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OXFORD UNIVERSITY PRESS

The British Society for the Philosophy of Science

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Author(s): Richard H. Schlagel

Source: *The British Journal for the Philosophy of Science*, Vol. 35, No. 4 (Dec., 1984), pp. 359-374

Published by: [Oxford University Press](#) on behalf of [The British Society for the Philosophy of Science](#)

Stable URL: <http://www.jstor.org/stable/687339>

Accessed: 25/01/2011 13:34

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A Reasonable Reply to Hume's Scepticism

by RICHARD H. SCHLAGEL

According to Hume, no knowledge attainable by human beings would *ever* justify rational belief in recurrent physical properties and causal effects. He arrived at this conclusion because he denied the possibility of knowing—but not the reality of—either the 'inner natures' or the 'secret powers' of objects which would enable one to intuit or to demonstrate a 'necessary connection' between the internal structures of objects and their observable properties, or between the causal powers of entities and their effects. The purpose of this article is to show that while Hume's scepticism was justifiable in his day given the generally accepted limitations then of scientific inquiry and explanations, it no longer is reasonable in light of later scientific discoveries and theories. To a degree to which no eighteenth-century philosopher or scientist could anticipate, experimental inquiry has disclosed the inherent natures of objects and the underlying causes of phenomena that attest to the interconnectedness of physical reality and thus justify, at least to some extent, our instinctive beliefs in the uniformity of nature and predictability of events.

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I INTRODUCTION

Unlike almost all other philosophical notions whose grip on the minds of philosophers has receded with time, Hume's analysis of causation and induction are still commonly regarded as being as valid today as when he first proposed them more than two centuries ago. Indeed, Hume's critical analysis and proposed solution are often cited as the one example of a philosophical contribution that has escaped the usual demolition from critical analysis. Philosophers as diverse as Kant, Strawson, Popper, and Quine each has paid tribute in his own way to Hume's position.

Kant [1783], for example, states that 'Hume . . . demonstrated irrefutably that it was perfectly impossible for reason to think *a priori* and by means of concepts . . . a combination [of cause and effect], for it implies necessity'.

Strawson [1958] writes: “‘If . . . there is a problem of induction, and . . . Hume posed it, it must be added that he solved it. . . .’” Popper [1962], as is his wont, claiming to have ‘solved’ Hume’s problem of induction, asserts: ‘There is neither a psychological nor a logical induction. *Only the falsity of the theory can be inferred from empirical evidence, and this inference is a purely deductive one.*’ But the greatest compliment has been paid by Quine [1969]: ‘On the doctrinal side, I do not see that we are farther along today than where Hume left us. The Humean predicament is the human predicament.’

Given this portentous authority, the reader undoubtedly will regard this article with an understandable degree of Humean scepticism. Nonetheless, I think it can be shown quite convincingly that Hume’s critique of causality and induction, like his conception of the origin and structure of knowledge, on which it so fatally depends, though then a stunning insight, *betrays the limited understanding at the time of knowledge in general and of scientific knowledge in particular.* That is, when examined within the context of the explanatory limitations of eighteenth-century science, not only does the rationale for Hume’s position become eminently clear, so does the resolution of the problem. Just as his basic analysis of knowledge into atomic impressions and their replication as faint copies or ideas ought to appear to anyone today as simplistic, *so his notion that scientific inferences are limited to the succession of ideas or even to the observable qualities of objects should strike one as definitely contrary to present scientific methodology.* It was the ahistorical or anti-historical approach of recent analytic philosophers, especially the positivists, that prevented them from seeing the solution to Hume’s scepticism. If, as Reichenbach claimed, the ‘justification’ of a view is to be kept completely separate from the context of its ‘development’, then one is prevented from examining the historically derived presuppositions that contributed to the generation of the problem, presuppositions that often appear less plausible from a later perspective. Yet the realisation that an understanding of the historical context within which a traditional problem was conceived can lead to a clarification of the problem, along with its solution, itself required a revolutionary change of view, a change generally accepted now by philosophers of science.

2 HUME’S SCEPTICAL POSITION

Turning to Hume’s sceptical arguments, he was aware that no experience or knowledge of the world acquired in the past would have the least significance for the future but for two beliefs: (1) that what we shall encounter in the future will resemble what we have experienced in the past, and (2) that whatever ‘mechanism’ or causes produced these similarities will remain the same. Hume never questions the first belief, presumably because it can be easily confirmed, directing his argument against the second. That is, even when we can identify objects and events as being similar to those experienced in the past, we have no *rational* grounds for believing that

whatever mechanisms or causes produced those objects and events either remain the same or continue to be operative. As our experience is limited solely to the resemblances and successive appearances of objects—or more accurately to impressions or ideas—we do not experience their underlying causes, therefore without some knowledge of a *necessary* connection with those causes the similarities themselves are not evidence of any continuation or identity in what produces them. As he states in the *Enquiries*:

In vain do you pretend to have learned the nature of bodies from your past experience. Their secret nature, and consequently all their effects and influence, may change, without any change in their sensible qualities. This happens sometimes, and with regard to some objects: Why may it not happen always, and with regard to all objects? What logic, what process of argument secures you against this presupposition? ([1777], p. 38).

Hume's position implies a strange kind of impressionistic ontology according to which we do not confront any actual causes or productive processes in nature, but merely the surface succession of qualities. All that is productive or causal is hidden: volcanoes, hurricanes, forest fires, tidal waves, or epidemics are not symptoms of discoverable, underlying, dynamic processes and causes, but cinematic sequences the mere succession of which creates the illusion of causal production. Naturally, if we had no evidence *whatsoever* of the dependence of the sensible qualities of objects and their effects on the object's inherent nature, then of course the qualities and effects could be considered entirely disconnected from any inherent properties of the object, such that the former could remain unchanged while the latter changed. But were this the case, one wonders why we ever could have been deluded into thinking that there was a dependent connection in the first place!

To be fair to Hume, perhaps there is a sense in which his view could be considered to be partially correct in that human beings, or, as he would say, 'human nature', tends to confuse familiarity with understanding. When we do not understand a written sentence, for example, we sometimes read it over several times until the mere repetition itself conveys a feeling of comprehension. Similarly, people do tend to delude themselves into believing that they understand the familiar processes of nature. As he says:

The generality of mankind never find any difficulty in accounting for the more common and familiar operations of nature—such as the descent of heavy bodies, the growth of plants, the generation of animals, or the nourishment of bodies by food: But suppose that, in all these cases, they perceive the very force or energy of the cause, by which it is connected with its effect, and is for ever infallible in its operation (*ibid.*, p. 69).

Granting this, there still is a radical difference between the insight that people deceive themselves in thinking that they understand familiar phenomena and the claim that they are deluded in believing that the ordinary occurrences in the world are reliable signs or manifestations of

productive causes—in contrast to disconnected, free floating, discrete qualities.

3 HIS DENIAL OF NECESSARY CONNECTIONS IN NATURE

To justify the belief that the experienced similarities in nature are reliable indicators of continuing productive causes we would have to have, according to Hume, knowledge of a ‘necessary connection’ among such objects or causes and effects as are contiguous in space, successive in time, and constantly conjoined. These latter three relations, while necessary *conditions* for there being necessary connections among objects, are not sufficient to establish such connections. Because rationalists like Descartes [1642] had assumed as the foundation of their rational reconstruction of the world that ‘there must . . . be as much reality in the . . . cause as in the effect’, Hume is concerned to deny such conceit: ‘The mind can never possibly find the effect in the supposed cause, by the most accurate scrutiny and examination’ (*ibid.*, p. 29).

Not only is it impossible to find the effect in the cause, we cannot establish any binding tie between the cause and the effect because to do so we would have to be able to ‘intuit’ or ‘demonstrate’ an ‘invariable’ connection between the two. Analogously, to justify the belief that objects resembling those in the past will react in the same manner in the future we would have to obtain either an intuitive or demonstrative knowledge of the inner nature or powers of the object that determines it to behave as it does—a knowledge completely beyond us.

No object ever discovers [*i.e.*, discloses], by the qualities which appear to the senses, either the causes which produced it, or the effects which will arise from it; nor can our reason, unassisted by experience, ever draw any inference concerning real existence and matter of fact (*ibid.*, p. 27, brackets added).

In addition to the fact that no causal powers are revealed in the qualities of objects, we cannot *infer* such powers from those qualities: ‘Should it be said . . . we *infer* a connection between the sensible qualities and the secret powers; this, I confess, seems the same difficulty. . . . The question still recurs, on what process of argument this *inference* is founded (*ibid.*, pp. 36–7)?’ It must be emphasized, because many philosophers have misread this, that Hume *is not* denying the *existence* of such secret natures and causal powers, but that we have any basis for claiming *knowledge* of them.

Along with the lack of observational and inferential evidence to support our belief in the necessary connection among causes and effects, Hume relies on another criterion at least as important, that of contradiction. If there were ‘necessary connections’ evident between causes and effects or between the secret natures or powers of objects and their manifest properties, then it would be contradictory to deny such connections. As he says in the *Treatise*: ‘Such a connection wou’d amount to a demonstration, and wou’d imply the absolute impossibility for the one object not to follow, or to be conceiv’d not

to follow upon the other: Which kind of connection has already been rejected in all cases' ([1739], pp. 161–2); or, as he says in another passage, 'Such an inference wou'd amount to knowledge, and wou'd imply the absolute contradiction and impossibility of conceiving any thing different' (*ibid.*, p. 87). But as we can always deny the truth or conceive the contrary of any matter of fact or empirical judgment, no necessary connections can be attributed to causal relations or empirical objects: *i.e.*, we can always deny without apparent contradiction that the sun will rise tomorrow, that fire will burn paper, or that bread will nourish the human body.

Again, there is an obvious sense in which Hume's view is correct and a deeper sense in which it is incorrect. Obviously, the semantic relation between the terms 'the sun' and 'will rise tomorrow' or 'fire' and 'will burn paper' or 'bread' and 'will nourish the human body' is not as tight as that between 'red' and 'being coloured' or between 'rose' and 'being a plant'. While a denial of the latter expressions clearly would be contradictory, this is not as apparent regarding the former. Yet, as I shall argue more fully later, within the context of Newton's universal law of gravitation and laws of dynamics, *it would be contradictory* to maintain that under the usual physical conditions and application of Newton's laws the earth could cease to rotate on its axis and the sun fail to maintain its orbital position, thereby preventing the apparent rising of the sun.

Similarly, given what we know about the radiant energy of fire and the composition of paper or of the nutritional properties of bread and the digestive processes of a human body, *it would be contradictory* to deny that fire will burn paper and that bread will nourish the human organism. Although the semantic relations between these empirical concepts are not analytical in the usual sense, given what we have discovered about the physical properties of solar bodies (*e.g.*, mass, inertia, gravity, *etc.*) and the nature of fire and paper or bread and the human digestive tract, *it would be inconsistent* to maintain that certain predictable effects would not take place under conditions similar to those that prevailed when the discovery and explanations of these effects occurred. *While not analytically connected, given the experimentally discovered interrelatedness of the empirical concepts of scientific theories, the necessity of certain effects can be inferred, such that their denial would be inconsistent.* As Quine has stated, the strands linking our theoretical network and web of beliefs are not all of the same closeness or tautness, yet they do constitute some degree of semantic connectedness.

According to Hume, for there to be predictable connections among matters of fact they would have to exhibit the same kind of necessity as occurs in mathematics and logic: *i.e.*, the necessity must be self-evident or deductive. Having distinguished sharply the two forms of knowledge, 'relations of ideas' and 'matter of fact', and maintained that the former consists of 'intuitive' or 'demonstrative relations' among certain ideas that can be established by reason independently of experience, Hume surprisingly demands that the network of empirical, scientific ideas display the

same kind and degree of analytical or implicative connectedness; then, not finding such necessary connections among our impressions or ideas of observable objects or in matter of fact knowledge, he concludes that the necessity must be subjective, derivable from the mind itself.

Thus as the necessity, which makes two times two equal to four, or three angles of a triangle equal to two right ones, lies only in the act of the understanding, by which we consider and compare these ideas; in like manner the necessity or power, which unites causes and effects, lies in the determination of the mind to pass from the one to the other. . . . 'Tis here that the real power of causes is plac'd, along with their connection and necessity (*ibid.*, p. 166).

4 HIS CONCEPTION OF CAUSAL NECESSITY

Hume's negative critique of objective necessity leads directly to his positive thesis as to how we subjectively acquire the idea of causal necessity. Given the repetitive similarities among objects and events, human nature is such that our minds habitually or customarily expect these resembling instances to recur. It is this subjective propensity based on recurrent similarities that constitutes the feeling or *impression* of necessity from which the *idea* of necessity is derived.

The idea of necessity arises from some impression. There is no impression convey'd by our senses, which can give rise to that idea. It must, therefore, be deriv'd from some internal impression, or impression of reflection. There is no internal impression . . . but that propensity, which custom produces, to pass from an object to the idea of its usual attendant. This therefore is the essence of necessity. Upon the whole, necessity is something, that exists in the mind, not in objects . . . (*ibid.*, p. 165).

This conclusion ties in with his thesis that all ideas (with the exception of the idea of an intervening shade of colour) are derived from impressions, and, except for compounded complex ideas, are merely faint copies of them. As is well known, it is this empiricist epistemology that underlies Hume's analysis of causality and induction. As impressions are discrete, disconnected sensory elements so are their faint copies or ideas, thus reinforcing the view that such cognitive units are so independent that no necessary connection can be intuited or demonstrated among them, and hence no denial of their conjunction or recurrence can be contradictory. If we could infer a necessary connection such an inference 'wou'd imply the absolute contradiction and impossibility of conceiving any thing different. But as all distinct ideas are separable, 'tis evident there can be no impossibility of that kind' (*ibid.*, p. 87). Thus Hume's impressionistic conception of nature can more accurately be described as pointilistic.

Consistent with his criterion that the contrast between ideas and impressions depends on nothing more than their vividness, Hume attributes any difference between opinion and belief or degrees of belief to their relative force or liveliness: 'an opinion or belief is *nothing but a strong and lively idea deriv'd from a present impression related to it . . .*' (*ibid.*, p. 105).

Granted these epistemic assumptions, it naturally follows that we cannot have any knowledge of nature as such nor any *reasonable* justification for believing in the uniformity of nature. In contrast to mathematical knowledge or deductive implications among ideas, which do exhibit necessary connections but do not constitute knowledge of nature, whatever apparent systematic connections occur among our empirical ideas or matter of fact knowledge derive entirely from subjective impressions and consequently are essentially irrational.

Thus all probable reasoning is nothing but a species of sensation. 'Tis not solely in poetry and music, we must follow our taste and sentiment, but likewise in philosophy [including natural philosophy or science]. When I am convinc'd of any principle, 'tis only an idea, which strikes more strongly upon me. When I give the preference to one set of arguments above another, I do nothing but decide from my feeling concerning the superiority of their influence. Objects have no discoverable connection together; nor is it from any other principle but custom operating upon the imagination, that we can draw any inference from the appearance of one to the existence of another (*ibid.*, p. 103, brackets added).

Thus for Hume no objective truths or rational arguments can be adduced to support our belief in empirical inferences or scientific knowledge!

5 CRITIQUE OF HUME'S POSITION

But *is* it the case that the evidence and reasoning supporting our scientific theories are based on nothing more cogent than subjective feeling and that the extensive body of exact knowledge acquired in physics, chemistry, biology, and astronomy since Hume's day has no relevance whatsoever for our expectations and understanding of nature? Hume of course acknowledged that our ordinary behaviour and beliefs belie his sceptical conclusions, but he challenged philosophers to provide a *rational justification* for our confidence in induction, a challenge which I shall now take up.

Hume is largely correct, it seems to me, in maintaining that our everyday experience of the world does not initially or directly disclose the underlying causal powers (*i.e.*, the unobservable infrastructures, particles, forces, *etc.*) on which the manifest qualities and occurrences of the world depend. When we observe any ordinary object or scene before us, for example, we do not see the radiant energy that illuminates the visual aspects of the world, nor do we experience as such the effects of this reflected radiation on our retinas and its encoded transmission as chemical-electrical discharges through the optic nerves to the visual centres of the brain. What we experience is the outcome of this tremendously complex but necessary process, not the underlying transaction itself. Similarly, when we feel an object to be cold, hard, and metallic, we do not perceive the atomic-molecular structure of the object that accounts for these tactual properties. We know that ordinary water has a precise specific gravity and a definite freezing and boiling point, but initially we do not know anything of the molecular structure, chemical bonds, and

electromagnetic weak forces or exchange of virtual photons which we now believe, on sound experimental evidence, account for these properties.

But while this is true of our initial observations—although it does not really take into account the extent to which even our primitive observations can be exploited to further our understanding of nature (*cf.* Churchland [1979])—our knowledge is not restricted, as Hume repeatedly maintains, to sensory observations and associations. In a way that no eighteenth-century philosopher—nor scientist, for that matter—could anticipate, our investigations of nature supplemented by refined instruments of observation, controlled experiments utilizing ever more sophisticated apparatus, physical and chemical analysis, mathematical extrapolation and theorizing have enlarged our knowledge tremendously. Hume not only repeatedly affirms that certain explanations which are commonplace today were not accessible then, he asserts that they *never* could be attained, the phenomena being so ‘incomprehensible’. Citing his own examples, the impact of billiard balls, the production of a sound by a vibrating string, the occurrence of ‘palsy’, the control we exercise by means of our nerves over the muscles of the body, and the digestion of bread, not only can such phenomena not be explained, according to Hume, but any explanation is intrinsically ‘inconceivable’—as in fact it was in terms of his epistemology! As he says in the *Enquiries* ([1777], p. 72) regarding the cause of movement by physical impact: ‘We are ignorant . . . of the manner in which bodies operate on each other: Their force or energy is entirely incomprehensible. . . .’ Concerning the production of sound by a vibrating string, he claims that apart from the fact that ‘*this vibration is followed by this sound . . . we have no idea of it*’ (*ibid.*, p. 77). As for palsy and the voluntary control of our muscles by our nerves, he states that they are ‘to the last degree, mysterious and unintelligible . . . wholly beyond our comprehension’ (*ibid.*, pp. 66–7). But his profession of ignorance regarding the nutritive powers of bread is the best illustration of the tremendous gap in knowledge between Hume’s day and our own.

It is confessed that the colour, consistence, and other sensible qualities of bread appear not, of themselves, to have any connexion with the secret powers of nourishment and support. For otherwise we could infer these secret powers from the first appearance of these sensible qualities . . . contrary to plain matter of fact. Here, then, *is our natural state of ignorance with regard to the powers and influence of all objects* (*ibid.*, p. 37, italics added).

In another passage he says that ‘neither sense nor reason can ever inform us of those qualities which fit it for the nourishment and support of a human body’ (*ibid.*, p. 33).

While it is true that the nourishing properties of bread are not revealed in its sensible qualities, we are no longer limited merely to sensible qualities in explaining how and why bread nourishes. Today there is found on most packages of bread a list of ingredients such as flour, milk, and vegetable shortening, as well as nutritional components like vitamins, proteins, minerals, *etc.*, which at least partially account for the nutritional value of

bread. It is the responsibility of chemists and pharmacologists in the Food and Drug Administration to ascertain by chemical analysis and metabolic studies the ingredients and harmful or beneficial properties of various foods and drugs, thereby *forewarning* the public regarding their possible effects. As disappointing as these results may sometimes be, they do constitute a form of knowledge with *predictable* consequences which Hume claimed 'never' could be attained.

6 HISTORICAL BASIS OF HIS SCEPTICISM

The essential reason for Hume's scepticism is that he believed that scientific knowledge was *inevitably* limited to the observable qualities and conjunctions of objects, or, more accurately, to our ideas of them. This belief, in turn, was founded on two factors: (1) his phenomenalistic epistemology, discussed earlier, based on impressions and ideas, and (2) the universally acknowledged limitation in Hume's day of explanations in terms of 'insensible powers'. As he frequently states, 'there is no known connection between the sensible qualities and the secret powers' (*ibid.*, p. 33). Again, however, he is not denying that 'secret powers' exist. In the *Treatise* he affirms 'that almost in every part of nature there is contain'd a vast variety of springs and principles, which are hid, by reason of their minuteness or remoteness' ([1739], p. 132), but not realising the possibility of discovering by experimentation some of these hidden 'springs and principles', thereby accounting to some extent for the properties and effects of things, he concluded that they were inevitably 'secret', 'hidden', and 'incomprehensible'. Consequently, in spite of recurrent resemblances we could have no reason for believing that the causes of these resemblances would persist and thus support our inductive inferences.

This scepticism regarding possible explanations of phenomena in terms of their underlying causes was not unique to Hume, but generally prevalent at the time. Anticipating Hume (as well as Kant), Locke, in spite of his belief in primary qualities, states that

it seems probable to me, that the simple ideas we receive from sensation and reflection are the boundaries of our thoughts; beyond which, the mind, whatever efforts it would make, is not able to advance one jot; nor can it make any discoveries when it would pry into the nature and hidden causes of those ideas [1690].

Locke also antedated Hume in affirming that there was 'no necessary connection of real existence with any idea a man hath' (*ibid.*, IV, XI, 1).

While Locke denied any 'necessary connection between ideas and real existence', Berkeley carried the sceptical argument further in maintaining that there is no justification for inferring a 'real existence' at all, at least in terms of material or natural causes.

I say . . . that it is possible we might be affected with all the ideas we have now, though no bodies existed without, resembling them. Hence it is evident the supposition of

external bodies is not necessary for the producing our ideas: since it is granted they are produced sometimes, and might possibly be produced always in the same order we see them in at present, without their concurrence [1734].

If phenomena *could occur* just as they do now *without* any accompanying physical causes, then for all we know they also *could not occur as they do*, as Hume concluded. In addition, Berkeley anticipates Hume in asserting that ‘food nourishes, sleep refreshes, and fire warms us . . . all this we know, not by discovering any necessary connection between our ideas, but only by the observation of the settled laws of Nature’ (*ibid.*, I, 31). Hume’s originality consists in denying any justification for expecting even the continuation of the ‘settled laws of Nature’.

But it was probably the ‘incomparable Mr Newton’, as Locke described him, who was the principle source and authority for a reserved scepticism, since in a famous passage he appears to limit knowledge to a ‘deduction from phenomena’—though in many other passages he attests to a deeper understanding of nature in terms of ‘natural powers’ and the ‘forces of nature’.

Hitherto we have explained the phenomena of the heavens and of our sea by the power of gravity, but have not yet assigned the cause of this power . . . [because] I have not been able to discover the cause . . . and I frame no hypotheses; for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy [1686].

Thus Hume, for all his notorious critique of the uniformity of nature and of induction, actually was following out the consequences of a well established empiricist scepticism. As such, his most eloquent expression of that scepticism, as stated in the *Enquiries*, reflected the generally accepted limits of possible knowledge of the eighteenth century.

It is confessed, that the utmost effort of human reason is to reduce the principles, productive of natural phenomena, to a greater simplicity, and to resolve the many particular effects into a few general causes, by means of reasoning from analogy, experience and observation. But as to the causes of these general causes, we should in vain attempt their discovery nor shall we ever be able to satisfy ourselves, by any particular explication of them. These ultimate springs and principles are totally shut up from human curiosity and enquiry. Elasticity, gravity, cohesion of parts, communication of motion by impulse; these are probably the ultimate causes and principles which we shall ever discover in nature [practically a direct paraphrase of Newton’s *Principia*]. . . . The most perfect philosophy of the natural kind only staves off our ignorance a little longer. . . . Thus the observation of human blindness and weakness is the result of all philosophy, and meets us at every turn, in spite of our endeavours to elude or avoid it ([1777], pp. 30–1, brackets added).

If this expression of the ‘ultimate’ limits of knowledge were all Hume’s argument came to then I doubt that many would disagree with him; however, it is *crucial* to remember that his scepticism cuts much deeper, affirming not only that we do not have a knowledge of ‘ultimate springs and principles’, but that *no knowledge we can ever have* of the natures or causal

powers of objects would constitute a rational justification for believing that they would continue to produce the same properties and effects (under similar conditions) in the future. Yet given the discovered fact that it is free hydrogen ions in acids that cause litmus paper to turn red, is it just as likely that in the future a liquid manifesting all the properties of sulphuric acid will turn litmus paper blue? Or considering our knowledge of the atomic-molecular structure of hydrochloric acid (HCl) and sodium hydroxide (NaOH) which when combined form salt (NaCl) and water (H₂O), is it just as possible that in the future they will combine and form potassium sulphate and mercury oxide? Or consider Popper's example [1972] of the people in a French village who died from eating their usual *baguettes*, would we entertain for one moment the belief that bread *with the very same ingredients* would have its causal powers just change in such a way as to produce those tragic effects, or would it be more reasonable to expect that some foreign ingredient had entered the bread accounting for the disastrous results, isolating ergotism as the cause?

Knowing what we do now about the function of *DNA* in cell replication, is it just as probable that when a human cell is fertilized it will develop into a giraffe, rather than a human being? Considering our knowledge of nuclear fission, when uranium atoms are split by neutrons releasing tremendous amounts of nuclear energy would it be just as likely that the world would instantly freeze over? Having constructed a match from known chemicals that will ignite under certain conditions, is it just as reasonable to expect that when we strike a match the Tour Eiffel will collapse or that the moon will change its orbit or that the holder of the match will disappear?

As far fetched as these examples are, according to Hume it is just as probable that the most familiar object will produce the most unexpected, bizzare effect because *no connection can ever be established* between the internal natures or causal powers of objects and their effects or properties. Everything is disconnected! As he unequivocally states: 'Upon the whole, there appears not, throughout all nature, any one instance of connection which is conceivable by us. All events seem entirely loose and separate' (*ibid.*, p. 74).

7 THE PRESENT UNREASONABLENESS OF THIS SCEPTICISM

But surely this conception of the world is no longer true! If in our investigations and explanations of nature we *were* limited to the manifest qualities of phenomena, such that we could never experimentally discover nor imaginatively conceive of any other domains of nature, then Hume's conclusion would be plausible. If we knew nothing more than the sensory appearances of acids then of course we could not understand why they turn litmus paper red, and therefore why litmus paper is a test of acidity. Were our knowledge of hydrochloric acid and sodium hydroxide restricted to sensory observations then we could not know why they form salt and water

when combined. If we had no knowledge of atomic or nuclear physics, then how could we produce a controlled nuclear reaction? Knowing nothing of the ingredients of bread and why they have the physiological effects they do, we would be ignorant of why it nourishes. If only the external body could be observed and therefore we knew nothing of the difference between striated and unstriated muscle fibres and even less of neurons and the transmission of electrical discharges to the muscle tissues, then of course it would be 'incomprehensible' as to how our nerves activate our muscles. What would be the purpose of building electron microscopes, cyclotrons, linear accelerators, and giant optical and radio telescopes with the intent of penetrating more deeply into the inner core and outer recesses of the universe, if knowledge were limited solely to observable phenomena? But even more conclusively, how could we have landed astronauts on the moon, with all the sophisticated technology, exact understanding of forces such as gravity and thrust, and precise calculations and predictions of manoeuvres that this required, if our scientific knowledge were as limited as Hume maintained?

If the Humean persists in asking why these discovered causes, structures, and functions have the effects they do, then one can only reply that an explanation has to be in terms of something (unless we eventually arrive at a bootstrap theory). One can ask for deeper explanations, but even these deeper explanations eventually would have to terminate in the fact that some things or states (such as fields) just have the properties and effects that they do. Yet this *does not* concede Hume's thesis. Hume claimed that since we could only observe disconnected sensory qualities or ideas we could never know the 'hidden natures' or 'secret powers' that produce the observable similarities and sequences which he never denied. If we now respond to his scepticism by replying that these observable effects are produced by experimentally discovered and confirmed substructures and the Humean persists in demanding, 'but why should these substructures have these effects', then we need only reiterate that an explanation will always have to be in terms of something, otherwise we would be led to an infinite regress, which was not Hume's argument.

Or, we can take the offensive and ask the Humean what would be an acceptable answer? If explaining acidity in terms of hydrogen ions, chemical combination in terms of sharing free electrons, digestion in terms of nutritional value, solidity in terms of strong and weak nuclear forces or the exchange of virtual particles are not explanations, then what would be? If landing men on the moon is not an indication of confirmed inductive generalizations and predictions, what would be accepted as confirmation? A question for which there is no possible answer is not a reasonable question!

Consider the example of a spring driven, stem watch. If a person were unfamiliar with the works of such a watch he could observe the regular movement of the hands but would not understand how or why they rotate: though the watch kept perfect time he would have no reason for expecting it to continue to keep time in the future. But suppose one explains to the

person the mechanism of the watch in terms of springs, gears, jewels, stem, *etc.*, and also removes the base of the watch exposing the works. Would he now have more reason, based on his understanding of the functioning of the mechanism, to expect that when wound up the watch will continue to run in the future? I think we would all agree that he would. But suppose the Humean persists and asks, 'why should we expect, given the observed mechanism, that it will continue to function in the future as it has in the past?' Supplementing the previous explanation, one can answer in terms of the molecular properties of metals and Newton's laws of dynamics, explaining the tension of springs, the engagement of gears, the hardness of metals, the crystalline structure of jewels, *etc.*, and the way in which all of these components interact under the usual conditions of gravity, humidity, and temperature to produce the movement of the hands. If the Humean still demands, 'why should we expect the atomic-molecular structures and dynamic laws to persist so that they have the same effects in the future,' how are we to reply? What would the Humean accept as an answer? The point is that a reasonable answer to Hume's scepticism has been provided and any further scepticism is otiose. Knowledge of the world as we know it is possible precisely because phenomena, although existing within certain contexts or conditions, possess a certain degree of autonomy so that we can explain the occurrence of such phenomena relative to those conditions without possessing a complete or ultimate knowledge of nature (*cf.* Schlager [1981]).

8 CONCLUSION

Quite simply, then, since Hume's scepticism regarding the uniformity of nature and of induction depended upon a lack of knowledge as to how and why things work and produce the effects they do, the resolution of this scepticism consists in demonstrating that today we do possess such knowledge, at least to a certain degree. By examining phenomena under various experimental conditions (*e.g.*, Rutherford's bombardment of gold foil with alpha particles to determine its atomic structure to Watson and Crick's investigations of phages and X-ray diffraction patterns of molecular structures to determine the precise molecular structure of *DNA*) in order to discover their 'hidden causes' and 'secret natures', and devising theories to interpret the experimental results, we have gained considerable insight into the workings of nature. The greatest success to date has been achieved with the atomic-molecular theory, as evidenced by the Periodic Table, chemical analysis, atomic, nuclear, and particle physics, molecular biology, and spectroscopic analysis in astronomy. While it is undoubtedly true that we are infinitely far from any final, conclusive, or 'ultimate' explanation of most natural phenomena—if such an account is even possible—this does not mean that the knowledge we do possess has no explanatory significance or predictive value. Fortunately, we do not have to know everything to explain

something. When we can determine the inner composition of substances and isolate the causes of phenomena so as to explain, control, and predict natural occurrences, even to the extent of preventing or curing diseases and creating new subnuclear particles, it would be *unreasonable* to disbelieve in our ability to discover some of the underlying conditions and physical interdependencies that support our inductive inferences. *Where experimental discoveries and theoretical constructs and frameworks have supplemented our limited and fragmentary sensory observations, our knowledge is more complete and our belief in the deeper interconnected causal matrix producing nature's manifestations more justified.*

In fact, such discovered interconnections attest both to a *natural* and a *conceptual* form of necessity, although because they are empirically discovered they are *a posteriori*, rather than *a priori* (*i.e.*, discoverable by reason itself), in contrast to the convictions of Hume and Kant. As Harré and Madden [1975] state in their excellent critique of Hume's position and defence of 'Causal Powers':

The natural necessity in the world is reflected in a conceptual necessity in discourse about the world. Predicates are bound into ensembles by virtue of the joint origin of the properties they ascribe to things, in the nature of those things. When we think there is a natural necessity between manifested properties and hypothesised dispositions, that is, a real connection via the nature of the thing, then we are entitled to make a conceptual link, incorporating the power or tendency to manifest the property within the concept of the thing or substance.

When substances and elements can be defined in terms of more basic particles, fields, or forces which also account for their physical properties, physiological functions explained by microstructures and chemical-electrical processes, and natural occurrences traced to necessary operative conditions, nature reveals a type of necessary connections that becomes embedded in our concepts and theories. These concepts and theories in turn provide conceptual implications from which necessary inferences can be made. Predictions in nuclear physics of particles whose existence was only confirmed years later, such as the neutron, neutrino, positron, and possibly quarks, confirm this. In addition, our theories provide more reliable criteria for identifying phenomena than those derived from sensible qualities. A solution (of sufficient strength) that does not turn litmus paper red is not an acid; a metal that does not have a density of 8.9, an atomic weight of 63.5 and number of 29, along with the typical properties of malleability, fusibility, ductility, and electrical conductivity is not copper; a liquid possessing the usual macroscopic properties but that does not have the molecular structure (or is not an isotope) of H_2O would be an anomaly.

Our concepts of things and their properties, as well as our broader theoretical interpretations, mirror the experimentally discoverable interconnections in nature. Though it is we who create the concepts and theories, they are based on controlled observations and carefully designed experi-

ments to ensure as tight a fit with nature as possible. In words echoing those of Harré and Madden, Newton-Smith [1981] says:

Certainly it is the way the world is that makes it true that water is H₂O. But what makes this truth necessarily true is not the way the world is, apart from our linguistic practices. For the necessity is a reflection of a general institutionalized linguistic practice of determining the extension of natural kind words by reference to the nature of ostended paradigm instances of the kind in question. The necessary connection between being water and being H₂O is imposed by us on the world. For given that water is H₂O our practice is not to count as water anything that does not have this nature.

Though similar to the position of Harré and Madden, in attributing the necessity of connections more to our conceptual-linguistic framework than to nature, Newton-Smith's position is more like the 'pragmatic *a priori*' of C. I. Lewis (*cf.* [1929]).

Accordingly, our framework of knowledge and network of beliefs do not consist of disconnected, contingently associated ideational or semantic elements that have no referential or representational significance as far as the world is concerned and therefore are completely devoid of predictive value. Although our theoretical frameworks are undoubtedly 'underdetermined by empirical evidence', as Quine [1960] claims, and therefore *are subject to constant revision*, they do constitute a systematic interpretation of certain domains, at least, of physical reality enabling us to draw certain inferences and make verifiable predictions. It would not have been possible to predict and confirm the existence of such previously unknown entities as the planet Neptune and the legionnaire's virus, or establish physical equivalences such as light and electromagnetic radiation and mass and energy, if our theories did not impinge upon physical reality to some degree.

Even the statistical predictions in quantum mechanics, in so far as they are precise predictions within certain parameters, represent objective constraints on quantal events. And though the quantum formalism does not provide a classical picture of the subatomic world, few scientists would maintain that there is no connection between successive observations or interactions with the apparatus and the superposition of states in the developing quantal system as predicted by Schrödinger's wave equation or quantum electrodynamics. As limited and tentative as our knowledge of nature is, in the sense that we may never attain an *exhaustive* knowledge of the *ultimate* natures of things (and here I may disagree somewhat with Harré and Madden), it is not illusory. So if we can be relatively certain of anything, it is that the human condition is not the Humean condition.

The George Washington University

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