



# An Aristotelian Account of Induction

Creating Something from Nothing

LOUIS GROARKE

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*Le Nouveau-né (The Newborn)* by Georges de la Tour (1593–1652) was perhaps intended as a nativity scene. It depicts a midwife holding a candle in front of a mother holding a newborn in surrounding darkness. The pictorial elements of la Tour's painting provide a physical parallel to the mental acts of creativity discussed in this book. Ancient and medieval authors compared human intelligence to a mental light that, proceeding from an unseen source, illuminated the darkness of ignorance. And Socrates, of course, thought of the philosopher as a midwife who attends to the student as he or she gives birth to a new understanding. To think is to conceive. Just as the mother in the painting grasps her newborn child, so the mind, in an act of immediate intellection or insight, *without logic*, brings into the world something new and wondrous. (Image courtesy of Musée des beaux-arts de Rennes.)

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## *A New (Old) Theory of Induction*

The theory of induction is the despair of philosophy – and yet all our activities are based upon it.

Alfred North Whitehead<sup>1</sup>

Western culture – any hopeful, humanitarian, knowledgeable, and right culture – depends on induction not merely in its parts, to justify its particular scientific inquiries and political inventions. It depends on induction altogether and in principle. *Spes est una in inductione vera* [Our only hope is in true induction].

Donald Carey Williams<sup>2</sup>

### PROLEGOMENON

**THIS IS A BOOK ABOUT INDUCTION.** Contemporary philosophers, almost universally, understand induction as the form of logical argument that allows us to infer universals from particulars: I see one black crow, two black crows, three, four, etc., and I conclude “all crows are black.” Or, more carefully, that “most crows are black.”

As anyone familiar with present-day philosophy will know, the established view holds that there is a logical problem with induction. Because I observe a hundred black crows I cannot logically infer that the next crow I observe will be black. The next crow may be an albino one, for all we know.

This general view that there is an unsolvable problem with induction has been embraced by most philosophers. It risks precipitating, however, an all-out scepticism. Donald Carey Williams, who links a loss of faith in science with a loss of confidence in inductive argument, goes so far as to make dire predications for the future of Western civilization. Williams cites Alfred North Whitehead: “the theory of induction is the despair of

<sup>1</sup> *Science and the Modern World*, 35.

<sup>2</sup> *Ground of Induction*, 16. The Latin phrase is from Francis Bacon, *Novum Organum*, bk 1, aphorism 14 (in Bacon, various documents).

philosophy – and yet all our activities are based upon it.”<sup>3</sup> Without an adequate basis for induction we cannot account for knowledge, for science, or for morality.

Williams, who has a penchant for embellished prose, proclaims,

so prodigious a theoretical contretemps cannot remain a tempest in the professors’ teapot. The news that no foundation is discoverable for the procedures of empirical intelligence, and still more the proclaimed discovery that there is no foundation, and still more the complacency which recommends that we ... proceed by irrational faith or pragmatic postulate, will slowly shatter civilized life and thought, to a degree which will make the modernist’s loss of confidence in Christian supernaturalism, so often cited as the ultimate in spiritual cataclysms, seem a minor vicissitude ... To dispute the rational validity of induction ... is to deny that reason and good-will have a purchase on reality, to deny mind’s hope of acclimating itself to any world whatever, natural or supernatural.<sup>4</sup>

Williams’ alarmist stance may overstate the degree of importance which ordinary people attach to theoretical problems in modern epistemology. I will argue, however, that scepticism regarding inductive reasoning does undermine knowledge in a radical and wholesale way. This book presents a response to scepticism about induction, a positive response, one that has been overlooked by modern authors such as Williams.<sup>5</sup> It attempts to reconstruct and argue for an account of induction that originates in the ancient Greek author Aristotle. Aristotle’s views clash with the modern consensus on this issue. He and his followers in the tradition provide a very different answer to the alleged problem of induction, an answer worth examining seriously.

Contemporary debates about inductive reasoning have pushed Aristotle’s comments on this issue to the margins of mainstream intellectual inquiry. Very able scholars have both interpreted and commented on Aristotle’s logical works, but this is a discourse of specialists focusing on historical concerns. Contemporary accounts of induction largely bypass Aristotle. I want to reintroduce Aristotle’s ideas on induction to the general philosophical

<sup>3</sup> Whitehead, *Science and the Modern World*, 35.

<sup>4</sup> Williams, *Ground of Induction*, 15–16.

<sup>5</sup> Williams does provide an answer to the problem of induction, based on the probability calculus.

reader, to students of Aristotle, and to specialists in philosophy of science and in argumentation theory.

The course of intellectual history has served to obscure Aristotle's ideas. The rise of empiricism, the triumph of the Enlightenment, the short-lived victory of positivism, and the supremacy of what has come to be known as analytical philosophy has changed the direction of philosophy. Aristotle's sophisticated but commonsense realism and, in particular, his account of induction has been buried under misunderstanding after misunderstanding. Modern scholars have variously overlooked, dismissed, or misinterpreted his views. This is unfortunate. The aim of the present book is to systematize and explain in a straightforward and accessible way Aristotle's somewhat scattered and abbreviated remarks on induction. The project is not antiquarian but critical. I will argue that Aristotle's account, properly understood, provides, at the very least, a cogent competitor to its modern empiricist rival.

Aristotle was a serious logician and provided a detailed and explicit theory of deduction in his account of the syllogism. This pioneering work, after passing through modifications, has given rise to a standardized theory of syllogistic that is still taught in undergraduate critical-thinking courses to this very day. Unfortunately, Aristotle never systematized his understanding of induction or ἐπαγωγή (*epagoge*) in any parallel way. What we have instead are brief and often obscure remarks scattered here and there throughout his *Organon* (the six books on logic) and elsewhere. There are at least three major kinds of problems.

Firstly, Aristotle's style of writing (if it is really *his* writing) poses serious problems. It may seem scandalous to begin a book on Aristotle with such a frank admission, but the difficulties posed by his prose cannot be passed over or attributed to a mere absence of literary style.<sup>6</sup> Aristotle's prose is laborious and less than felicitous. The texts that have come down to us belong, for the most part, to his pedagogical or acroamatic works, originally published, catalogued, and edited by Andronicus of Rhodes.<sup>7</sup> These texts, which represent private lectures given to advanced students at the Lyceum, are only compilations and notes – one translator speaks of “*rough notes*” – collated, at a later date, by members of Aristotle's school.<sup>8</sup>

6 This is the traditional suggestion. See, for example, Jaeger, *Aristotle*, 6; Bambergh, in Aristotle, *Philosophy of Aristotle*, 18; Copleston, *Greece and Rome*, pt 2, 12 – and so on.

7 For an accessible discussion of the provenance of the actual texts, see Guthrie, *History of Greek Philosophy*, “Aristotle: The Written Remains,” vol. 6, 49–65.

8 E.S. Forester, introduction to the *Topics*, 206 (in Aristotle, *Aristotle in 23 Volumes*).

Although the ideas expressed are both insightful and compelling, the prose is repetitious, elliptical, disconnected, broad-ranging, technical, and highly obscure. The logical works especially are largely impenetrable to the causal modern reader.

Richard McKirahan describes the text of the *Posterior Analytics*, a key source for Aristotle's thought about induction. "As usual," McKirahan writes, "we find obscure arguments, unclear transitions and cross-references, and inadequate examples, all of which place stringent demands on the reader. But in addition the work seems rough and unfinished, a series of jottings on different aspects of its subject matter ... It does not read like a finished treatise, making definitive statements, but like an inchoate collection of thoughts, some worked out more thoroughly than others."<sup>9</sup> This list of problems is emblematic of the textual difficulties Aristotelian scholars must face. The philosopher's tortuous prose has limited his influence among a broader, educated public and fostered fractious and sometimes fruitless debates among scholars.

Some historical commentators have gone so far as to claim that Aristotle consciously chose to write in a challenging style. Contemporary specialist Lambertus Marie de Rijk relates an amusing story about Ammonius, an early commentator, who compares Aristotle's inscrutable prose to a curtain in a religious temple used to shield the most sacred objects from the eyes of the unwashed multitudes. Ammonius explains, "Just as in temples curtains are used to prevent everyone, and particularly the impure, from encountering things they are not worthy of meeting, so Aristotle uses the obscurity of his philosophy as a veil, so that good people may stretch their minds even more, and bad people can be deterred."<sup>10</sup> Keeping to the spirit of the metaphor, I want to pull back the temple curtain, so to speak, to open wide a window on Aristotle, to explain and elucidate his thoughts in a way that renders his account of induction intelligible to anyone who takes the trouble to wrestle with his challenging ideas. I believe that Aristotle's ideas are eminently understandable. In my own teaching, I have found that his common-sense realism strikes a sympathetic cord even with students. (And if non-specialists can understand his general drift, so much the worse for the distinction between the academically pure and the unwashed multitudes!)

The second type of problem facing anyone searching into Aristotle's account of induction is that the philosopher clearly believes that the process of induction is, to some degree, self-explanatory. In the *Topics*, he goes so

9 McKirahan, *Principles and Proofs*, 3.

10 De Rijk, *Aristotle*, vol. 1, §22, 18. De Rijk's source is *Ammonius in Aristotelis Categoriae commentarius*.

far as to remark, “What induction is, is obvious.”<sup>11</sup> Such comments are less than helpful! And yet, they do illustrate a general attitude. Unlike modern philosophers of more sceptical or suspicious bent, Aristotle is not in the business of justifying or defending induction. He simply accepts that we can derive knowledge of universals from specific sense perceptions and proceeds accordingly. Perhaps this is why, although he touches on important points here and there, he does not feel the need to provide any exhaustive, detailed justification of the subject.

Thirdly, I will argue that induction itself is an elusive process. Although Aristotle explicitly comments on the leap of mental cognition that initiates induction, he does not consistently explore the ramifications of his own theory. This has led to considerable misunderstanding. Inasmuch as induction is a creative act that produces new knowledge, it relies crucially on a moment of mental insight or inspiration. An attentive survey of empirical data is not enough. Sense perception must be illuminated by mind or νοῦς (*nous*), a mental capacity allowing us to leap from the individual to the universal. Aristotelean induction is, then, fundamentally and inevitably creative. His theory borrows more from Plato’s philosophy than is commonly recognized.

Aristotle’s view of induction sharply contrasts with what has become the received modern view. Contemporary accounts of induction can be traced back to David Hume, who is well-known for having brought the incomplete nature of the inductive process into clear light with his trenchant critique of metaphysical theories of induction. Hume’s account has, over time, established itself as the new orthodoxy. I will argue that considered as a criticism of Aristotle, the Humean account is seriously inadequate. Although the Humean model has provided the impetus for a much more sophisticated account of probabilistic reasoning, Aristotle’s account more closely mirrors the most familiar form of induction that ordinary people regularly resort to in everyday discourse. His lost perspective better illuminates the inductive method of science and more deftly captures the heuristic insight that makes inductive reasoning possible.

Aristotle’s explanation of induction may, paradoxically, strike the contemporary reader as iconoclastic. If the critic complains that the arguments elaborated here clash with the received wisdom of the present age, this is, of course, true. But such complaints are misguided. In fact, the Aristotelian stance I defend is the traditional point of view; it has been defended and elaborated by a long line of important historical authors. Situated within the history of Western philosophy, it is the majority view.

11 *Topics* (Forester), pt 8, ch. 1, 157a8.

Although it has been vilified, caricatured, or, most often, simply forgotten in the present age, this is a fairly recent phenomenon. In any case, the Aristotelian stance is not wrong because it has fallen out of favour. As an account of inductive reasoning, it must be judged on its own merits.

In this book, I approach traditional philosophy with respect but not with uncritical devotion. Earlier authors, Aristotle included, made mistakes, sometimes serious mistakes. I try to present an original synthesis of the best that has been said before. I am indebted both to traditional philosophy and to contemporary scholarship. While delving into exegetical and historical issues, I want, first and foremost, though, to present a critical account of induction, one that can rival predominant trends in contemporary argumentation theory, ethics, and modern philosophy of science. The account I elaborate may, as a minority view, serve to illuminate contemporary debates from a neglected perspective.

#### FIRST PRINCIPLES

The content of this volume may be described in another way. Although it is principally a book about induction, it is equally one about first principles. Greek philosophers from the Presocratics onward searched into the *ἀρχαί* (*archai*), the roots or origins of the cosmos. Aristotle was not content to limit his investigations to the deep nature of the physical world. In his study of the human person, he turned the inquiry inward, searching into the roots or origins of human thought. As we shall see, he believed that induction supplies first principles, the most basic building blocks, the *archai* of human knowledge.

We must begin by clearing up a misunderstanding. Contemporary thinkers view induction primarily as an argument form that, in the paradigm case, moves from incomplete premises dealing with particular instances to a conclusion that makes a universal claim. For Aristotle, induction is not, first and foremost, a form of argument, but a kind of intelligent grasping that allows the knower to move from a more restricted to a more general understanding. The human mind is somehow able to synthesize experience, to bring together within a single concept or claim what is uniform, constant, or necessary about the world. The same basic process of mental illumination produces individual concepts, general rules about mathematics and logic, and universal claims about the empirical world. At the deepest level, induction produces the first principles of knowledge.

Aristotle proposes, then, a much broader account of inductive reason than those we find in circulation at present. The conclusion of the inductive

argument (above) that “all crows are black” is a product of induction. But even the concept “crow,” or the concept “black,” is a product of induction. These concepts materialize in the mind because we can somehow seize on an underlying similarity that brings together a number of otherwise divergent experiences. Inductive arguments are, then, an expression of a deeper, more comprehensive mental process. Aristotle uses the Greek term for induction, *epagoge*, to refer, in the first instance, to this process, and only secondarily, to induction understood as an argument form.

One might argue that Aristotelian induction is, at its origins, a form of intuition, except that the debased, vernacular use of the word “intuition” sends the wrong message. The modern English term “insight” better captures Aristotle’s basic attitude. We *see* what must be true. Reasoning begins in the mental activity of induction, understood not as an argument form, but as a mental realization triggered by sense perception. Earlier authors in general distinguish between discursive and inductive reason. Discursive reason moves from claim, to claim, to a conclusion. Inductive reason, understood as an initial capacity for intelligent discovery, provides the immovable starting points for intelligible discourse. There is often a powerful psychological side to this inductive process – grasping a universal truth may, for example, be accompanied by an aha! experience. Nonetheless, Aristotelian induction is a properly epistemological mechanism. It is not a matter of mere feeling.

A contemporary rationalism demands a reason for everything. But thought does not begin in argument. The goal of intellectual inquiry is ultimately knowledge; however, we cannot argue, let alone think, unless we have something to think with. On the Aristotelian account, induction, understood as a capacity for accurate mental insight, supplies us with a wide assortment of concepts, definitions, universals, logical and metaphysical laws, the most basic natural facts of science, and moral principles. This is where thought begins, with induction understood as an intuitive cognitive capacity, not with argument. Consider an analogy.

Suppose George, an engineer, is an expert bridge-builder. And suppose we take away the tools and materials he needs to build bridges. Suppose we confiscate every bit of wood, metal, plastic, brick, and cement. We remove all aids: his calculator, his pencil and paper. What can George use to build bridges with? Perhaps, the sly will respond, he can build imaginary bridges inside his mind. But suppose we could somehow take away the tools and the materials he needs to think with. Eliminate all concepts, definitions, rules of grammar, laws of logic and mathematics, all knowledge of physics or chemistry, and so forth. At the end of the day George will be left with nothing to build bridges with. It does not matter if he has the

talent to be a superior bridge-builder; without the necessary tools and materials, he will be unable to build bridges.

Traditional authors such as Aristotle conceived of the activity of first thought in a similar way. Thought presupposes certain tools and raw materials. It presupposes the requisite immaterial objects: concepts, definitions, the rules of logic and grammar, the first principles of the physical sciences, and so on. Intuitive induction supplies these first principles. Although ancient and medieval philosophers believed that induction could be formalized as an argument (i.e., as a syllogism), they would never have supposed that we could *prove* the soundness of the mental activity of induction. They would instead have dismissed any such demand for proof as misguided. This is to get the epistemological process backward. We do not use propositions to prove first principles; rather, we use first principles to prove propositions. If, however, we do not prove first principles, it does not follow that they are arbitrary. First principles force themselves on us. Our rational understanding hits on them in a momentous and necessary insight. We derive them, not out of thin air, but from an intelligent – even cunning – analysis of experience.

In the present climate, any talk of first principles may summon up images of old-fashioned claims to absolute truth. But Aristotle never makes claim to the kind of absolute infallible knowledge commonly reviled in contemporary philosophy. Indeed, the fashionable myth that earlier authors were well-meaning but gullible sorts who uncritically assumed that their own opinions were true without qualification is a conspicuous caricature perpetrated by philosophical pundits who, apparently, do not bother to read primary sources. In his *Metaphysics*, Aristotle complains about people who demand a reason for everything. This is, he says, impossible. We simply cannot come up with a reason for everything, for human finitude is an unbreachable obstacle.

Aristotle's epistemological stance balances between two extremes. On the one hand, he is, in contemporary terms, a fallibilist. (One might be so bold as to call him a pragmatist, but a pragmatist who still believes in metaphysics.) He makes no claims to providing an absolute proof for the veracity of first principles, and he seems entirely aware of sceptical challenges. On the other hand, he insists that first principles are, properly understood, infallible. *Seen from a human perspective*, certain beliefs are inescapable. They cannot be doubted. They must be accepted as true.

The ancients and medievals in general did not believe that we could make knowledge claims from the omniscient perspective of a perfect God. Aristotle makes no claims as to the noumenal (or superhuman) validity of knowledgeable assertion. In a pre-Kantian world, this is not at issue. Along



with other authors in the mainstream historical tradition, Aristotle adopts a sophisticated (not a naive) commonsense realism. All that we can surmise from the evidence we are presented with is that any intelligent attempt to understand the world must embrace specific claims, concepts, definitions, rules, and so on. These cannot be consistently doubted. This is what Aristotle (and other early authors) meant by the infallibility of first principles. We shall investigate this issue further in a later chapter.

While, then, this is a book about induction, it is also about the first principles produced by induction and, inevitably, about the limits of philosophy. Human reasoning must begin somewhere, and it must end somewhere. Beginning in induction, it ends in the ineffable, in mysticism if you will. A contemporary rationalism raises suspicions about induction and it denies, of course, anything resembling mysticism. This is not a book about what, if anything, lies beyond philosophy. An attentive study of the history of ideas reveals a (sometimes misguided) striving toward transcendence. If the human mind strains skyward, toward ultimate and universal explanations, this may, among other things, tell us something important about the indomitable human spirit, about the existence of God, or about the human need for overcoming. Whatever our account of the *au delà*, Aristotle insists that philosophy, science, and morality originate in induction, in a non-discursive but epistemologically authoritative moment of intellectual understanding or insight.

#### METHODOLOGY

This book is driven by several methodological convictions. The approach can be described as synoptic, historical, critical, informal (or semantic), positive and negative, and self-contained.

As Jon Moline observes, Plato coins the Greek term συνοπτικός (*synoptikos*), which means “seeing the whole together” or “taking a comprehensive view<sup>12</sup>” – hence, we have the modern English equivalent “synoptic.” Aristotle is a synoptic philosopher in that he devotes himself to elaborating a comprehensive world view, rather than exclusively developing one, specialized branch of learning. The general reader may find Aristotle’s synoptic propensities a refreshing relief from the overly technical discourses of much current work, but even when it comes to the exploration of more specialized topics, the synoptic method is itself a useful exegetical tool. We cannot understand Aristotle’s account of induction by focusing on isolated passages. It is a mistake to focus exclusively on familiar sections from the

12 Moline, *Plato’s Theory of Understanding*, xi.

*Prior Analytics*, the *Posterior Analytics*, the *Metaphysics*, or the *Nicomachean Ethics*. Puzzling passages need to be examined in light of other passages, and still others, and ultimately in the light of a general, overarching world view. The best guide to Aristotle is Aristotle himself. The approach adopted here is *synoptic* in that it tries to bring together in one coherent account the notion of inductive reasoning implicit in Aristotle's logic, metaphysics, natural philosophy, psychology, and moral philosophy. When we focus on the philosopher's overall ideas and how they link together, details often felicitously fall into place.

Distinguished scholars such as D.W. Graham, G.E.L. Owen, and Terence Irwin distinguish sharply between the young, anti-Platonic Aristotle of the *Organon* and the more mature, reconciliatory Aristotle of the *Metaphysics*.<sup>13</sup> Although I dispute their specific account, no one who seriously reads Aristotle could overlook many apparent inconsistencies in the text. Jonathan Barnes cites two quick examples: the differing accounts of pleasure in the *Nicomachean Ethics* and his contradictory comments about the provability (or unprovability) of definitions in the *Topics* and *Posterior Analytics*.<sup>14</sup> I deal with the latter issue directly, but the more general point is well taken. A detailed analysis of Aristotle's original corpus is a risky and sometimes inconclusive business.

When it comes to interpretative details, Aristotle specialists and classicists do not agree among themselves. Still, many apparent inconsistencies resolve themselves when his comments are seen for what they are, scattered notes and remarks, composed on various occasions, for various purposes, by a subtle thinker who must have modified his general philosophical world view over time.<sup>15</sup> While some details remain obscure, we can nevertheless distil a relatively uncontroversial description of Aristotle's general philosophical approach or world view. Using the principle of charity, we can follow through the ramifications of his thought to their logical conclusion.

If the present volume is intended as a contribution to contemporary debate on induction, the method is *historical*. J.R. Milton writes, "Many philosophers in the analytic tradition have professed a conception of the nature of their subject which makes the history of philosophy almost completely irrelevant; the occasional remarks and discussions about historical figures are as perfunctory as those which appear in scientific textbooks,

<sup>13</sup> See Graham, *Aristotle's Two Systems*; Owen, "Tithenai ta Phainomena"; and Irwin, *Aristotle's First Principles*.

<sup>14</sup> Barnes, "Life and Work," 15.

<sup>15</sup> For the classical statement of the chronology and development of Aristotle's ideas see Jaeger, *Aristotle*.

and indeed have a similar function.”<sup>16</sup> Someone who wants to learn about chemistry does not devote much time to the study of medieval alchemy. The history of philosophy is a history of past mistakes; not much is to be gained from the perusal of ancient or medieval sources.

This kind of triumphalism is on the wane, but it has not been completely extinguished. One champion of the modern mindset explains that contemporary logicians and philosophers of language, unlike ethicists, have little, if anything, to learn from history. As he puts it,

Twentieth Century, Logic and Philosophy of Language are two of the few areas of philosophy in which philosophers made indisputable progress. For example, even now many of the foremost living ethicists present their theories as somewhat more explicit versions of the ideas of Kant, Mill, or Aristotle. In contrast, it would be patently absurd for a contemporary philosopher of language or logician to think of herself as working in the shadow of any figure who died before the Twentieth Century began. Advances in these disciplines make even the most unaccomplished of its practitioners vastly more sophisticated than Kant. There were previous periods in which the problems of language and logic were studied extensively (e.g., the medieval period). But from the perspective of the progress made in the last 120 years, previous work is at most a source of interesting data or occasional insight. All systematic theorizing about content that meets contemporary standards of rigor has been done subsequently.<sup>17</sup>

This is, to say the least, a little rich. There are, no doubt, more people who share this view than those few who are foolhardy enough to say so in print. The present book, needless to say, is motivated by a different mindset. I argue that modern logicians ignore what ancient and medieval philosophers had to say about induction at their peril. The blanket rejection of past philosophy as a comedy of errors does not withstand scholarly scrutiny. Indeed, modern accounts of induction are defective, in large part, because we have forgotten or misunderstood the work of earlier authors. If, however, we are to profit from our acquaintance with earlier philosophers such as Aristotle, we must work at developing a historically precise interpretation of his works. This is an arduous task. Our own assumptions and prejudices do not fit the assumptions and prejudices of earlier ages. What comes naturally to us is not necessarily what earlier authors had in mind.

16 Milton, “Induction before Hume,” 49.

17 Stanley, “Philosophy of Language,” 1 (online).

It would be self-defeating to remake Aristotle in our own image. Reading him is a salutary philosophical exercise precisely because his views are radically different from the assumptions that underlie so much of contemporary philosophy. He offers modern readers a refreshingly novel perspective on the problem of induction. All too often we are subjected to an anachronistic reading of earlier authors. Such efforts seem, from both a historical and a critical perspective, a sheer waste of time. They subvert the originality of their subject matter and block access to a larger world of ideas outside our own epoch and more comfortable ways of thinking.

We can study history for history's sake, to better grasp what earlier individuals were doing and thinking. But we can also study history in order to access the knowledge and wisdom that has been obscured by contemporary prejudices. In the later case, historical research becomes a tool to a better philosophical understanding. The study of the history of ideas advances hand in hand with critical philosophy. The present project has two goals: to secure an accurate historical interpretation of Aristotle's philosophy and to develop a modern theory of induction *ad mentum* Aristotle. These twin goals are necessarily connected. Looking at Aristotle through the lens of history produces a philosophically defensible understanding of induction.

Historical awareness is an aid to philosophical understanding. We must not lose sight of the bigger picture. Contemporary philosophy, like all important intellectual traditions, is a product of historical development. To make a long story much too short: Aristotle's empiricism was reworked by medieval authors and eventually supplanted by the ideological empiricism of early modern authors such as Locke and Hume. This new scientific philosophy of the Enlightenment, adopted and adapted by Kant, gave rise, in turn, to contemporary schools of Continental and Anglo-American philosophy. I offer a historical analysis of this development as it relates to the problem of induction, paying special attention to authors who preserved and developed the Aristotelian synthesis such as Thomas Aquinas and some of his more recent disciples.

We should have the greatest respect for Aristotle's prodigious intellectual achievement, and for the wonderfully patient work of succeeding generations of commentators. Still, the man the medievals called "the philosopher" did not say all there is to say. Indeed, his formulation of his own position is not without its shortcomings. There are gaps in his account. What he merely hints at must be elaborated at length; scattered observations, systematized; his assumptions rigorously argued for, in light of modern challenges; and his (and others') confusions, cleared away. Aristotle does not always acknowledge the implications of his own stance or the

radical nature of some of his suggestions. He could not have foreseen the development of competing schools of modern philosophy, but the appearance of these rivals provides an opportunity for a more balanced elucidation and evaluation of points of view he sometimes takes for granted.

We need to approach Aristotle's comments *critically*. It is not that he completed the specific philosophical project he began. It is rather that he initiated a certain philosophical approach, a commonsense realism that stands in need of further elucidation and continued development. The point is not to rely on mere argument from authority. A certain theory of induction is not correct because it originates in Aristotle, who is after all, a fallible thinker like the rest of us. An Aristotelian theory of induction must, in the end, stand on its own two feet. This book aims to capture all that is best in Aristotle's understanding of induction, without refraining from necessary criticism and amendment.

This is not a book on formal logic. I do briefly consider some formal aspects of the syllogism in chapter 6, but in a short-hand way that should be accessible to the uninitiated. The approach I adopt borrows heavily from contemporary argumentation theory, what is familiarly but somewhat misleadingly called "informal logic." Argumentation theory began, in large part, as an attempt to open up the study of argument to wider concerns than those privileged in modern courses on formal logic.<sup>18</sup> Contemporary philosophers such as Stephen Toulmin, Ralph Johnson and Tony Blair, Douglas Walton, Leo Groarke, and representatives of the Dutch "pragma-dialectic" school, such as Frans H. van Eemeren and Rob Grootendorst, have pushed the study of logic and persuasion in a unique direction.<sup>19</sup> Without eschewing a legitimate preoccupation with issues of logical form and deductive validity, argumentation theorists turn their attention to the study and evaluation of concrete "real-life" examples, to natural-language arguments, and to rhetoric and dialectic. While this is a book on inductive reasoning, there is nothing exotic about the process. We all induce conclusions on a regular basis, in both academic and casual contexts. I want to study Aristotle's account, in part because of the light it sheds on this everyday argument form.

Of course, this kind of *informal* approach includes consideration of the formal issues. Most importantly perhaps, I will argue that Aristotle, in

18 For a brief introduction to contemporary argumentation theory see *Stanford Encyclopedia of Philosophy*, s.v. "Informal Logic" (by Leo Groarke).

19 Authors such as Chaim Perelman and Lucy O'lbrecht-Tyteca have done similar work in the field of contemporary rhetoric, and overall the list should include further authors, such as John Woods, Paul Schollmeier, Trudy Govier, Robert Pinto, Christopher Tindale, Michael Gilbert, and Hans Hansen.

complete contrast to most modern authors, presents inductive arguments as deductively valid. There is a deep epistemological puzzle about the success of inductive reasoning, but this relates to the issue of creativity not to issues of logical form. I will argue that Aristotle's attitude toward inductive inference mirrors, more or less, that of deductivists, as they are called, in argumentation theory.<sup>20</sup> Although the modern-day deductivist account needs to be carefully qualified, I will show that Aristotle maintains that all good arguments have a valid form. It follows that inductive syllogisms are amenable to symbolic treatment and that we can elaborate a deductively valid account of the inductive syllogism using elementary notation.

The notion of a more informal approach to logic has not always been welcomed by theoreticians. The early Rudolf Carnap famously (or infamously) wrote, "All questions in the field of logic can be formally expressed and are, then, resolved into syntactical questions. A special logic of meaning is superfluous; 'non-formal logic' is a contradiction *in adjecto*. Logic is syntax."<sup>21</sup> Carnap here appeals to a common distinction between syntax and semantics. Many argumentation theorists are uncomfortable with this distinction (in ways too complicated to describe or evaluate in any detail here). According to this way of thinking, those who study argument can move in two directions. Those who study syntax (ways of putting properly formulated assertions together regardless of meaning) focus on proof. The basic goal is to show, by means of a series of well-formed statements, that if something is true, something else can be logically derived from it. On the semantic side of things, the focus is on the meaning and reference of concepts and statements, on issues of truth, and on validity or weaker (inductive) versions of logical cogency. The basic goal is the construction of arguments, often in natural language, that move from meaningful premises to meaningful conclusions while communicating or preserving (as much as possible) truth. (Questions naturally arise as to the relationship between the semantic and the syntactic side of things. Does validity always lead to provability, and does provability always lead to validity? Etc.)

Insomuch as we want to rely on this terminology, this project moves toward the semantic side of things. The focus is squarely on inductive reasoning understood in the context of scientific discovery, on substantive (not mathematical) reasoning, on natural-language arguments, on validity understood as a kind of truth preservation or entailment, on issues having to do with the definition and content of concepts, and even on

20 See Louis Groarke, "Deductive Account of Induction."

21 Carnap, *Logical Syntax of Language*, 259.

direct intellection as a “formless” (or “method-less”) conduit to truth. The focus is not on the construction of logical proofs or derivability. Clearly, Aristotle is very proud (excessively proud perhaps) of the syllogism, but his theory of logic, as we shall see, has both formal and semantic elements. On an Aristotelian account, they cannot be definitively separated, for the precise meaning of terms and propositions has an important bearing on the degree to which a given argument has logical force. It is the combination of logical form *and* the content in terms of meaning (and reference) that determines the kind of argument we are dealing with. In chapter 6, I do introduce a very simple formalism for inductive syllogisms (what might be loosely called an arithmetic of syllogisms), but even here the focus is on validity and entailment rather than on what modern specialists conceive of as formal proof.

There are inevitably two sides to any controversial treatment of contemporary issues. My method has a *negative* and a *positive* aspect. I criticize the orthodox empiricist account of induction, and I elaborate a competing theory. My critique is not intended as an assault on any one author or identifiable school, but as a protest against a widespread dogma that often functions as an unassailable presumption, a self-evident axiom contemporary thinkers often take for granted. I mean to challenge the usual view of induction and present, in a more constructive light, a very different explanation of its logical persuasiveness.

Taken as a whole, this book captures the development of my thought as the project progressed. The finished product preserves, I hope, something of the sense of intellectual discovery I experienced over years of close acquaintance with Aristotle. It is humbling to find at least hints of solutions to contemporary philosophical problems already laid out in an ancient author. Although the book as a whole looks at inductive reasoning from a wide-ranging perspective, individual chapters are largely *self-contained*. They can, for the most part, be read on their own. Each chapter focuses on a different issue, and each issue is, inasmuch as that is possible, considered in its own right and in as accessible and as jargon free a manner as possible.

A word about Greek terminology. This is a work of contemporary critical philosophy rather than a study in classics. I want to elaborate on the importance of Aristotle’s ideas for contemporary philosophers. It is necessary, nonetheless, to review Aristotle’s exact terminology, for the Greek terms he employs do not always map neatly onto their contemporary English counterparts. Etymology is, at times, a crucial aid to understanding. I will, then, refer to Aristotle’s technical nomenclature where appropriate. Any standard ancient Greek dictionary would provide additional help with the common Greek terms referred to here.

As this is a work directed toward a wide audience, readability is an important concern. Clearly, many translations of Aristotle's works are available. To cite only one example, the *Posterior Analytics*, an especially important work for any investigation into Aristotle's attitudes about induction, has been wholly or partly translated by such eminent classical scholars as W.D. Ross, Jonathan Barnes, Hugh Tredennick, Hippocrates Apostle, Renford Bambrough, G.R.C. Mure, W.K.C. Guthrie, G.E.L. Owen, Terrence Irwin, Richard McKirahan, Robin Smith, Paolo Biondi, and so on. I try to introduce and explain Aristotle's technical terminology, while citing from translations that are accessible to modern-day readers with only a modicum of classical learning. One inevitably prefers some translations to others, but nothing in my argument hinges on one precise translation. Understanding the Stagirite is not a matter of literal translation, but of understanding the systematic orientation of his thought, the overall structure of his arguments, the historical context of his writing, and the general thrust of his ideas. (Aristotle was traditionally dubbed "the Stagirite" because he was born in the northern Greek colony of Stagira.)

#### PLAN OF THE BOOK

Turn now to the plan of the book. Chapter 1 is, of course, this introduction. Chapter 2 begins by briefly describing induction as an argument form. I consider, in some detail, the standard modern view of induction and particularly Hume's famous attack on the validity of inductive reasoning. This enormously influential historical landmark has set the tone for a certain type of discussion. Modern authors of all colours and stripes have commented on the problem of induction, variously attempting either to secure the validity of inductive reasoning or to show that all such attempts are doomed to failure. I argue that the familiar Humean critique of traditional accounts of induction depends crucially on a caricature of the metaphysical notion of substance. The Humean critique conflates "Cartesian" with evidence-based scepticism. It mistakes a dogmatic uncertainty, deriving from inevitable human fallibility, for an evidence-based uncertainty that motivates reasonable doubt.

In chapter 3, I go on to explore Aristotle's basic approach to inductive argument as a response to the Humean puzzle. In contrast to many recent commentators, I argue that Aristotle's famous example of an inductive syllogism in *Prior Analytics*, book 2, chapters 23–4, does not refer to an instance of so-called "perfect induction." This widespread interpretation rests on a misunderstanding. On Aristotle's account, inductive arguments are *valid* syllogisms that depend on a presumed resemblance and, more



fundamentally, on a notion of identity. His approach resembles that of a largely neglected school of older textbook authors, including “traditional logicians” such as Richard Clarke, Peter Coffey, Ralph Eaton, George H. Joyce, and Jacques Maritain.

In his discussion of the inductive syllogism, Aristotle appeals to the key concept of “convertibility” or “counter-predication.” I investigate this forgotten logical relation in some detail. Although Aristotle’s understanding resembles that of the deductivists in contemporary argumentation theory, we can reformulate his account, using modern propositional logic and the argumentation-theory device of hidden or implicit premises. As we shall see, Aristotelian induction applies to both natural and artificial kinds. It is the identification of an underlying similarity that binds individuals together within a specific species or genus, securing a form of logical necessity.

In chapter 4, I argue that Aristotle’s theory of induction is more finely structured than in the prevailing account. I identify five main levels of induction. The first two involve a non-discursive mode of intuitive insight or intellection. The first, which I call “true induction” or “induction proper,” is more rigorous than the second, which is merely a generalized sensitivity to resemblance. The first level begets the concepts, definitions, universals, laws, and natural facts acting as the starting points for the activity of rigorous science. In a practical vein, it also produces the first principles of morality. It operates by means of contemplative thought or νόησις (*noesis*). The second level involves the way we identify a contingent likeness. It operates by a less reliable form of inductive insight that I will call “recognition.”

The remaining three levels involve actual arguments. We can, then, distinguish between three types of inductive argument. What I call “true inductive syllogism” makes inferences about the necessary or essential properties of things; it produces universal knowledge or ἐπιστήμη (*episteme*). It can be described as an unorthodox or imperfect type of demonstrative syllogism or ἀπόδειξις (*apodeixis*). Rhetorical (or dialectical) induction produces general but not necessarily universal or necessary knowledge. Aristotle identifies two kinds of rhetorical induction: what he calls arguments from likeness (ὁμοιοῦς) and arguments from example (παράδειγμα). Both these arguments produce probable or plausible conclusions. The third type of inductive argument involves modern treatments of mathematical probability. Aristotle overlooks this last category of statistical inference. Given his biological view of science, it seems safe to say that he would have considered it the least important form of induction.

In chapter 5, I consider Aristotle’s account of the role of inductive reasoning in moral philosophy as elucidated in texts such as *Nicomachean Ethics*. I argue that Aristotle’s account of moral deliberation echoes his

inductive-deductive model of theoretical science. It can be divided into stages: moral induction and practical syllogism. Morality involves practical reason or φρόνησις (*phronesis*). Science is logically a more rigorous form of intellectual inquiry. Nonetheless, the first principles of science and morality are equally fallible (or equally authoritative) in that they both spring from the same ultimate source in inductive reason.

In chapter 6, I propose a formal account of the inductive syllogism. George Englebretsen has shown how Fred Sommers' account of the syllogism can be used to formulate a term logic that can replace or supersede more popular mathematical accounts of sentential logic.<sup>22</sup> My goals are more modest. I revisit, in passing, the historical controversy that swirled around William Hamilton's suggestion that the predicate term in a categorical statement be quantified along with the subject term. Reworking Hamilton's proposal, I develop an elementary formalism based on a parallel form of double quantification. One can use the very same formalism to evaluate deductive and inductive syllogisms. It could easily be used to teach Aristotelian logic to undergraduates. The notation (overlooked by Aristotle and his later medieval commentators) is, in effect, a formal expression of his somewhat hasty treatment of the key concept of convertibility.

Aristotle, like other traditional philosophers, situates the beginning of reason in induction. In chapter 7, I offer a historical overview of the way several important philosophers account for our ability to recover first principles. I begin with the Presocratics, Plato, and Aristotle. As it turns out, the Aristotelian concept of *epagoge* or induction closely parallels the Platonic concept of ἀνάμνησις (*anamnesis*) or recollection, in that both processes depend on some mysterious capacity for creative intuition or νόησις (*noesis*). I go on to briefly examine Neoplatonic notions of *noesis*, Thomas Aquinas' doctrine of *intellectus*, René Descartes' account of the natural light of reason (*lumine naturali*), and Blaise Pascal's description of "knowledge from the heart," and, in a turn to contemporary philosophy, Bernard Lonergan's understanding of "insight." I claim that earlier accounts share a common understanding that more recent authors misconstrue. Representatives of the modern view such as Descartes and Lonergan embrace, wittingly or unwittingly, an eliminative rationalism that leads inevitably to the dead end of scepticism.

<sup>22</sup> See Englebretsen, *Three Logicians*. Other logicians have busied themselves translating Aristotle's syllogistic into a propositional calculus. Cf. J. Lukasiewicz, *Aristotle's Syllogistic from the Standpoint of Modern Formal Logic*. Or see the scholarly apparatus in Jonathan Barne's translation of the *Posterior Analytics*.

In chapter 8, I focus the creative aspects of induction. In the Greek mind, inductive inference is not irrational, but it is quasi-divine, for it involves, in a way to be explained, the creation of more from less. It is the creative leap at the heart of induction that rankles modern empiricists. Mathematical or computational attempts to reproduce or represent the inductive insight in cognitive science fail. In some important sense, they miss the point. I argue that art provides a more instructive analogy. Indeed, the way Renaissance sculptor Michelangelo Buonarroti describes artistic inspiration closely parallels Aristotle's account of inductive insight. Induction is, in some qualified sense, a τέχνη (*technē*), a kind of making. It *makes* first principles. If, however, this is a creative endeavour, it does not follow that first principles are purely subjective or arbitrary.

In chapter 9, I consider the epistemological status of induction and the role it plays in modern science. Ancient and medieval authors claimed that first principles are infallible. In an age of philosophy still marked by a lingering Cartesian doubt, these claims have been misunderstood. I elucidate and defend the traditional point of view. First principles are infallible inasmuch as they cannot, *from a human perspective*, be meaningfully challenged. They are, so to speak, immovable. To eliminate them is to undermine our very sanity. In the course of my argument, I consider modern and not-so-modern attempts to undermine perhaps the most celebrated first principle of all, the law of non-contradiction. I provide an Aristotelian solution to the liar's paradox and critique the narrow formalism of modern treatments. Though first principles are authoritative expressions of human intelligence, we can, of course, still make mistakes in inductive reasoning. I examine Thomas Aquinas' explanation of intuitive error and Aristotle's use of ἡ (qua) as method for resolving inductive ambiguity.

Although modern scientific philosophers have been, at times, hostile to Aristotelian metaphysics, this attitude is far from universal. Contemporary philosophers of science such as Hilary Kornblith, Brian Ellis, Howard Sankey, and James Freeman argue for a "new essentialism," which they allege is necessitated by the discoveries of modern science. I give this new essentialism and the associated attempt to recover a notion of *a posteriori* necessity a sympathetic reading. I do, however, argue that Aristotle's original account of induction is superior to modern notions of abduction or "inference to the best explanation." I also argue that we cannot consistently embrace the new essentialism and reject metaphysical realism. I finish the chapter by showing that the alleged logical incompatibility of Aristotle's metaphysics with modern theories of evolution is largely based on a misunderstanding.

## *Before and after Hume*

Like every other innovator of modern times, [Darwin] had to combat the authority of Aristotle. Aristotle ... has been one of the great misfortunes of the human race. To this day the teaching of logic in most universities is full of nonsense for which he is responsible.

Bertrand Russell<sup>1</sup>

I doubt, therefore I exist.

René Descartes<sup>2</sup>

THE POPULAR SCIENCE-FICTION WRITER ISAAC ASIMOV, in *The Intelligent Man's Guide to Science*, tells an all-too-familiar tale about the triumph of modern science over earlier natural philosophy. Asimov presents Galileo Galilei (1564–1642) as a kind of rebel hero who courageously rejected the narrowly deductive methods of traditional ancient thinkers. “Galileo’s general viewpoint,” we are told, “was just the reverse of the Greeks.” If “the Greeks minimized the role played by induction, Galileo looked upon induction as the essential process of gaining knowledge, the only way of justifying generalizations.”<sup>3</sup> Galileo, on this account, turned ancient philosophy upside down, ushering in a new scientific world view. His revolutionary insight “consisted in elevating induction above deduction.”<sup>4</sup>

Since Asimov’s version of intellectual history is only a popular account, it seems less than charitable to labour over obvious inaccuracies. Even from a book directed at the educated layperson, however, the quoted passage is illuminating as a not-too-distant echo of a ubiquitous attitude and conspicuous foil to the view to be developed here. Asimov, the amateur philosopher, confuses Greek philosophy as a whole with the schools of Plato and

1 *Scientific Outlook*, 15.

2 *Recherche de la vérité*, 1135–6 (my translation throughout).

3 Asimov, *Intelligent Man's Guide to Science*, 17.

4 *Ibid.*, 16.

Pythagoras. Ancient Greek thinkers were, he thinks, abstract thinkers, in love with mathematics and formal geometry. They were impressed “with the beauty of pure deduction.”<sup>5</sup> In their enthusiasm for the spiritual purity of immaterial mathematical forms, they did not deign to observe attentively the physical world around them. This “worship of deduction from self-evident axioms” brought Western civilization to “the edge of a precipice with no place to go.”<sup>6</sup> It was, in other words, an intellectual dead end. As Asimov describes the history of Western civilization, the ancient and mediaeval world was left wallowing in a sea of ignorance and unscientific superstition until Galileo and his followers came to the rescue with their invention of “the inductive method [that] starts with observations and derives generalizations ... from them.”<sup>7</sup> Modern science went on to save the modern Western world from the sterility of abstract philosophy.

If popular culture lacks philosophical sophistication, it is, for that very reason, unable to wrestle itself free from the reigning orthodoxy. This misinterpretation of Western intellectual history is not unprecedented. Asimov is not a trained philosopher, but what are we to think of Bertrand Russell’s comments on the “deductive attitude of the Greeks,” which, according to Russell, “made the experimental method scarcely possible.”<sup>8</sup> Russell attributes the Greeks’ aversion to science to two factors: their poetic temperament and their aristocratic ways. In his words, “the Greek genius was deductive rather than inductive” because they “observed the world as poets rather than as men of science ... [and] because all manual activity was ungentlemanly, so that any study which required experiment seemed a little vulgar.”<sup>9</sup>

Russell’s text is the probable source of Asimov’s caricature. But this deductive account of the Greek mind has historical roots.<sup>10</sup> Henry Tappan, in the introduction to an important logic textbook published in 1856, grandly asserts, “The work undertaken here differs ... from the systems of logic which have hitherto been given to the world. The Aristotelian logic is simply the method of deduction; and as such, it is complete. Subsequent works ... have closely copied the great master [confining] themselves to an exhibition of deductive principles and processes.”<sup>11</sup> Tappan, in elaborating

5 Ibid., 15.

6 Ibid., 13.

7 Ibid., 16.

8 Russell, *Scientific Outlook*, 20.

9 Ibid., 18.

10 Ibid.

11 Tappan, *Elements of Logic*, 3.

his own account of induction, believes that he is filling a vacuum, that he is doing something never done before. He dismisses or ignores the inductive theories of the ancients. It is as if the ancient Greek philosophers had no grasp of the inductive method whatsoever.

Whereas Asimov points to Galileo as the modern champion of the empirical method, one could better award that distinction to Francis Bacon, in many ways, the founder of British empiricism. J.R. Milton, in an informative paper on the history of induction, writes, "Francis Bacon appears, as he would have wished, as the first really systematic thinker about induction."<sup>12</sup> But Bacon, like Asimov, Russell, and Tappan, overlooks (and misunderstands) the ancient doctrine of induction. In the *Novum Organum* (1620), Bacon lumps together under the pejorative rubric of "Sophist" almost all ancient philosophers, including, "Gorgias, Protagoras, Hippias, Polus ... Plato, Aristotle, Zeno, Epicurus, Theophrastus, and their successors Chrysippus, Carneades, and the rest."<sup>13</sup> Bacon believes that all these philosophers force nature into the straitjacket of their own abstract, *a priori* philosophical conceptions. In a passage remarkable for its historical inaccuracy, Bacon complains that even Aristotle, the empiricist student of Plato, does "not consult experience ... but having first determined the question according to his will, he then resorts to experience, and bending her into conformity with his placets, leads her about like a captive in a procession."<sup>14</sup> And so it is for Greek philosophers generally. "All is tainted and corrupted," Bacon laments, "in Aristotle's school by logic; in Plato's by natural theology; in the second school of Platonists ... by mathematics."<sup>15</sup>

The attitudes of thinkers like Asimov, Russell, Tappan, and Bacon notwithstanding, the empirical method of scientific observation is not, needless to say, a modern innovation. Long before the advent of modern Renaissance science, Aristotle recognized and discussed, in some detail, the momentous nature of the inductive method. This book attempts to elucidate and extend his thought. I will argue that Bacon and succeeding generations of modern philosophers advance a misleading caricature that has little to do with what the real, historical Aristotle or his later followers taught or believed. If we cut through layer upon layer of caricature and return instead to the actual texts (or to enlightened commentary), we will discover an

12 Milton, "Induction before Hume," 49. Milton is describing the received view, not his own idiosyncratic but helpful account.

13 Bacon, *Novum Organum*, bk 1, aphorism 71 (in Bacon, various documents).

14 *Ibid.*, bk 1, aphorism 63.

15 *Ibid.*, bk 1, aphorism 96.

account of induction that makes sense even today. Aristotle's account needs to be refined and expanded, no doubt, but it is, in the main, correct.

An early modern thinker such as Bacon was not in a position to fairly evaluate or even understand earlier theories of induction. His patience tried by generations of scholastic commentary, Bacon goes so far as to assert that the authority of Aristotle is an obstacle to intellectual and scientific progress. We must reject Aristotle if we wish to move forward. He peevishly observes, "Knowledge is like a water that will never arise again higher than the level from which it fell; and therefore to go beyond Aristotle by the light of Aristotle is to think that a borrowed light can increase the original light from whom it is taken."<sup>16</sup> But the simile is doubly incorrect. Firstly, Aristotle would undoubtedly think of his own philosophy, not as the source of light, but as a lens through which the light shines. Aristotle is not worthy of critical scrutiny because he is Aristotle but because his doctrines capture something true about the facts of human experience and our relationship to the world. It is the penetration and scope of his thought that interests the philosophically minded reader.

Secondly, it is a mistake to think of Aristotle's corpus as the idiosyncratic work of an aloof, lonely genius. Aristotle was, of course, Plato's pupil, was well-traveled, had connections in high places, ran his own school, taught many students, and was wholly familiar with the thought of other Greek philosophers. His encyclopaedic oeuvre is, in part, a compendium of philosophical opinions from diverse sources. I will approach Aristotle, not as I would a solitary genius, but as a representative of an ongoing tradition that captures something true and deep about the inductive method. His position on induction is articulated, at least in part, by groups of thinkers, both before and after him. Aristotle, however, expresses this view in a particularly forceful and comprehensive way.

The present chapter begins with a brief introduction to Aristotle's view. I will then move on to consider contemporary theories of inductive reasoning and their historical antecedents. David Hume's famous critique of induction successfully shifted the focus of philosophical attention and set the scene for modern empiricist treatments of the "problem of induction." I revisit and re-evaluate Hume's influential argument, which derives ultimately from John Locke and is reiterated by a host of early modern philosophers. Despite Hume's undeniable eloquence, I claim that his account depends crucially on an epistemological attitude I call "Cartesian scepticism." Consistently applied, Cartesian scepticism undermines, not only induction, but

<sup>16</sup> Bacon, *Valerius Terminus*, ch. 4, "Of the Impediments of Knowledge, Being the Fourth Chapter, the Preface Only of It."

every other kind knowledge. I will elaborate a more detailed treatment of Aristotle's ideas in chapter 3, "A 'Deductive' Account of Induction," chapter 4, "Five Levels of Induction," and chapter 5, "Moral Induction."

#### WHAT IS ARISTOTELIAN INDUCTION?

Begin with Aristotle who distinguishes, in various places, between two different ways of knowing.<sup>17</sup> In deduction or *σὺλλογισμὸς* (*sullogismos*), we move from previously established propositions to a conclusion that follows necessarily; in induction or *ἐπαγωγή* (*epagoge*), we move from the observation of particular instances to general claims about the nature of the kind of thing in question. Deduction involves an inference from previous statements, whereas induction requires a cognitive "progress from [observed] particulars to universals."<sup>18</sup> Consider a simple example of induction Aristotle himself refers to.

Sometime, at the dawn of geometry, someone or some group of people must have examined one or two or however many triangles and come to understand that the interior angles of *any* triangle add up to 180 degrees. These individuals were led from the observation of *some* triangles to the recognition of an abstract principle that applies to *all* triangles.<sup>19</sup> They could somehow leap to "the universal from ... the particular."<sup>20</sup> This is, for Aristotle, what induction is all about. Induction supplies "proof from a number of particular cases that such is the rule."<sup>21</sup> We *observe* particulars and somehow arrive at an overarching principle applicable to every case.

Aristotle gives divergent examples of inductive arguments. Some are explicitly stated; some are implicitly referred to in the text. In a frequently discussed example explaining the difference between "knowledge of the fact" and "knowledge of the reasoned fact," Aristotle demonstrates that planets, unlike stars, do not twinkle (undergo intermittent variation in luminosity), because they are closer to us.<sup>22</sup> He claims that the universal

17 See, for example, *Prior Analytics*, bk 1, ch. 2, 24b18–20; *Posterior Analytics*, bk 1, ch. 1, 71a1–10; *Topics*, bk 1, ch. 1, 105a11–20; and *Rhetoric*, bk 1, ch. 2, 1356b. We will return to these passages later.

18 *Topics* (Forester), bk 1, ch. 14, 105a10–15 (in Aristotle, *Aristotle in 23 Volumes*).

19 See *Posterior Analytics*, bk 1, ch. 1, 71a20–25, where the process is reversed.

20 *Posterior Analytics* (Tredennick), bk 1, ch. 1, 71a5–10 (in Aristotle, *Aristotle in 23 Volumes*).

21 *Rhetoric* (Freese), bk 1, ch. 2, 1356b10–16 (in Aristotle, *Aristotle in 23 Volumes*).

22 *Posterior Analytics*, bk 1, ch. 13, 78a20 ff.



principle that nearby light sources do not twinkle has to be established “by induction or sense perception.” This rather bald textbook example can be read in two ways.

We might, at first, jump to the universal conclusion that nearby light sources do not twinkle, by observing that nearby light sources – i.e., those here on earth – do not (as a rule) twinkle. But this kind of mechanical conclusion begs the question. Why should what happens in the heavens be the same as what happens on earth? Aristotelian induction is more than a matter of thoughtlessly jumping to a conclusion that what we are used to (on earth) is what must be the case (in the heavens). Something more complicated is going on here. Why should we, on seeing that the stars twinkle and the planets do not, come to the conclusion that the latter are *necessarily* closer? Think of what twinkling involves. To twinkle is to intermittently undergo something close to extinction. It is to give off an intensity of light that is continually interrupted by moments of dimness. Hence the key insight: sources very far away, being much weaker, are subject to intermittent dimness, i.e., they twinkle. Whatever physics of light we adopt, the farther a source is away from us, the more tenuous its effect on us. Hence the (correct) conclusion that twinkling is (in the case of the stars) a function of their great distance from us. Once we know this, we can go on to conclude that the planets, which do not twinkle, are closer than the stars.

Scientific induction is, for Aristotle, a matter of understanding what must be the case; it is the capacity of insight (not argument) that allows us to make logical sense of observation. We can (as we shall see) turn an inductive insight into an argument. Indeed, Aristotle gives precise instructions as to how we are to do this. But, for Aristotle, induction, in its purest sense, begins in an intelligent leap that grasps what is going on. This mental quickness supplies us with the first principles of science. Confronted with repeated instances of a phenomenon; human reason arrives at a universal principle, and then goes on to use this universal principle in scientific argument.

In the *Topics*, a sometimes neglected book about strategies of dialectical (as opposed to scientific) reasoning, Aristotle supplies a string of inductive examples. Some of these are rather trite textbook cases, but the general theme is unmistakable. Debaters may secure their conclusions by deduction or induction, by referring to previously established propositions or by examining concrete cases illustrating a general principle. Induction is presented as an important source of general knowledge. Aristotle suggests, for example, that we “try to obtain knowledge” of ethics, logic, and cosmology “by the habitual practice of induction, examining

[each subject matter] in the light of ... examples.”<sup>23</sup> If we wish to debate about morality, we should examine particular examples of moral and immoral acts. If we wish to debate about logic, we should examine particular examples of good and bad arguments. And if we wish to debate about astronomy, we should examine particular examples of individual planets, stars, or constellations. In each case, an investigation of particular instances provides insight into the general principles underlying the corresponding subject matter.

Consider another example of inductive reasoning. Aristotle enunciates a basic metaphysical principle: “If the increase of the accident follows the increase of the subject ... it is obvious that it is really an accident of the subject, but if it does not follow it, it is not an accident of it.” He concludes, “This result must be obtained by induction.”<sup>24</sup> What does Aristotle have in mind? There is no need to be intimidated by this metaphysical terminology. Consider a modern example. A child is blowing up a balloon. And suppose the expression, “New York,” is written on the balloon. As the balloon increases in size, the letters in the expression, “New York,” also increase in size. The balloon is “the subject”; the lettering is “the accident.” So the increase in the size of the lettering, the accident, follows upon the increase in the size of the subject, the balloon. We can then conclude that the lettering is a genuine part of the balloon. Suppose, however, there is a paper tag with the words, “New York,” attached to the end of the balloon. As the balloon increases in size, the words, “New York,” on the tag do not increase in size. So we can conclude that the tag is not a genuine part of the balloon. The general point is clear: when the accidental attribute genuinely belongs to the subject, an increase in a subject must be accompanied by an increase in the accident.<sup>25</sup> There are possible counter-examples, but Aristotle does not, in any case, intend this as an instance of foolproof metaphysical reasoning.<sup>26</sup> Dialectical reasoning deals with “generally accepted opinions” rather

23 *Topics* (Forester), bk 1, ch. 14, 105b25–30. Aristotle had earlier suggested that debaters make up lists of examples about “the good” or about “animal life,” etc. (bk 1, ch. 14, 105b12–16).

24 *Ibid.*, bk 2, ch. 10, 115a1–6.

25 There are other examples of this kind of induction-based debating exercise. See, for example, *ibid.*, bk 4, ch. 2, 22b15–20; bk 4, ch. 3, 123b1–10; and bk 8, ch. 1, 155b30–35.

26 One might complain, for example, that the hair, fingernails, and toenails are parts of the subject that continue to grow long after the latter’s growth stops, except that hair and nails are made up of dead tissue and are not literally part of the living organism. But we need not investigate such details here.

than scientific truth.<sup>27</sup> What is important is that we can establish, through an induction from observations, a plausible metaphysical principle.

Aristotle writes that induction is “the way in which general concepts are conveyed to us by sense perception.”<sup>28</sup> Sense perception accesses particular things in the world: this chair, that tree, this sunset, that falling object. Induction turns this limited experience of particular things in the world into knowledge of the general case. It is the mental ability to somehow “jump” from an experience of particular things to concepts, rules and principles covering a wide variety of cases. We can, then, define Aristotelian induction in two different ways. If induction is, as traditionally understood, an inference from particular to the universal, it is also, in its most basic form, an inference from sense perception to knowledge. We begin in perception and we end up with words or symbols: with propositions made out of some kind of language, with verbal or linguistic claims that ultimately affirm what is true, in a general way, about the world.

Aristotle writes, “We cannot employ induction if we lack sense perception, because it is sense perception that apprehends particulars.”<sup>29</sup> Sense perception is, so to speak, the ground floor of knowledge. All knowledge ultimately arises out of sense perception, and therefore, out of induction. For Aristotle, we do not learn by accessing inborn ideas ready made inside our heads or by moving, in the first instance, from one state of knowledge to another. Aristotle writes, “States of knowledge are neither innate in a determinate form, nor developed from higher states of knowledge, but [developed] from sense perception.”<sup>30</sup> In other words, we learn, in the first instance, through an induction from observation. Clearly, induction is crucial to knowledge. Indeed, it is, for Aristotle, the ultimate source of all knowledge.

In contrast to Plato, Aristotle privileges the essential role of observation in learning.<sup>31</sup> At the beginning of the *Metaphysics*, he points out that we naturally revere the senses because they help us to know.<sup>32</sup> Again, in the *Posterior Analytics*, he remarks that “if any sense-faculty has been lost, some knowledge must be lost with it.”<sup>33</sup> Those who go blind or deaf, those who lose their sense touch or taste or smell, lose their access to a realm of

27 Ibid., bk 1, ch. 1, 100b18–25.

28 *Posterior Analytics* (Tredennick), bk 2, ch. 19, 100b1–5.

29 Ibid., bk 1, ch. 18, 81b5–10.

30 *Posterior Analytics* (Mure), bk 1, ch. 1, 100a10 (in Aristotle, *Works of Aristotle*).

31 It is not, as some seem to think, that Plato left no room for sense perception, but Aristotle came to *privilege* its role in a way foreign to Plato.

32 The sense of sight, especially, *Metaphysics*, bk 1, ch. 1, 980a22–30.

33 *Posterior Analytics* (Tredennick), bk 1, ch. 18, 80b15–20.

human experience that plays a role in knowledge formation. This point of contact between the human being and the surrounding world is where knowledge starts. On Aristotle's account, someone who lacked all sense perception to begin with, someone born totally devoid of all five senses could never learn. Knowledge would be inaccessible to them.

Although this picture of Aristotelian induction is, in the main, true, it is admittedly overly simple. Aristotle's use of the term *epagoge* is multi-layered. Depending upon the context, the term may refer to the method of observation, to a cognitive process of illumination, or to various types of syllogisms. If induction begins in a bout of illumination that is more than merely psychological (it is not a matter of mere feeling), this direct insight gives rise to concepts, to propositions, and ultimately to arguments describing reality in general terms. When it comes to the kind of inductive arguments contemporary logicians place at the center of their investigations, we can make an induction from particular instances. To use the old saw, "Socrates, Plato and Aristotle are men. Socrates, Plato, and Aristotle are mortal. Therefore, all men are mortal." Or we can make an induction from smaller groups to larger groups, i.e., from species to genus or from genus to larger genus. For example, we can argue: "All human beings are animals. All human beings are mortal. Therefore, all animals are mortal." Overlook, for the moment, issues about the logical validity of such arguments. Clearly, the conclusion, "all animals are mortal," includes animals other than human beings. Because this argument entails a movement from a smaller to a larger group, it counts as an instance of induction. As Robin Smith points out, Aristotle considers individual and group predications as formally equivalent.<sup>34</sup> When it comes to rigorous science, however, Aristotle privileges arguments having to do with species and genera.

And there are other variations in Aristotle's theory of inductive inference. In *Topics*, for example, he recommends its use to deliberately arrive at a generalization to be subsequently shown to be false.<sup>35</sup> This is a kind of *reductio ad absurdum* reasoning. Again, the Philosopher refers to a rhetorical kind of induction he calls "argument from example." Here the movement is not from "part to whole ... but [from] part to part, or like to like."<sup>36</sup> This is, in the modern idiom, reasoning from analogy. And so on. We shall explore all these different levels of Aristotelian induction in a future chapter. The

<sup>34</sup> *Stanford Encyclopedia of Philosophy*, s.v. "Aristotle's Logic" (by Robin Smith) (an excellent general introduction).

<sup>35</sup> *Topics*, bk 2, ch. 5, 111b37–112a1.

<sup>36</sup> *Rhetoric* (Freese), bk 1, ch. 2, 1357b (in Aristotle, *Aristotle in 23 Volumes*).

present discussion is only meant as a brief introduction. Nonetheless, the general picture is clear. Induction involves a mental leap from particular to general. It begins with an intelligent movement of understanding giving rise to concepts, propositions, and arguments. At the most basic level, it is the bridge between sense perception and knowledge; it somehow penetrates concrete, particular experience to produce a general understanding of a nature.

#### MODERN DOGMA

There is an approach to induction that is distinctly modern. Most contemporary commentators question the authority, the reliability, or at least the logical rigor of inductive reasoning. As *The Oxford Companion to Philosophy* declares “most philosophers hold that there is a problem about induction.”<sup>37</sup> On this pervasive view, induction usually involves an attempt to predict something about the future, but we can never be sure that the future will conform to past experience. In Bertrand Russell’s colourful words, “All [our] rather crude expectations ... are liable to be misleading. The man who has fed the chicken every day throughout its life at last wrings its neck instead.” If inductive reasoning assumes that the future will resemble the past, we may, philosophically, “be in no better position than the chicken which unexpectedly has its neck rung.”<sup>38</sup>

Norman Campbell describes induction as “the process of arguing from the particular to the general, or from the small portion of our experience of which we have knowledge ... to the much greater portion which is at the time wholly unknown to us.”<sup>39</sup> It is this movement from what is known to what is unknown (or from past to future) that disturbs the modern mind. Consider our original example about black crows. We observe that this crow, that crow, and that other crow are black. We see hundreds of black crows. We conclude, “all crows are black.” The problem is, of course, that not all crows are black. There are rare albino crows and crows with spots of white on their wing, toes, bills, or other parts of their bodies. So the generalization “all crows are black,” understood as a blanket statement about what must be the case about crows, turns out to be false, even though it may conform to our own everyday experience.

The abstruse qualifications of analytical philosophy notwithstanding, knowledge still tends to be associated in some way with empirical verifiability.

37 *Oxford Companion to Philosophy*, s.v. “Induction” (by Michael Collins).

38 Russell, *Problems of Philosophy*, 63.

39 Campbell, *Foundations of Science*, 89.

Hence the so-called problem of induction. Induction entails a movement “from the observed to the unobserved.”<sup>40</sup> We observe *these* particular crows and are led to a generalization that pertains to *all* crows. But how can we have conclusive or necessary or authoritative knowledge about crows that have not been and never will be observed? We can explain the problem in the following way.

Translate every observation of a black crow into a premise, “this crow at this time at this place was observed to be black.” Gather these premises together in support of the conclusion, “all crows are black.” The conclusion of this argument applies to all crows at all times in all places. In Brian Skyrms’ words, it “asserts more than the premises.”<sup>41</sup> Even if all observed crows are black, it is still possible that some unobserved crows are not black. It does not matter how many observations we collect. The premises of the argument (in Richard Feldman’s words) “always leave some room for the falsity of the conclusion.” So the conclusion of an inductive argument does not follow necessarily from the premises. Inductive inference “is not conclusive.”<sup>42</sup>

A standard textbook neatly lists the alleged differences between deductive and inductive reasoning.<sup>43</sup> Firstly, the truth of the premises in a (properly constructed) deductive argument guarantees the truth of the conclusion, whereas the truth of the premises in a (properly constructed) inductive argument does not guarantee the truth of the conclusion. Secondly, all the content of the conclusion in a deductive argument is implicitly present in the premises; whereas the conclusion of an inductive argument has content that goes beyond the content of its premises. (Deduction is “non-ampliative,” indeed tautologous, whereas induction is “ampliative” and non-tautologous.) Thirdly, although the addition of new premises cannot undermine the formal validity of a properly constructed deductive argument, it may completely undermine even a strong inductive argument (deduction is, and induction is not, “erosion proof”). And fourthly, all valid deductive arguments are equally valid, whereas properly constructed inductive arguments may be stronger or weaker, depending upon the amount of evidence amassed in support of each conclusion.

<sup>40</sup> This is an echo of Aristotle and Mill; *Routledge Encyclopedia of Philosophy*, s.v. “Inductive Inference” (by Patrick Mayer), 756.

<sup>41</sup> Skyrms, *Choice and Chance*, p. 8.

<sup>42</sup> Feldman, *Reason and Argument*, 104.

<sup>43</sup> This list has been adapted from Salmon et al., *Introduction*, 11.

(Deductive validity is held to be all or nothing, whereas inductive arguments come in various degrees of probability or strength.)<sup>44</sup>

This overview may seem to throw a rather worrisome light on the soundness of inductive reasoning. But we need induction. As John Kemeny comments, induction is “a much more useful kind of thing than deduction. Induction tells us things we did not know before, whereas deduction only tells us things we knew already but did not realize we knew.”<sup>45</sup> Indeed, we need induction, not just for science, but in order to survive. As Kemeny drily observes, “If nature was designed so that plausible inductions invariably turn out to be wrong, the human race would be wiped out soon.”<sup>46</sup> If we could not make accurate generalizations, if we could not accurately predict the future, science – indeed, human life – would utterly fail. We are left with a pressing philosophical problem: How can we justify a “logical” procedure that we must, and indeed we do, use?

Mark Kaplan states that “the problem of induction” is that we must be able “to show how we can be justified in regarding one [statement] as evidence for the truth of another when the first does not logically imply the second.”<sup>47</sup> Contemporary logicians, with few exceptions, accept that inductive arguments are *invalid*: the premises do not, in any strict sense, entail the conclusion. This problem has haunted modern philosophy. In a valid argument, the conclusion follows necessarily from the premises. It is impossible for the premises to be true and the conclusion to be false. Validity does not, of course, guarantee the truth of premises or conclusion. *If*, however, the premises in a valid argument are true, the conclusion *must* be true. It should be clear from the preceding discussion, however, that inductive arguments are not (at least not in this precise sense) valid. Even if we have observed innumerable black crows, it does not follow, *as a matter of necessity*, that all crows are black. Because the conclusion covers more cases than the premises, the truth of the premises about our previous observations of black crows cannot guarantee the truth of the conclusion. Even if the premises are true, it is at least possible that the conclusion is false.

44 Hence Williams, in an unusual passage, argues that inductive arguments invoke “a degree of implicative connection intermediate between strict entailment and inconsistency” (Williams, *Ground of Induction*, 47).

45 Kemeny, *Philosopher Looks at Science*, 113.

46 *Ibid.*, 121.

47 *Shorter Routledge Encyclopedia of Philosophy*, s.v. “Epistemic Issues in Induction” (by Mark Kaplin), 748.

On the modern view, even a *good* inductive argument will be invalid. Wesley Salmon writes, “a logically correct inductive argument may have true premises and a false conclusion.”<sup>48</sup> John Vickers concurs: “good inductions may lead from true premises to false conclusions.”<sup>49</sup> In other words, even the best inductive arguments are uncertain. As John Hospers explains to introductory-level students, “inductive arguments are not deductively valid and the conclusion [of an inductive argument] does not logically follow from the premises.”<sup>50</sup>

Albert Blumberg summarizes the difference between deductive and inductive arguments. “It is *impossible* for the conclusion [of a deductive argument] to be false if the premises are true,” whereas “it is [only] *improbable* that the conclusion [of an inductive argument] is false, given that the premises are all true.”<sup>51</sup> We are left with a twofold division in modern logic. S.F. Barker notes that inductive conclusions are only “supported or confirmed or made probable,” whereas deductive conclusions are logically “implied or entailed.”<sup>52</sup> Richard Feldman informs us that inductive arguments are characterized by mere “cogency,” whereas deductive arguments are characterized by logical “validity.”<sup>53</sup> Merrie Bergmann, James Moor, and Jack Nelson observe that inductive arguments are “weak” or “strong,” whereas deductive arguments are “valid” or “invalid.”<sup>54</sup> P.F. Strawson carefully distinguishes between inductive “support” and deductive “entailment.”<sup>55</sup> And so on. If a properly constructed deductive argument with true premises guarantees the truth of the conclusion, the best we can say of a properly constructed inductive argument is that it inspires (in Tom Tymoczko and Jim Henle’s phrase) “some degree of confidence.”<sup>56</sup>

The contemporary view establishes, in effect, two independent standards for good reasoning. Good deduction must conform to a strict standard of validity. Good induction must satisfy a weaker standard; it must establish that the conclusion is more *likely* than not, that it is *probably* true,

48 Salmon, *Logic*, 53 (1984 edition).

49 Vickers, “Problem of Induction” (online).

50 Hospers, *Introduction to Philosophical Analysis*, 122.

51 Blumberg, *Logic*, 10.

52 S. Barker, *Induction and Hypothesis*, 3.

53 Feldman, *Reason and Argument*, 102–7.

54 Bergmann, Moor, and Nelson, *Logic Book*, 10–12.

55 Strawson also distinguishes between “premises” that prove a deductive conclusion and mere “evidence for an inductive conclusion” (*Introduction to Logical Theory*, 237).

56 Tymoczko and Henle, *Sweet Reason*, 358.



that we have *some* reason to believe it. Clearly, some inductive arguments seem strong; some seem middling; some seem weak. None of this is intended to suggest that all inductive arguments inspire the same degree of confidence. The question is whether the modern (non-Aristotelian) account gives us adequate grounds to accept the logical authority of inductive reason.

Since Aristotle's time, one may chronicle a major shift in philosophical conceptions of induction. Whereas Aristotle defined induction as an argument that moves from particular to universal, as up to date an authority as the *Stanford Encyclopedia of Philosophy* dismisses this idea as "outdated and too narrow."<sup>57</sup> *The Philosopher's Dictionary* reports as follows: "In an outdated way of speaking, deduction is reasoning from the general to the particular, and induction is reasoning from the particular to the general. Nowadays, this distinction between kinds of reasoning is made as follows: correct deductive reasoning is reasoning of a sort that if the premises are true, the conclusion must be true; whereas correct inductive reasoning supports the conclusion by showing that it's more probably true."<sup>58</sup> But this is only to say that correct deduction is, and correct induction is not, valid. It seems, then, that philosophers have moved away from traditional conceptions of induction privileging the movement from the particular to the universal, in favour of an account privileging the idea that induction is, unlike deduction, invalid. This is not a trivial shift. Compare briefly the Aristotelian with the contemporary account.

#### ARISTOTELIAN AND CONTEMPORARY DESCRIPTIONS OF INDUCTIVE ARGUMENT

On the older view, deduction is a logical movement from more general to more specific; induction, from more specific to more general. The argument, "All human beings are mortal; Socrates is a human being; therefore Socrates is mortal," is a deduction. The "reverse argument, "Socrates is a human being; Socrates is mortal; therefore all human beings are mortal," is an induction. Vickers, who summarizes a wide swath of opinion, complains, however, that the old view that induction moves from specific to general, and deduction from general to specific, falls apart under more rigorous inspection. He presents three short arguments that are supposed to explode the traditional account. Consider his arguments briefly. As we shall see, they are quickly disposed of.

<sup>57</sup> Vickers, "Problem of Induction" (online).

<sup>58</sup> Martin, *Philosopher's Dictionary*, s.v. "Deduction/Induction."

(1) First, in direct opposition to the traditional view, Vickers contends that there are *deductions* that move from specific to general. He cites as proof the following argument: “New York is east of the Mississippi. Delaware is east of the Mississippi. Therefore, everything that is either New York or Delaware is east of the Mississippi.”<sup>59</sup> This is a deductively valid argument: the truth of the premises guarantees the truth of the conclusion. But as we discuss below, Aristotle believes that properly constructed inductive arguments are deductively valid. So the mere fact that this argument is deductively valid does not show that it is not an inductive argument. A deeper question is whether it really does represent a movement from more specific to more general. If I insist, “Gorgi is tall; Yannick is tall; therefore Gorgi and Yannick are tall” – does this really count as a logical inference? A careful Aristotelian would probably claim that this is mere repetition. Logical inference must arrive at a new understanding. So either the argument is a deductively valid induction or it does no logical work. One way or another, the intelligent traditionalist will not be shaken by Vicker’s counter-example. Nothing here shows that the traditional view is wrong.

(2) Vickers argues next that there are inductive arguments that from general to specific. He offers the following (famous) example: “All observed emeralds have been green. Therefore, the next emerald to be observed will be green.”<sup>60</sup> The point is supposed to be that this inductive argument moves from a larger group, “all emeralds observed in the past” to a smaller group, “the next observed emerald.” So we move from a group made up of many exemplars to a group made up of only one. Yet this reading is little more than verbal slight of hand. In fact, the argument about the next green emerald presupposes a hidden subconclusion that “all emeralds are green.” At least, this is the most natural reading of what is going on.

Vicker’s example (which he borrows from Nelson Goodman) is not essentially different than the extended argument, “all observed crows have been black; so all crows are black; so the next crow will be black.” There is a hidden inductive step here; we move from observed emeralds in the past to the universal conclusion, “all emeralds are green,” and only then to an implicit deduction, “because all emeralds are green, the next one will be green as well.” Vicker’s treatment glosses over these details. But we cannot *logically* conclude that the next emerald will be green without assuming that all, most, many, or at least the majority of emeralds (including those which are unobserved) are green. Otherwise, we would have no rational basis for adopting this conclusion. So this kind of argument inevitably includes an

59 Vickers, “Problem of Induction” (online).

60 Ibid. (online).

inductive step or stage. As we shall see in a future chapter, Aristotle rigorously examines such arguments. The intelligent traditionalist will, once again, have no problem dealing with this alleged counter-example.

(3) Vickers argues, finally, that some inductions involve a movement from an individual case to another individual case without any kind of generalization. Vickers claims that this kind of “singular predictive inference” (what is essentially an argument from analogy) does not involve a movement from less to more. But here again, this seems hasty. In fact, Aristotle gives a detailed account of such arguments, claiming that they always involve an implicit movement up from one individual case to a larger generalization and then back down to the next individual. We discuss the issue below. For the moment, simply note that there is nothing here that defeats the traditional account of induction as a movement from specific to general. (In fact, the traditional view is more complicated than Vickers realizes. Some traditional authors do argue that some inductive arguments involve a movement from general to specific, but that is a special case we discuss in a future chapter.)

Champions of the contemporary view reject the older view of induction as a movement from less to more. One sometimes gets the impression that they understand induction in opposition to deduction as that argument form that, *unlike deduction*, is invalid. Robert Baum goes so far as to define inductive reasoning as “any argument which is not deductively valid.”<sup>61</sup> Skyrms concurs.<sup>62</sup> If this seems extreme, it is arguably the end the modern account logically tends toward. Traditional authors point to the mental movement from particular to universal as the defining property. But once we reject this description, what are we left with? Vickers argues that “inductive inferences are contingent, deductive inferences are necessary.”<sup>63</sup> In other words, inductive inferences may or may not turn out to be reliable. But this seems to be just another way of saying that inductive arguments are invalid. On the modern account, it seems that invalidity is not just a necessary property of inductive arguments: it seems, indeed, to operate as the defining property.

But perhaps this is too negative. After all, most modern logicians acknowledge that there are good inductive arguments. It is not just that proper inductive arguments are invalid; in the best case scenario, they are *invalid and strong* at the very same time. The question is, of course, whether we can make sense of this in-between status. Broach the problem through a

61 Baum, *Logic*, 22.

62 Skyrms, *Choice and Chance*, 8–9.

63 Vickers, “Problem of Induction” (online).

quick example. Consider the previously mentioned argument: “all observed crows have been black; therefore, the next crow will be black.” Do these premises in this inductive argument provide at least some support for the conclusion? Vickers mistakenly suggests that “until the middle of the previous century induction was understood to be what we now know as enumerative induction.”<sup>64</sup> Although thinking about induction as a kind of enumerating or tabulating has older antecedents, it is, in fact, a fairly late development in mainstream Western philosophy. Here lies the problem. As we shall see in subsequent chapters, Aristotelian induction is about causality. The main focus is not, as in the modern philosophy, on predicting when (or how often) something will occur. The focus is squarely on understanding what is happening. This is where induction derives its logical force. Once we understand what exactly is happening, we can, for example, know how and when something will occur.

The modern account, furthermore, predicts what will happen by analyzing the frequency of past occurrences. But without knowing why something occurs, we cannot know when it will happen again. This is Russell’s point about the chicken: several hundred times in a row the farmer comes in and feeds it until the absolutely last time, when he comes in and abruptly cuts off its head. Admittedly, once we know *what* is going on – the farmer is fattening the chicken in order to eat it – we can easily predict what will eventually happen. When we focus solely on the frequency of past events without understanding what the farmer is doing, we misconstrue what is going to happen. It is not, then, the number of times that the farmer feeds the chickens that is the key to this situation; it is the rationale behind the farmer’s actions. This is why modern accounts of induction are inherently problematic, because they rely on mere counting rather than on explanatory inference.

It does not matter how sophisticated our mathematical apparatus is, a reliance on sheer number is not enough to distinguish a random string of happenings from a law-like sequence that follows in some orderly fashion. Consider the every-crow-is-black argument. We are asked to conclude that because the last one hundred crows were black, the next crow will be black. But one hundred black crows, evaluated solely in terms of frequency, do not provide sufficient evidence for determining that the next crow will be black. Numbers are just numbers. Suppose that the difference between the next crow being white or black is like flipping a coin. We could, in principle, flip a coin one hundred times and always get heads. And we could flip it one more time and get tails. Every time we flip the coin, there is an equal

64 Ibid. (online).

possibility of heads or tails. (To think that the previous sequence of coin flips somehow influence future flips is in fact a well-known fallacy.) If, then, crow colour is like a random coin-flipping, we have no way of knowing what the colour of the next crow will be. Black or white is equally likely, regardless of the previous sequence of all black crows.

This is not a book about probability. Still, we should note that the probability of randomly flipping a coin and getting one hundred heads in a row, followed by a one hundred tails in a row, is no smaller than that of any other sequence of results. (In fact, the probability for any fixed set of two hundred outcomes is the same:  $(\frac{1}{2})^{200}$ .) If then, the possibility of a black or white crow is like the possibility of heads or tails, it does not matter how many black crows we have already seen in the past. This does not (contrary to popular belief) make it any more likely that the next crow will be black. So there is a serious problem with induction.

But in fact the situation may be even worse than first appears. A definite probability is associated with coin-flipping, precisely because a coin has a definite nature, because the force of gravity does not change, the laws of physics regulating quantities such as velocity, acceleration, momentum, and work are orderly and predictable, and so on. In a purely random world, we would have nothing to base probability calculations on. Anything could happen. But how do we know that we are not in a purely random world? The numbers themselves do not rule out this possibility. They are equally open to any interpretation. In a purely coincidental world, we could observe one hundred black crows, followed by a white crow, or three thousand black crows, followed by fourteen white crows, or any other combination. Everything is just coincidence. So the inductive conclusion that the next crow is likely to be black does not follow logically in a purely coincidental world.

Of course, we all believe that it cannot be a coincidence that we have observed one hundred black crows in a row. But it is not the numbers that matter; it is the numbers combined with an unprovable metaphysical belief that the world is regular, orderly, and composed of things with definite natures. This metaphysical belief is what makes us accept the probability calculus as a good predictor of what will happen in the future. We believe the world must have something non-random about it that makes the previous one hundred crows black and that this feature – whatever it is – must operate somehow consistently. We interpret numerical frequency, then, as an expression of a deeper, ordered causality and logically conclude that the frequency of events puts on display some kind of (often complicated) metaphysical design. But ultimately it is not the numbers but the metaphysical belief in an underlying order that makes even numerical induction work.

Seen from an Aristotelian perspective, numerical accounts of induction, considered on their own, miss the point. Induction is about understanding why crows are black, which has something to do with understanding the physical anatomy of feathers, the chemical composition of pigment, the biological mechanism of sexual reproduction, and so on. Aristotle believes that we can go some way to understanding what is going on. And once we understand what is going on, we will have some reason for believing – although this is not the main purpose behind induction – we can make a good case that the next crow will probably be black.

#### THE WHITE-SHOE PARADOX

Numerical accounts of induction have more than one strange consequence. Let us briefly examine a logical puzzle Carl Hempel is thought to have solved, which I will call the white-shoe paradox.<sup>65</sup> Because the numerical account understands induction as a matter of probability and the Aristotelian one defines it as a matter of explanatory causality, they view the problem Hempel raises in a different light. Focusing briefly on this issue should help to elucidate the basic difference between the two views.

Begin with the inductive generalization, “all crows are black.” On the numerical account, every time I see a black crow, this further supports the claim (assuming the world is regular) that all crows are black. This much, at least, seems intuitive. But suppose I observe that a white shoe is not a crow. Oddly enough, this observation also supports the claim that all crows are black. Why? To say that all crows are black is logically equivalent to saying that anything that is not black is not a crow. A white shoe is obviously not black and is not a crow. So the observation that a white shoe is not a crow lends some support to the claim that all crows are black.

But this seems counterintuitive. How could the obvious fact that white shoes are not crows have anything to do with proving the claim that “all crows are black?” And yet, if induction is a kind of tabulating, this makes perfect sense. Consider an altogether simple thought experiment. Suppose the universe contained only four objects: a black crow, a white shoe, a red scarf, and a blue marble. And suppose we have already observed the black crow. In this four-object universe, the individual observation of the white shoe removes one possible counter-example from the list. It significantly increases the probability that all non-black things (in this universe) are not crows. And suppose we go on to observe that the red scarf and the blue marble are not crows. This clinches the case. Taken together, these

65 Hempel, “Studies,” pts 1 and 2.

individual observations prove that all non-black things in this universe are not crows. It *must* follow that all crows – only one exists here – are black. So the seemingly irrelevant observation that a white shoe is not a crow can, in this universe, add further support to the claim that all crows are black. Of course, the universe we live in is filled with a limitless number of many-coloured objects. So the knowledge that a white shoe is not a crow is (in our universe) a trivial advance in knowledge; indeed, it represents such a slight increase in knowledge as to be entirely inconsequential. Still, as Hempel suggests, the white-shoe inference is not so much wrong as trivial.

On an Aristotelian account, by contrast, the observation that a white shoe is not a crow is truly a non sequitur. It has nothing to do with what induction and science generally are about. If we observe the world carefully, we can use our intelligence to see *what* must be case. This is, in the first instance, what induction is about. When we understand *what* things are, we can understand why things are the way they are. The all-important question is, “What?” Observing that a white shoe is not a crow cannot help us to understand *what* a crow is. It cannot help us understand *what* makes the crow’s feathers black. It cannot help us understand *what* accounts for the transmission of colour traits from parents to fledgling. So this true observation has no inductive value. It has no inductive value, not because it is false, but because it is beside the point.

Return to the four-object universe. Aristotle would think that the observation that the white shoe is not a crow is unhelpful even in this kind of universe. It would not constitute a momentous advance in knowledge. Adding up samples may be a prelude to scientific discovery, but it is not what science is really about. The point is not to determine how many crows are black but to *understand* why crows are black. Realizing that the white shoe, the red scarf, and the blue marble are not crows does not do any inductive work. Induction is about discovering *what* it is that makes crows black. It is hard to see how the mere observation that this white shoe is not a crow could trigger this kind of understanding.

But this is not all. Aristotle believes that we do not have to rely on mere counting, for thorough observation can uncover the nature of things in a non-random world. Before dismissing this “naive” confidence, note that the argument from “all crows (or ravens) are black,” repeated *ad nauseam* in the literature, is *wildly* misleading. This would be, from the perspective of real biology, an altogether suspect assumption. As it turns out, many members of the crow family (the family Corvidae in the genus *Corvus*) have white feathers. Hooded crows (*Corvus cornix*) have large amounts of white or grey on their bodies; the thick-billed raven (*Corvus crassirostris*) has a large, distinctive patch of white on its neck and a spot of white on its bill;

the pied crow (*Corvus albus*) has a large white region ranging from shoulders to its lower breast – and so on. Even the familiar American crow (*Corvus brachyrhynchos*) is not always black. According to one report from the field, about 4 per cent of nestlings have white spots on their bills, toes or other non-feathered parts, whereas about 1 per cent have some white feathers.<sup>66</sup> Add to this the well-known phenomenon of albinism and the regularly reported observance of albino crows. A thorough biologist is hardly going to jump to the conclusion that a white crow is an impossibility. They will, on the basis of adequate observation, arrive at the correct conclusion that non-black crows are a definite possibility. Good induction begins with observation, not stereotypes.

The Aristotelian account of induction is close to the commonsense view. There are different kinds of things in the world. Because things possess a certain kind of nature, they act and react in specific ways. Once we ascertain their nature, we can know something about when they occur, although this is not the main point about induction. Modern numerical induction has its place. In some cases, we simply cannot know the complicated and contingent causes of things (in many public opinion polls, for example). In other cases, numerical induction is really a kind of observation. It is the first step in understanding what is going on. But this is not a book about numerical induction (a topic which is more than adequately treated by many contemporary logicians). This is a book about the mental faculty that makes various types of induction – including numerical induction – possible.

When we add our belief in the regular nature of the world to an understanding of probability, we can make sense of the modern account of induction. We cannot believe that it is just a coincidence that so many crows are black, because we do not believe in a purely coincidental world. It is our commitment to an ordered world that makes statistical induction persuasive. It is this metaphysical supposition that things in the world have a predictable nature (despite whatever appearances to the contrary) that gives numerical induction its logical force. Frequency is, so to speak, an expression of some deep order; it is not just a random by-product of something that can change without rhyme or reason. Even if the frequency model has, in light of this (unprovable) metaphysical assumption, considerable logical force, it is not what Aristotle is about. Put a little too strongly, numerical induction would be a minor subset of a minor subset of Aristotelian-type induction. Although we can use Aristotle's model to explain numerical induction, we need, first and foremost, to explain the basic orientation of earlier generations of philosophers toward inductive reasoning. Induction is

66 McGowan, "White Crows?"



not, for Aristotle, an issue of mere counting. What makes an inductive argument a good one is its explanatory power.

Aristotle, in direct opposition to the usual modern view, believes that inductive arguments are valid (though not necessarily sound). In his formulation of the syllogistic, true premises in a properly constructed inductive argument *guarantee* the truth of the conclusion. But his basic approach can be symbolized by means of other formal techniques. The deeper issue is that Aristotle believes that inductive reasoning is logically compelling because there are natural kinds in the world and because we have the intelligence needed to recognize and explain them. (This power of explanation is, in some sense, what Aristotle thinks intelligence is.) The modern approach has forced philosophers to ask deep questions about the epistemological justification of inductive reasoning. Aristotle, who is not uncritical or absolutist, offers a sensible and thoroughly pragmatic answer to such doubts. But before engaging in the Aristotelian account in more detail in later chapters, we must turn back to the origins of the modern view of induction in Locke and Hume. If Aristotle needs to be consulted, it is because of problems inherent in the modern, post-Enlightenment account of induction.

#### HUME: SLICES OF BREAD

Ludwig Wittgenstein, in the *Tractatus*, observes that induction “has no logical justification but only a psychological one.”<sup>67</sup> This is a paraphrase of David Hume. As Hume is widely recognized as having discovered the modern view of induction, we need to examine his account closely.

The usual focus on Hume’s scepticism regarding induction is historically misleading. John Haldane ventures the opinion that “inductive scepticism of the type associated with Hume predates him by at least four centuries.”<sup>68</sup> Haldane points to medieval authors such as Nicholas of Autrecourt, Al-Ghazali, and Nicholas of Cusa as representatives of a similar school of thought. Hume’s own views derive, more immediately, from Locke. And even Locke’s views are similar to those found in contemporary authorities such as Pierre Gassendi (1592–1655), the authors of the *Port Royal Logic* (Antione Arnauld, 1612–1694, and Pierre Nicole, 1625–1695), Thomas Hobbes (1588–1679), and at least the early Gottfried Wilhelm Leibniz (1646–1716).<sup>69</sup> Still, the relevant passage in Hume’s *An Enquiry Concerning Human Understanding* contains what is probably the most influential

67 Wittgenstein, *Tractatus Logico-Philosophicus*, §6.363 1.

68 Haldane, “Insight, Inference, and Intellection,” 34.

69 See Milton, “Induction before Hume,” for an excellent review of sources.

account of induction in the entire history of philosophy.<sup>70</sup> As such, it deserves close scrutiny.

Hume, following after Locke, sees himself as an Enlightenment empiricist and a fierce opponent of an outmoded Aristotelianism. Neither a rigorous technician nor an assiduous student of the history of philosophy, he associated traditional metaphysics with religion and superstition. Metaphysics is “not properly a science,” but “an inevitable source of uncertainty and error.” Metaphysical distinctions arise “either from the fruitless efforts of human vanity, which would penetrate into subjects utterly inaccessible to the understanding, or from the craft of popular superstitions, which, being unable to defend themselves on fair ground, raise these intangling brambles to cover and protect their weakness.”<sup>71</sup> In contrast to the metaphysician, who would penetrate the world of appearances to gaze upon a truer reality composed of naked substances, occult causes, and ghostly essences, Hume claims that the only thing we can know is sensation.

Hume, like Locke, was deeply influenced by Robert Boyle’s corpuscularism, the forerunner to modern atomic theory that supplanted a more traditional Aristotelianism. On this scientific account, the activity of an underlying realm of unobservable particles or corpuscles determines the surface appearances of things. Hume assumes, quite naively, that the precise nature of this substratum, the residuum that underlies empirical experience, is thoroughly unknowable. So the real, true nature of things is – like Kant’s *noumenon* – inaccessible. This opens the door to a general suspicion about induction. We can set out Hume’s position on induction in a few steps:

- (1) Nature is secretive. As Hume explains, “Nature has kept us at a great distance from all her secrets, and has afforded us only knowledge of a few superficial qualities of objects; while she conceals from us those powers and principles, on which the influence of these objects entirely depends.”<sup>72</sup>
- (2) Because nature is secretive, when we perceive objects or events in the world, we do not perceive the true causes which regulate and constitute the objects or events in question. Hume assures us that “the particular powers, by which all natural operations are performed,

<sup>70</sup> Hume, *Enquiry*, §4, pt 2. See also *Treatise*, bk 1, pt 3, §6.

<sup>71</sup> Hume, *Enquiry* (Selby-Bigge, Nidditch), §1, para. 6, 11 (in Hume, *Enquiries*).

<sup>72</sup> *Ibid.*, §4, pt 2, para. 29, 32–3.

never appear to the senses.”<sup>73</sup> We only perceive the exterior aspect, the surface appearances of things, the outer shell so to speak. In other words, we do not perceive the cause, only the effect.

- (3) When we make generalizations about similar sensible objects, we inevitably *assume* that they are always produced by the same secret powers and principles. We assume that the same observable effect is produced by the same underlying cause. Hume writes, “Notwithstanding this ignorance of natural powers and principles, we always presume, when we see like sensible qualities, that they have like secret powers, and expect that effects, similar to those which we have experienced, will follow from them.”<sup>74</sup>
- (4) But different causes may produce the same effect. I may, for example, feel hot, either because (1) it is a sweltering summer day or because (2) I have a fever. The same effect, the feeling of being physically hot, has a different cause in each case. This obvious truth undermines our previous assumption (3), above.
- (5) It follows from (4) that similar objects or properties or events may have different – indeed, very different – causes. Suppose object *A* and *B* resemble one another. We cannot assume, despite the observed resemblance, that similar objects *A* and *B* will be alike in all respects, for these objects may have different secret causes.
- (6) It follows that induction, which is based on the assumption that similar effects derives from similar causes, is inevitably an inconclusive form of reasoning.

Hume illustrates his meaning with the example of slices of bread. When I have a piece of toast in the morning, I assume that this slice of bread will be like other slices I have eaten, and consume it without any compunction. As Hume puts it, “If a body of like colour and consistence with that bread, which we have formerly eat, be presented to us, we make no scruple of repeating the experiment, and foresee, with certainty, like nourishment and support.”<sup>75</sup> But Hume thinks that the implicit induction, “other slices of bread were nourishing, therefore this one will be nourishing,” is logically suspect. He asks a rhetorical question: “The bread, which I formerly eat, nourished me; that is, a body of such sensible qualities was, at that time, endued with such secret powers: but does it follow, that other bread must also nourish me at another time, and that like sensible qualities must always be

73 Ibid., §5, pt 1, para. 35, 42.

74 Ibid., §4, pt 2, para. 29, 33.

75 Ibid.

attended with like secret powers?" And he responds, "The consequence seems nowise necessary."<sup>76</sup>

Induction is, for Hume, an argument from ignorance. Our knowledge is limited to what we perceive. We never come into direct contact with the secret corpuscular powers that underlie the sensible characteristics of the world. Although we can see and touch and taste and smell each slice of bread, we cannot perceive or even understand the secret metaphysical nature causing its nourishing properties. Induction is based then, not on certain knowledge, but on a lack of knowledge. It is an argument from presumption. We do not move from knowledge of the cause to knowledge of the effect. We move from knowledge of the effect to a guess or a presumption about an inaccessible cause. But guesses or presumptions are, in a logical sense, inconclusive.

Hume writes, "It is allowed on all hands that there is no known connexion between the sensible qualities and the secret powers; and consequently, that the mind is not led to form such a conclusion concerning their constant and regular conjunction, by anything which it knows of their nature."<sup>77</sup> Because we have no insight into the relationship between the secret causes that determine the nature of objects and the sensory appearances we actually perceive, we cannot assume that we are, in similar situations, dealing with the same thing. We cannot even be certain that the same secret cause will always produce the same effect. Even if two sensible objects had (unknown to us) the same cause, we cannot be certain that they would have the same properties.

Hume's attack on induction might be described in the following way. Suppose Aunt Mary were to give me a tin box with a picture of a cake on the lid. And suppose I open the box and, indeed, find a freshly baked cake inside. Further suppose Mary (being a most generous aunt) gives me a similar tin box with a similar cake inside it every morning. Does it logically follow that the box must contain another cake when I open it tomorrow? Surely not. A box with a picture of a cake on the lid could, without contradiction, contain a completely different object the next time around – an orange, an old shoe, a golf ball. This is how Hume envisages induction. Because objects with the outside appearance of bread have been edible and nourishing in the past, this does not guarantee that they will enclose the same secret powers of nourishment in the future. The outside impression may be completely misleading. Whatever it is that provides nourishment in the case of a slice of bread may or may not be

<sup>76</sup> *Ibid.*, §4, pt 2, para. 29, p. 34.

<sup>77</sup> *Ibid.*, §4, pt 2, para. 29, 33.

future cases, but this is irrelevant. Our observations do not determine the nature of the chemical reaction. They only reveal a pattern already at work.

Chemistry has its laws. If someone were to mix an aqueous solution of silver nitrate and salt and obtain a different result, this would require a momentary suspension of the laws of chemistry. In short, it would require a “miracle.”<sup>96</sup> But Hume himself dismisses any belief in miracles as preposterous. “Uniform experience,” he writes, “amounts to a proof ... a direct and full proof ... against the existence of any miracle.”<sup>97</sup> According to Hume, the sane person expects the non-miraculous event “with the last degree of assurance, and regards his past experience as a full *proof* of the future existence of that event.”<sup>98</sup> If, therefore, past experience provides a “full proof” of future events, inductive reasoning must provide “full proof” of its conclusions. When we compare Hume’s position on miracles with his stance on induction, it reveals an obvious conflict, not to say a contradiction, defying resolution.

Hume asks a rhetorical question, “Why is it *more than probable*, that all men must die; that lead cannot, of itself, remain suspended in the air; that fire consumes wood, and is extinguished by water; unless it be, that these events are found agreeable to the laws of nature, and there is required a violation of these laws, or in other words, a miracle to prevent them?”<sup>99</sup> But these laws of nature are, of course, the product of inductive reasoning. When Hume says that they are *more than probable*, he seems to suggest they are authoritative. Indeed, they are remarkably authoritative. They cannot be broken without a miracle. (Knowing Hume’s position on miracles, that seems tantamount to saying that they can’t be broken.) If, however, the laws of nature cannot be broken, then we *can* predict the future (given adequate knowledge) and induction is, at least in principle, sound.

Hume seems to paint himself into a corner. On the one hand, he wants us – in good Enlightenment form – to accept the authority of science. On the other hand, he argues against the reliability of induction. One cannot have it both ways. To believe in science is to believe in induction. Surely, we do not want to argue that the laws of physics are based on mere habit or custom. The universal law of gravitation is not like the social custom of holding your fork in the right or left hand. You can do either. Gravitation is, in contrast, something logically or at least metaphysically necessary. (At least, this is what most scientists claim.) We can perhaps make better sense

96 This is how Hume defines miracles. This is, rigorously speaking, not a proper religious definition.

97 Hume, *Enquiry* (Selby-Bigge, Nidditch), §10, pt 1, para. 90, 115.

98 *Ibid.*, §10, pt 1, para. 87, 110 (original italics).

99 *Ibid.*, §10, pt 1, para. 90, 114–15.