility for over three hundred years. The railway engineer designing an intercontinental railway will manage fine with just Newtonian mechanics. Admittedly, the designer of the GPS satellite system that that railway might depend on does need to take into account the laws of nature covered by the theory of special relativity as a result of the accuracy required of the timing synchronisation of the satellites.

Our inability to prove scientific theories, as discussed above, does not limit our ability to use their findings and predictions to support our technologies, industries, institutions, and daily lives. While it is not rational to believe that scientific theories regarding the laws of nature are absolutely certain, neither is it rational to discard them. Philosophers perhaps have a responsibility to choose their words with care since headlines such as "Scientific Proof Is A Myth" in *Forbes* magazine can easily fuel anti-science movements, conspiracy theorists and climate change deniers.³⁹ This problem is exacerbated by the common usage of the word 'theory' to mean a hunch or a guess whereas in science it is "a well-substantiated explanation of an aspect of the natural world".⁴⁰ Just because a theory cannot be proven does not mean it can be rationally assumed to be false: stepping off the roof of a high building is not advisable even though one can assert, with full confidence, that the laws of gravity are not proven.

³⁸ Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago ; London: University of Chicago Press, 1970).

³⁹ Ethan Siegel, "Scientific Proof Is a Myth," *Forbes* (2017), <https://www.forbes.com/sites/startswithabang/2017/11/22/scientific-proof-is-a-myth/>.

⁴⁰ American Museum of Natural History, "What Is a Theory?," <https://www.amnh.org/exhibitions/darwin/evolution-today/what-is-a-theory> (2020).

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