

Explaining Nature and the Nature of Explanation

2.1 Beginning in wonder

‘Human beings began to do philosophy’, says Aristotle, ‘even as they do now, because of wonder, at first because they wondered about the strange things right in front of them, and later, advancing little by little, because they came to find greater things puzzling’ (*Met.* 982b12). As Aristotle sees things, if we reflect at all on the universe of common experience, if we scratch the surface even a little, we find puzzles and peculiarities residing not far below. That we find such puzzles – about space and time, about human freedom and autonomy, about justice and goodness, about the character and reliability of our own faculties – is only to be expected: the universe is a puzzling place. Consequently, while not everyone will be a philosopher or a physicist, as long as we have leisure from labour most of us will wonder about the universe and our place within it. When we wonder, we begin to philosophize.

We do not need to seek out the puzzles which the world presents. They are, says Aristotle, right in front of us. If we look into the night sky, we readily wonder whether the universe is infinite in space or somehow bounded. Questions about spatial limits quickly give way to what then become unavoidable questions about time and order. Does the universe have a beginning in time, perhaps because it is the handiwork of a surpassingly great being whose intentional actions and purposes also explain its order and

intelligibility? Or do the regularities of nature owe simply to brute laws, without there being any further explanation of their necessity? Or, then again, are we already mistaken in presuming that there are regularities in nature? Perhaps the laws we take ourselves to apprehend as given by nature are in fact imposed by us, in a desperate attempt to find meaning and regularity in a world of undifferentiated and purposeless disarray.

For that matter, does it make sense even to suppose that the universe could have a spatial boundary or a beginning in time? What, we are inclined to ask, can be said of the period *before* the universe began or of the area *outside* its outermost boundaries? Upon even a moment's reflection, it is initially hard to fathom that the universe extends infinitely backwards in time. For if that is so, it must also be so that an infinite number of moments have come and gone, and that right now, today, in this instant, it is entirely possible that someone, the angel of infinity perhaps, or some other meek and dutiful creature, has been always counting backwards, from infinity, and has just now finished counting ever downwards, having at long last reached zero, the final member in the infinite series of numbers she has now actually enumerated aloud. If we bristle at the suggestion that such a scenario is coherent, then we seem pushed back in the direction of thinking that the universe cannot extend infinitely backwards in time; but then, again, we wonder: what of the period *before* time began?

These and like questions incited wonder very early in the history of Greek philosophy, and Aristotle found them irresistibly engaging. In his *Physics*, Aristotle treats the nature of time, infinity, boundary, chance, purpose, and change. He typically begins, as we have seen, by recounting the phenomena and recounting the *endoxa*,¹ or reputable opinions, where as often as not these derived from the speculations of the philosophers who preceded him. He does so because he thinks we can learn about our own puzzles by considering how others who have thought hard about them have done

so, even if we find it necessary to disagree with them. In fact, Aristotle regularly faults his predecessors, and he does so in a patterned and predictable way: he commonly contends that their explanations are at best only partially correct, first because they rest upon false assumptions but also because the earliest philosophers had not reflected sufficiently upon the character of explanation itself. If we wish to explain some phenomenon completely and accurately, then our explanations had better adhere to some canon of explanatory correctness. It is not enough that we find the explanations we offer ourselves convincing.

Aristotle's way forward in philosophy and science is to reflect overtly upon the standards of adequacy in explanation. We make progress, he thinks, only by beginning in wonder and then moving to explanations which satisfy objectively given standards of adequacy. We *do* make progress, Aristotle supposes; when we do, however, we often enough discover newer, more difficult problems lurking in our solutions, with the result that we turn directly to them once we have made our way a little and so push ever forward.

Why should we behave this way? Why, as a species, do humans as a matter of fact try so relentlessly to understand the universe and our place within it? As we have seen, Aristotle supposes that we wonder for the simple reason that it is our *nature* to do so. 'Every human being, by nature, desires to know' (Met. 982a23).² In so supposing, Aristotle locates our nature in our *cognitive capacities*, in our natural and indomitable drive to learn and acquire knowledge.

Thus far, then, we might ask Aristotle why we should agree that humans have a nature or that we have just the sort of nature he supposes we have. His view seems surprising, or even idiosyncratic. Judged from a certain remove, Aristotle's first contention may also appear rather antiquated and unstable: why suppose that humans have a nature at all, of any kind? After all, along with natures *go essences*, and more recent thinkers have had myriad motivations – some political, others biological, and still others more narrowly metaphysical – for wanting to assail the very notion of essences. If

we have natures, then we are essentially, that is to say *necessarily*, a certain way; but we are not necessarily any way at all, these detractors contend. We are free to create ourselves as we wish, to be the architects of our own destinies. So, this talk of natures must cease.

Another sort of critic is happy to agree that humans have natures of a determinate sort, but that Aristotle has badly misjudged what this nature might be. In so far as it makes sense to say that there is such a thing as human nature, this critic insists that humans are naturally selfish, or self-interested, or self-promotional.

Aristotle disagrees with both sorts of critics, and believes that he can show that we have a nature of a definite and discernible sort, and that it is one having everything to do with our innate cognitive endowments and little to do with our proclivity towards self-promotion. Since his views are controversial, Aristotle owes us a defence.³ The first inkling of the sort of defence he is inclined to provide has already made an appearance: human beings, as a matter of simple and undeniable fact, *wonder* about things. We are information-seeking sorts of beings. We want to know how and why the world works; we want to know, closer to home, how and why our bodies function as they do, how and why our minds and perceptual systems acquire, store, and process data; how and why we must or should or may act when dealing with others of our kind, whether justice requires conduct of a certain sort or whether justice is itself fashioned to suit the conduct we prefer; and we want to know whether the universe is a purposeful sort of place or a vast cauldron of atoms swirling in an indifferent void.

Many of the things we wish to know have an immediate practical import, as when we want to know whether a given mutated microbe can be controlled with an available antibiotic. In many other cases, we want to know things with no immediate practical import, and with perhaps no remote practical import either. What is the highest Mersenne prime? What colour skin did the Stegosaurus have? Did Napoleon die of lead poisoning induced by the

colour pigment used in the drapery in his room? Why do some people mispronounce the word ‘nuclear’ in predictable and patterned ways? In these cases, we seek explanations and are satisfied when we have them, though we do not suppose that our doing so holds for us any immediate practical benefit, or indeed even any benefit at all beyond the satisfaction of a curiosity resolved. In short, we human beings seek explanations, and then provide them for ourselves, some good, some bad, some practical, some theoretical, some hopeful, some rather less so. This broad fact about our explanation-seeking proclivities is undeniable. Like other facts, contends Aristotle, this fact itself wants an explanation. Aristotle’s first approach at an explanation of our explanation-seeking proclivities is simple: we desire explanations because it is our nature to do so. We seek knowledge not just accidentally or haphazardly, but as a result of our essential features – as a result of those very features which make us the kind of beings we are.⁴

This is why, contends Aristotle, we begin in puzzlement and move from wonder to world-view. Philosophers and scientists alike identify patterns they take to be significant, notice anomalies and puzzles in those patterns, and then redouble their efforts to provide ever deeper and more penetrating explanations. At each stage of development, inferior explanations give way to superior explanations. We come to a natural resting place when we believe that our explanations, if not perfect or perfectly comprehensive, are at least locally complete and correct.

2.2 Explaining explaining: The four causes

Along the way to establishing complete and correct explanations, we often find ourselves entertaining or even accepting explanations which we eventually reject. There are two ways of thinking about discarded explanations, corresponding to an important distinction between two conceptions of what explaining consists in. This distinction is key to understanding Aristotle’s approach to explanation.

To illustrate the distinction, we may consider an actual case, involving the now well-understood disease malaria. At one stage scientists wondered why malaria spread so rapidly in tropical areas. An explanation was proposed to the effect that warmer water in temperate zones is hospitable to spores carrying the disease. Such spores might then be carried through rivers and other water ways, which would explain why outbreaks of the disease tended to be concentrated near bodies of water. Eventually, this suggestion was shown to be false when it was demonstrated that certain sorts of mosquitoes are the primary transmitters.

How should we think about the initial proposal regarding spores in the drinking water? We may say either: (i) our initial explanation was supplanted by a superior explanation; or (ii) spores in the drinking water never really explained the spread of malaria at all, not least because there never were any such spores. The first way of speaking treats explanations as *interest-relative* or as somehow *subjective*, such that something's qualifying as an explanation simply consists in its satisfying a curiosity. On this approach, it is an explanation of Penelope's being a moody person that she was born on the cusp of Pisces, because someone somewhere is satisfied when that reason of her conduct is offered. The second approach to explanation, Aristotle's preferred, treats explanation as *objective*, such that *x* explains *y* just in case (i) *x* and *y* are states of affairs in the world, and (ii) states of affairs of the *x*-type *cause* states of affairs of the *y*-type.⁵ As he says:

Since the object of our inquiry is knowledge, and we do not think we know a thing until we have grasped why (*dia ti*) it is so (where this is to grasp its primary cause (*prôtê aitia*)), it is clear that we must also find this in the case of coming to be, perishing, and of all natural change, so that when we know the principles of things we can endeavour to refer what we are seeking back to these principles.

(Phys. 194b16–23; cf. Met. 983a25)

An explanation requires grasping the primary cause of what we want explained; something's primary cause is not, however, something whose mention merely happens to satisfy someone seeking an explanation. Rather, a primary cause is what in fact makes it the case that a certain state of affairs obtains.

In thinking of explanations as objective, Aristotle accepts a commitment to there being causes which obtain in the world prior to and independent of our interaction with it. He also consequently distinguishes between *objectively good* explanations and *objectively bad* explanations, in terms of those which do, and those which do not, cite suitable connections between states of affairs obtaining in the world. It is important, then, that we reflect upon what makes a connection between states of affairs suitable to ground an objective explanation. Aristotle contends that genuine connections, the sort cited in objective explanations, are *causal*. Consequently, in order to understand the sorts of objectively obtaining relations required for adequacy in explanation, it is of course necessary to appreciate when causal relations obtain and when they do not. To come to this appreciation in turn, it is first of all necessary to understand what a causal relation is. After all, someone pressed to explain how the signs of the Zodiac influence our moods might simply contend that the configurations of the heavenly bodies *cause* us to feel and behave in certain ways. If we think that is nonsense, then we also think that only some claims to causal connection are genuine, while contending that others are spurious. Which?

In reflecting on this matter, Aristotle offers a response which begins simply and intuitively, but which then grows increasingly complex and technical as he presses it into service in the course of his actual explanatory practice. At the root of his approach to causation is a distinction among kinds of causes: Aristotle doubts that all causal explanations are of a single unified sort. Instead, he distinguishes *four kinds of causes*, four *aitiai*,⁶ all of which, in different ways, provide objectively obtaining grounding relations between the things we want explained and the things which explain them.

Jointly, Aristotle's appeals to these four causes constitute what we may call his *four-causal account of explanatory adequacy*:

One way in which cause is spoken of is that out of which a thing comes to be and which persists, e.g. the bronze of the statue, the silver of the bowl, and the genera of which the bronze and the silver are species.

In another way cause is spoken of as the form or the pattern, i.e. what is mentioned in the account (*logos*) belonging to the essence and its genera, e.g. the cause of an octave is a ratio of 2:1, or number more generally, as well as the parts mentioned in the account (*logos*).

Further, the primary source of the change and rest is spoken of as a cause, e.g. the man who deliberated is a cause, the father is the cause of the child, and generally the maker is the cause of what is made and what brings about change is a cause of what is changed.

Further, the end (*telos*) is spoken of as a cause. This is that for the sake of which (*hou heneka*) a thing is done, e.g. health is the cause of walking about. 'Why is he walking about?' We say: 'To be healthy' – and, having said that, we think we have indicated the cause.

(Phys. 194b23–35)

Aristotle thus, crucially and centrally, identifies the four kinds of causes to be cited in objective explanations.

Because the *four-causal account of explanatory adequacy* is central to very nearly all of Aristotle's philosophy, we will first reproduce his contention in more familiar and informal terms, and then offer a series of defences for his claims, the first relatively superficial, but eventually becoming more complex and nuanced.

Aristotle's initial thought is relatively uncomplicated, as can be appreciated by reflecting on a simple illustration. Suppose that we are walking deep in the woods in the high mountains one day and

we come to notice an object gleaming in the distance. When it catches our eye, our curiosity is piqued; indeed, Aristotle thinks so much is almost involuntary. When we come across an unexplained phenomenon or a novel state of affairs, it is natural – it is due to our nature as human beings – that we wonder and fall immediately into explanation-seeking mode. What we see glistens as we approach it, and we wish to know what it is. Why do we wish to know this? We simply do: so much is unreflective, even automatic. As we come closer, we ascertain that what is shining is something metal. Upon somewhat closer inspection, from a short distance, we can see that it is bronze. So, now we have our explanation: what we have before us is polished bronze.

Still, if we find a bit of bronze in the high mountains, we are apt to wonder further about what it is – what it is, that is, beyond being so much bronze. We will want to know in addition exactly what it is that is made of bronze. We may conjecture in different ways. Perhaps it is debris from an abandoned mine; or perhaps it is metal left behind by early explorers who had been attempting to transport it over a high pass as material for a machine to be built at their destination; perhaps instead we have before us the remnants of an airplane which had crashed in the recent past. No. As we approach still closer, we ascertain that it has a definite shape, the shape of a human being: it is a statue. So now we know what it is: it is a statue, a polished bronze statue.

We also know further, if we know anything about statues at all, that the bronze was at some point in its past deliberately shaped or cast by a sculptor. We infer, that is, though we have not witnessed the event, that the shape was put into the bronze by the conscious agency of a human being. We know this because we know that bronze does not spontaneously collect itself into statues, and we discount the possibility that some discarded metal was perfectly moulded into the shape before us by a random bolt of lightning. So, now we know what it is: a statue, a lump of bronze moulded into a human shape by the activity of a sculptor.

Still, we may be perplexed. Why is there a statue *here*, high in the mountains where it is so unlikely to be seen? Upon closer inspection, we see that it is a statue of a man wearing fire-fighting gear; and we read, finally, a plaque at its base: ‘Placed in honour of the seventeen fire-fighters who lost their lives in the service of their fellows on this spot, in the Red Ridge Blaze of 23 August 1933.’ So, now we know what it is: a statue, a lump of bronze moulded into a human shape by the activity of a sculptor, placed to honour the fallen fire-fighters who died in service.

When we know that much, thinks Aristotle, we know all the kinds of things we need to know in order to have a full understanding of the phenomenon encountered. We know, that is, each of the four kinds of causes we can know about the statue. Although he does not use just these designators for the four causes, the tradition has come to label them as follows:

Table 2.1 The four causes

Cause	Characterization	Illustration
Material cause	That from which an entity comes to be	Bronze
Formal cause	The shape or structure of an entity	Human shape
Efficient cause	The agent imposing the shape or structure	Sculptor
Final cause	That for the sake of which	To honour the fallen

Aristotle makes two crucial claims about these four causes. First, he suggests that in the vast majority of cases a complete and adequate explanation must cite all four causes.⁷ This is why Aristotle feels justified in his frequent criticisms of his predecessors who, he maintains, confine themselves to a subset of the four causes and thus come up short.⁸ Second, as he contends directly, ‘This, then, is a sufficient determination of the number and of the kinds of cause’ (Phys. 195b29–30; cf. 198a21–24). There are no kinds of causes beyond the four enumerated.

Taken together, these two claims jointly state Aristotle's four-causal conception of adequacy in objective explanation:

- **E** is an adequate explanation iff **E** correctly cites each of the four causes: the material, the formal, the efficient, and the final.

Note that this formulation states both *necessary* and *sufficient* conditions for adequacy in explanation. The necessity condition: an explanation is adequate only if it correctly cites each of the four causes; any account which omits a cause where one is available is incomplete and so inadequate. The sufficiency condition: once an explanation has cited each of the four causes, it has left nothing out, and so is complete and adequate as an objective explanation.

The sufficiency condition may seem immediately objectionable, since it encounters two sorts of challenges straight away. First, a mere enumeration of four causes by itself does nothing to show that there are not yet other, non-equivalent types of causes still to be recognized. Second, it seems entirely possible to cite all of Aristotle's four causes and yet find oneself in need of additional information. If that is so, then it also seems that one could cite all four causes without producing an adequate explanation.

Aristotle is sensitive to the first worry, and in response he provides only a sort of challenge rather than an argument for closure. In his *Metaphysics*, he refers back to his introduction of the four causes, observing:

We have given sufficient consideration of this matter in the *Physics*. [When applying them] we shall either find another kind of cause, or be more convinced of the correctness of those which we now maintain.

(Met. 983a33–b6)

The passage contains an implicit challenge to those who wish to identify some fifth kind of cause beyond the four already attested. If there is another kind of cause not reducible to one or the other of

the material, formal, efficient, or final, it needs to be identified by its champion. Aristotle, at any rate, honestly reports that he can find no other. Rightly or wrongly, he now shifts the burden to his detractor. Although necessarily incomplete, this sort of response has at least the merits of forthrightness. Moreover, in any event, it may be observed that many modern thinkers fault Aristotle for countenancing too many kinds of causes rather than too few.

This brings us to our second challenge to the sufficiency condition, which is more probing. Why suppose that the mere citation of Aristotle's preferred causes should satisfy someone looking for fully explanatory connections between objectively given states of affairs? Suppose, for example, we meet someone wearing a new kind of jacket which repels water while allowing bodily moisture to escape, such that the jacket proves especially successful as athletic gear. The material cause of this jacket's success will be a new kind of fabric with the remarkable new traits. If we want to know how the jacket repels rain, it will be true but uninformative to say that it is made of fabric. This, though, seems in keeping with Aristotle's own specifications of the material cause. Yet what is really crucial is that the fabric itself has certain features, that it is, let us say, a new fluoropolymer fiber interwoven with nylon using a new weaving technique. So, someone omitting these facts when citing the material cause will leave an important feature of the object unexplained.

Aristotle is aware of this sort of worry as well. It illustrates, he thinks, not that another kind of causation is being overlooked, but that each of the individual four causes may be specified more remotely or more narrowly. Recall that when introducing the material cause, he mentioned first the 'bronze of the statue' and 'the silver of the bowl', but then alluded in addition to 'the genera of which the bronze and the silver are species' (*Phys.* 194b24–26; cf. *Phys.* 195b4–13). In speaking of *genera* here, Aristotle has in mind the kinds to which bronze and silver belong. At their most general, the bronze statue and the silver bowl have a common material cause, namely metal; but as we become more specific,

their material causes diverge, because they are different sorts of metal, one bronze, with all of the properties of that kind of metal, and the other silver, with its own peculiar features. From Aristotle's perspective, we do not cite a new kind of cause when we become more or less specific, but rather we move vertically within a kind of cause. After all, in each case, we specify more or less precise kinds of material. In the case of the waterproof jacket, then, what is wanted is a more refined specification of the material cause, not an altogether new form of cause.

The same distinction applies to the other three causes as well. When we specify the efficient cause of a sculpture as the sculptor, we might equally mention something more generic, the artist, or something more specific, the sculptor sculpting. When we cite an efficient cause generically, we say something true but less informative than we do when we specify the efficient cause in its most specific form. The bare existence of a sculptor is obviously compatible with the non-existence of this statue, this shaped bronze, because the sculptor, considered simply as a sculptor, may not have been busy with just this bronze. This is what Aristotle means when he says additionally that causes may be merely potential or actual: 'All causes ... may be spoken of either as potential or actual, e.g. the cause of a house being built is either a house-builder or a house-builder building' (*Phys.* 195b3–7).

In general, then, it is always open to us, contends Aristotle, to specify an efficient cause – along with each of the other four causes – more or less generically, and thus more or less informatively. When we do so, however, we do not advert to different kinds of causes beyond the canonical four, but to the four causes themselves, at different levels of specificity. Although we do not establish the sufficiency condition of Aristotle's four-causal account of explanatory adequacy by appealing to these sorts of distinctions, we do remove one natural and expected sort of objection to it. So far, then, Aristotle may claim that his four-causal theory suffices for adequacy in objective explanation. No further type of causation is required.

The necessity condition requires a fuller and more developed defence. This is especially so since Aristotle regularly upbraids his predecessors, including Plato, for failing to cite causes where they are needed. In our informal motivation of the doctrine of four causes, we saw that we would remain curious about a novel state of affairs, in our case a glimmering hunk of metal high in the forested mountains, until such time as we managed to mention each of the four causes. This may serve as an informal motivation, and may be useful as far as that goes, but it does not go far enough if Aristotle wishes his four-causal account of explanatory adequacy to qualify as suitably objective. So far, as regards the necessity condition, we have mainly noticed a subjective fact about ourselves, namely that in the face of novel phenomena we tend to remain curious until such time as we have cited all of the four causes. If we are lazy, or distracted by hunger, or occupationally obsessed with only one of the four causes, if e.g. we are metallurgists curious only about the tensile strength of metal, then we may not care about all of the four causes. Once we have ascertained that the shimmering stuff is not, for instance, edible, we may move on. If the only test for adequacy in explanation is the satiation of our curiosity, then we cannot be at all sure that the explanations to which we appeal track the objective relations between interest-independent states of affairs. If objective explanations require objective groundings, then we will have to look elsewhere.

Consequently, if he wishes to ground each of the four causes in an objectively given framework, Aristotle will need to advance some more detailed forms of argumentation. It will not suffice simply to point out that we may tend to be unsatisfied until we have cited all four causes, but then become satisfied once we have. Since he thinks that the four causes are real, objectively existing states of affairs, Aristotle owes some positive argument for this thesis; however natural he (or we) may find the four-causal explanatory framework, Aristotle is not at liberty simply to assume it.

Importantly, he does not. Aristotle argues for each of the four causes. His first and fullest arguments are on behalf of material and

formal causation. The primary orientation of these arguments is simple: without matter and form we cannot solve a significant puzzle which we really must solve.

2.3 A puzzle about change and generation

Aristotle's predecessors bequeathed him a variety of paradoxes of nature, some rather simple, but others extremely perplexing. One challenging paradox owes to Parmenides, who famously argued that despite what we take ourselves to perceive, *motion is impossible*.⁹

Parmenides' student Zeno of Elea developed novel arguments on the same theme, arguments so fiendishly difficult in their seeming simplicity that they have required centuries of mathematics to solve them adequately. Parmenides' original arguments, by contrast, are more complex in their background assumptions and are in consequence initially rather difficult to state. For our purposes, it will suffice to provide a formulation of Parmenides close to the understanding Aristotle himself seems to have had. As Aristotle reports him, Parmenides claims all being is one: 'Because he supposes that beyond being (to on) there is no non-being (to mê on), he thinks that being is of necessity one and that there is nothing else' (*Met.* 986b28–30; cf. *Phys.* 185a5–12, 191b36–192a2; *GC* 318b2–7; *Met.* 984b1–25; 1009b20–25). Although he credits him with having made some progress in difficult terrain, Aristotle believes that Parmenides goes seriously awry in his argumentation: not only are his premises false, but even if they were true they would fail to support his conclusion (*Phys.* 185a9–10).

Parmenides begins with the simple insight that, necessarily, whenever anyone thinks of something, there is something of which he thinks. Call that something the *object of thought*. If one succeeds in thinking of some object or other, then what one thinks exists. Indeed, every object of thought exists – else it could not be thought. Further, heading in the opposite direction, every object of thought is such that it can in principle be thought; everything

which exists is a possible object of thought. Taken together, these two claims form the basis of Parmenides' otherwise odd-sounding suggestion that what is and what can be thought are the same, or, as I will prefer, that what exists and what can be thought are necessarily co-extensive.¹⁰ If you try to think nothing, you invariably think something or other; if you are not thinking anything, then it is not the case that you have succeeded in thinking nothing. On the contrary, you are not thinking at all. Thinking is in this respect essentially relational, as is, for example, marrying someone. If you try to marry someone and they decline your overtures, then you have not succeeded in marrying nothing: you have failed to marry altogether.

Now, infers Parmenides, if what exists and what can be thought are necessarily co-extensive, it follows that we cannot think of what does not exist: we cannot, in Parmenides' way of putting the matter, think of non-being. Nor, indeed, can we even speak intelligibly of non-being; for surely we can speak intelligibly only about what we can think.

Now suppose, as some do, that the universe was generated *ex nihilo*, from nothing at all. Apparently, if Parmenides' principles are correct, those who make this sort of claim must, upon reflection, be speaking nonsense: they are implicated in talking and thinking about nothing. But this is impossible. So, not only are they mistaken in thinking that the universe is generated *ex nihilo*, but they are also, it seems, mistaken even in thinking that they are thinking such a thing. They seem to be in the position of those who suggest that they can think of a round square, even though round squares cannot possibly exist. The person who reports that she is thinking of a round square is either disingenuous, or, if sincere, seriously confused about the contents of her own thoughts. In either event, she is wrong to suggest that she can think of a round square. Likewise, if Parmenides is correct, with regard to someone who claims to think of something's being generated from nothing: such thoughts cannot occur.

So far, then, thinking of absolute generation, generation *ex nihilo*, is impossible. Parmenides pushes his point further by contending

that once we agree that we cannot think of generation or coming into being from what is not, we are similarly precluded from thinking of change at all. After all, whenever we think of change, we implicitly think of what is not. If we suppose that a man has learned to play the piano, then evidently we think he did not play the piano before learning. To put the matter in purposely cumbersome terms favourable to Parmenides, let us say that the piano-playing man was not before the piano-playing man came into existence – the piano-playing man did not exist, was, if you will, a *non-being*, before the piano-playing man was. Therein lies the difficulty: as soon as we think at all seriously about change, we find ourselves implicated in thinking about non-being. Since, however, what exists and what can be thought are co-extensive, we cannot think of non-being; neither, then, it seems, can we think of change. We think we can, but we are deluded, according to Parmenides. We can think of change only if we can think of generation; but we can think of generation only if we can think of non-being. This, however, we cannot do.

Now, Aristotle thinks that Parmenides' argument is a bad argument. He is right about that, since it has a clear flaw. Still, Aristotle is right to suppose that the argument merits careful consideration. At the very least, we will learn something of value by its consideration. Indeed, what we shall learn, suggests Aristotle, is that the universe contains, as objectively existing features, both matter and form; such features, existing objectively, exist prior to our subjective explanatory exigencies.

To see why, let us follow Aristotle's judicious methodological precept: 'For those who wish to solve problems, it is helpful to state the problems well.'¹¹ Here, then, is a formulation of Parmenides' argument *Against Change* (AC) which lays bare its essential structure:

- 1 Necessarily, what is and what can be thought are co-extensive.
- 2 Hence, it is not possible to think of non-being.

- 3 It is possible to think of generation only if it is possible to think of non-being.
- 4 Hence, it is not possible to think of generation.
- 5 It is possible to think of change only if it is possible to think of generation.
- 6 It is not possible to think of generation.
- 7 Hence, it is not possible to think of change.

AC-7 provides a direct statement of Parmenides' challenge. His point is not that we cannot suppose that we think of change, but rather that when we do, we are mistaken. Imagine for a moment that there is no highest prime number. Suppose further that we nonetheless think, wrongly on our supposition, that we have a proof for the existence of such a number. Our proof is complex and ingenious, but flawed – and necessarily flawed, for in fact, as we are now allowing, there is no highest prime. Note, however, that if there is no highest prime, then this fact cannot be merely contingently true. So, if we thought we had shown that there is a highest prime, we would not only be mistaken, but necessarily so. Such, if Parmenides is right, is our situation with respect to change. We think we can think of change, because we think that we experience change as actual; but we are wrong to suppose that we think this way, and necessarily so.

2.4 Matter and form I: Aristotle's hylomorphism

Aristotle's response to Parmenides initiates his defence of the existence of matter and form, objectively construed. His response helps us further to appreciate that matter and form are correlative notions, each one relying for its explication and defence upon the other.

The first point is to draw more explicitly a distinction already implicit in Parmenides' argument, but not drawn with sufficient clarity. **AC-5**, the claim that we can think of change only if we

can think of generation, is really an attempt to reduce one kind of change to another. Let us stipulate that change is any form of alteration whatsoever.¹² Now, we can intuitively recognize that some sorts of change involve the coming into existence of something which had previously not existed, while some other sorts do not. Thus, when a new house is built, after some process of building there exists something where earlier there had been nothing, namely a house. Or, when parents conceive and give birth, a new human being comes into existence where there had been none, namely their child. Call this sort of change *generation*. We suppose that generation occurs not least because each of us believes that there was a time before we were born, before we were conceived, when we did not exist.

Contrast generation with a milder form of change, *qualitative change*, which is the sort of change undergone by something already in existence when it somehow alters. Thus, if George Washington goes to the beach for a respite and falls asleep under the bright sun, he comes to be sun-burnt. Later, as the burn fades a bit, he acquires a handsome burnished tan. The right thing to say, evidently, is not that a pale man died, followed by the birth and death of a sun-burnt man, followed in its turn by the birth of a tan man. Rather, George Washington was first pale, and then sun-burnt, and then tanned. He altered, but did not thereby perish. That is, the right thing to say is that generation is not the same as qualitative change. As Aristotle observes, "Things are said to come to be in different ways. In some cases we do not use the expression "come to be", but rather "come to be so-and-so" (*Phys.* 190a32–33). Coming to be so-and-so is qualitative change; simple coming to be is generation.

It is important to reflect on the purport of this distinction for Parmenides' argument against change (AC). Evidently, it shows AC-5 to be false, inasmuch as that premise conflates two kinds of change, generation and qualitative change. Thinkers of Parmenides' ilk, says Aristotle, went astray because 'they failed to make this distinction ... and because of this ignorance they lapsed into still

greater error: they thought that nothing beyond what is comes to be or exists, and thus they did away with all generation' (Phys. 191b10–13). **AC-5** is false because it implicitly treats every instance of qualitative change as an episode of generation. Since one may systematically distinguish these, **AC** is unsound.

So much, however, does not diagnose the problem which led Parmenides to the conflation. One may state the root problem, implies Aristotle, in a linguistic mode. The problem stems from Parmenides' failure to mark two irreducibly distinct senses of the verb 'to be', corresponding to the two notions of change distinguished. In the case of generation, when we say that something comes to be, we mean that it comes into existence. Call this the existential sense of 'to be'. (We do not use this sense too often in contemporary English, but it is the sense at play in Hamlet's famous soliloquy, 'To be, or not to be ...').¹³ By contrast, when we speak of qualitative change, we mean that something already in existence comes to acquire or lose a trait, that it comes to have some predicate *F* predicated of it. Call this the predicative sense of 'to be'. Armed with this distinction, we can see, even granting **AC-2**, the claim that it is not possible to think non-being, we are not entitled to infer that we cannot think of something's changing in the predicative sense. If Washington comes to be sun-tanned, then he comes to be so not from what is not *simpliciter*, but rather comes to be *F* from something that is *not-F*, something which though not sun-tanned is nevertheless something else, something pale. Thus, even granting that we cannot think of non-being, we may nonetheless think of something being *not-F*, when it is *G*. Looked at this way, Parmenides' problem lay in his failure to distinguish what is *not-F*, what is not pale, from what is not *simpliciter*. What is not *simpliciter* does not exist, while what is *not-F* may nonetheless exist, by being *G*. Hence, even if Parmenides is right that to be and to be an object of thought are co-extensive, what is not may nonetheless be available as an object of thought: what is *not-F* may both exist and be an object of thought by being *G*.

Notably, when proceeding with this sort of diagnosis, Aristotle does not find himself in complete disagreement with everything Parmenides had said. On the contrary, he agrees that there is a reasonable point standing behind Parmenides' argument. After diagnosing a problem with the sort of mistake made by Parmenides and other thinkers of his sort, Aristotle observes:

We also affirm [i.e. along with these thinkers] that nothing comes to be without qualification from what is not. Nevertheless, we maintain that a thing may come to be from what is not in a certain way, for example, accidentally.

(Phys. 191b13–15)

Appreciating this concession is key to understanding Aristotle's defence of matter and form.

Once we have removed the threat of Parmenides' argument, we are free to affirm what seems plain to all, namely that there is change. We do experience change. Still, all change, whether generation or qualitative change, perforce involves *complexity*. Since nothing pops into existence from nothing, all change involves something underlying, something which persists even while there is alteration. In the case of generation, when a statue comes into being, the bronze which is fashioned into the statue exists before the change and continues to underlie the statue once it is in existence. In a case of qualitative change, as when an already existing statue is painted by an artist, the statue itself continues to exist. The complex, involved in both kinds of change, put most generally, is (i) something underlying and persisting; and (ii) something gained or lost. These two factors in the change Aristotle dubs (i) *matter* and (ii) *form*. In their most general frameworks, matter is what persists through change, while form is what is gained or lost in an episode of change. In this sense, Aristotle's introduction of matter and form – and hence of material and formal causation – depends crucially upon the existence of change, a process the existence of

which was denied by Parmenides but vindicated by Aristotle's distinction between qualitative change and generation.

Taken together, then, Aristotle's base argument for matter and form (**MF**) is simple:

- 1 There is change.
- 2 A necessary condition of there being change is the existence of matter and form.
- 3 So, there are matter and form.

Aristotle's rejection of Parmenides, together with his concession to him, explains and justifies **MF**-2: all change involves a complex of factors, something persisting and something gained or lost, which factors are precisely matter and form.

Note that this argument invokes very general conceptions of matter and form, conceptions which will develop and become increasingly refined as Aristotle begins to deploy the framework they invoke, *hylomorphism*, in a series of ever more complex applications. (The name derives from the Greek words *hylê*, or matter, and *morphê*, or form; thus Aristotle's hylomorphism is equivalently, if more clumsily, simply his *matter-formism*.) Hylomorphism, in its most basic formulation, is, as we have seen, the view that change involves a complex, with the result that all entities susceptible to change are metaphysical *compounds* rather than simples. We can, consequently, introduce the basic notions of matter and form, and then characterize Aristotle's most fundamental conception of hylomorphism in terms of them:

- x is matter =_{df} x underlies change in the acquisition or loss of a form.¹⁴
- x is form =_{df} x is a positive attribute gained or lost by matter in the process of change.

Note that so far the notions of matter and form are tied both to one another and to a conception of change whose articulation they

have been invoked to underwrite. So, there is some circularity in the notions of matter, form, and change. This need not, however, be regarded as immediately problematic. We interdefine other core theoretic notions, including, e.g., the modal concepts of possibility and necessity (x is possible = *df* not necessarily not- x ; x is necessary = *df* not possibly not- x) without loss of clarity or explanatory power.¹⁵

However that may be, we may now state Aristotle's basic hylomorphism:

- Hylomorphism = *df* ordinary physical objects are complexes of matter and form.

The point about 'ordinary physical objects' in this definition is rather vague, but it must be included because in due course Aristotle will come to argue for the existence of a being bereft of matter;¹⁶ and he will also allow, in some fashion, the existence of abstractions, including mathematical objects, which are purely formal as well. For now, though, it is easy to think of artefacts and organisms as standard cases of ordinary physical objects. A house comes to be when some matter, some bricks and mortar, are made to realize the form of a house by the activity of a builder, whose building activity is its efficient cause. So, the resulting analysis of the constructed house will require that it be a metaphysical complex: we can identify the matter of a house, its bricks and mortar, and, non-equivalently, its form, its shape or structure.

Importantly, Aristotle will contend that it is the form which makes the brick and mortar qualify as a house. The same bricks and mortar manifesting a different form would be a different kind of object altogether, for example a pizza oven or a long wall along the border of a Cotswolds estate. A similar account holds in the case of organisms, although the situation in their case becomes more complex. An organism comes to be when some pre-existing matter comes to realize the form characteristic of that species to which the

organism belongs. Thus, so much matter derived from the parents comes to realize the form of humanity, and grows, gaining matter subordinated to the realization of that form, over time. One consequential difference, according to Aristotle, will be that a living being, unlike an artefact, has its own internal principle of change, its own internal code for development; an artefact, by contrast, is fashioned from without, by the agency of its maker. Still, an organism, no less than an artefact, is a complex, a compound of matter and form.

With that in mind, we can state Aristotle's basic hylomorphism regarding ordinary physical objects, without also worrying about the exact range of physical objects or about the important distinctions Aristotle will eventually draw between the living and the artefactual:

- x is an ordinary physical object = *df* x is a complex of matter and form such that the presence of the form makes the matter exist as some F .

The form is that whose presence makes some matter come to be the matter of a particular physical object; the matter is that which persists through change and underlies the form. Every ordinary physical object, every *compound*, is thus a metaphysical complex consisting of matter and form.

2.5 Matter and form II: Hylomorphism refined and expanded

The observation that some quantity of matter might now be a house and now be a wall, depending upon what sort of form it manifests, suggests two further fundamental features of Aristotle's hylomorphism. Almost immediately upon introducing the notions of matter and form in the course of his refutation of Parmenides' unsuccessful argument against change, Aristotle observes that another sort of response might equally have served: 'This, then, is

one way of solving the difficulty. Another is to observe that the same things can be spoken of in terms of potentiality and actuality' (Phys. 191b27–29).¹⁷ He might have appealed to these notions to the same end of refuting Parmenides because there is another way of pointing out the problem with AC-5, the claim that it is possible to think of change only if it is possible to think of generation. So far we have proceeded by distinguishing the existential from the predicative senses of the verb 'to be' and have contended that even if it is not possible to think of what does not exist, it is nonetheless possible to think of what is not predicatively F, since we may think of what is not F as what is G, for instance of what is not sun-tanned as what is pale. Another way of putting very nearly the same point is this: we may think of what is not *actually* F, because some actually existing G is *potentially* F, for example some actually pale man is potentially sun-tanned. That is, even if we are prepared to concede that we cannot think of what does not exist, we do not thereby allow that we cannot think of something which is actually G but only potentially F. Consequently, again, Parmenides is misguided in his attempt to reduce qualitative change to generation.

Structuring his rejection of Parmenides by relying on the notions of actuality and potentiality permits Aristotle to introduce two further concepts fundamental to his hylomorphism. That these concepts might equally have sufficed for this purpose in place of matter and form already suggests the closeness of the connection Aristotle envisages between the two pairs: (i) matter and form, and (ii) potentiality and actuality. This is a connection he makes explicit in his *Metaphysics*, when he says: 'Matter exists in potentiality, because it may move into a form; and to be sure, when it exists actually, it is in its form' (Met. 1050a15–16). In fact, instead of relying on the notion of change for definitional purposes, we might equally have said:

- x is matter =_{df} x exists in potentiality.
- x is form =_{df} x makes what exists in potentiality exist in actuality.

There are two advantages to proceeding this way. If we accept potentiality and actuality as our primitive notions, then we may define matter and form in terms of them, and subsequently define change in terms of matter and form. That is, we can argue for the existence of matter and form by showing their indispensable role in change, and then in turn show how they may be defined in terms of two other primitive notions, for which we do not argue, namely actuality and potentiality.

Note that proceeding in this way is partly only a matter of expository convenience, but does have the advantage of taking as primitive two further notions, themselves interdefined, which are relatively easy to illustrate. If a woman, Cora, is not now in love, she is nevertheless potentially so. When she comes to love someone, she has changed somehow and has become actually in love. It is important to note in this connection that Aristotle's concept of potentiality is not equivalent to the related notion of possibility. When we say that Cora is potentially in love, we mean more than that it is possible for her to fall in love. Rather, she has the real capacity, given the kind of being she is, for loving. Her potentiality thus says more about her than some bare possibility. We may have a dream in which the refrigerator talks to us by flapping its door open and shut, entreating us, 'Come along now, why not have a lovely cheese sandwich? There is also some nice wine in the cupboard'. When we look to the cupboard, it follows suit, but says, 'Don't look at me like that. I cannot talk; I am a cupboard. Fool'. This dream represents what is possible, at least in the sense that it shows us something conceivable; it is precisely the sort of thing that an imaginative cartoonist might represent as actual. Still, in fact, refrigerators and cupboards lack the capacity to speak, and so lack the capacity to tell us that they cannot speak. If we dream of our mother offering us a cheese sandwich, then we dream of someone, our mother, of whom it is true to say that she potentially speaks, and not as a bare possibility. She has this potentiality by virtue of her being a rational being, a being with a mind, and also the sort

of animal which has a mouth and vocal cords – all features wanting in a refrigerator. Potentialities are grounded in real facts and in the actual features of the entities which manifest them.

For this reason, when Aristotle claims that he may equally have appealed to the notions of potentiality and actuality in his refutation of Parmenides, he suggests that his hylomorphism has at its conceptual foundation two further interdefinable concepts upon which his explanatory edifice rests. He does not propose to reduce these concepts to anything more fundamental. Still, to the extent that they are made clear by illustrations, actuality and potentiality may serve the purposes he envisages for them.

At the same time, the notions of potentiality and actuality introduce a refinement into Aristotle's hylomorphism, one showing a further way in which his concerns about change, even when allayed, can yield surprising consequences. When he confronted Parmenides with his hylomorphic analysis of change, Aristotle conceded something significant, namely that there is no generation *ex nihilo*, that nothing simply pops into existence from nothing at all. Chairs are made from pre-existing wood, statues from bronze, and so forth. Nonetheless, when distinguishing the two kinds of change he accused Parmenides of conflating, namely generation and qualitative change, Aristotle committed himself to two irreducibly distinct kinds of change. In fact, though, given his concession, one might well wonder why he is entitled to do so. If we think that all change, of whatever kind, involves the acquisition or loss of some form by some matter, then how is there real generation? Why, that is, are we precluded from representing the production of a statue or a human being as an instance of qualitative change rather than as a case of *bona fide* generation? If we say that a fence continues to exist when it is painted from grey to white, and thus suffers qualitative change but not generation, then we may equally say that a quantity of bronze alters when it loses its blob shape and acquires its fire-fighter shape. There seems to be no more need to hypothesize real generation in the case of a statue than there was in the case of a

fence. In each instance, we have some underlying stuff which persists, the matter – the fence and the bronze. What persists loses one form and acquires another. The fence loses greyness in favour of whiteness, while bronze loses its blob shape when acquiring its fire-fighter shape.

Aristotle's response is to take the first in a series of steps intended to refine and augment his conception of form by making it ever more metaphysically robust. So far, we have thought of forms in the broadest possible terms, as positive traits and as nothing more. This, indeed, is how Aristotle himself first introduced the notion in the context of analysing change. He then immediately refined the notion of form slightly, by regarding it in some cases not merely as a positive attribute, but as a positive attribute of a particular kind: as a shape. A shape is a complex configurational feature, something, he suggests, whose presence is capable of making a statue what it is. When, and only when, the lump of bronze manifests the shape of a fire-fighter does it constitute a statue of a fire-fighter; when it is molten and recast as a railing, the lump is no longer a statue but a railing. If we are willing to regard the situation in these terms, then we have already gone part of the way towards Aristotle's first and most important development in his approach to forms.

This development in turn allows us to appreciate Aristotle's response to our worry about qualitative change and generation. When confronted with the worry that all cases of generation might be reduced to qualitative change, Aristotle's response is to distinguish two kinds of forms, corresponding to two ways some parcel of matter may be said to be made actual. Aristotle contends:

Only substances (*ousiai*) are said to come to be without qualification. Now in all cases other than substance, it is plain that there is necessarily something underlying, namely the thing which comes to be [a certain way] ... But that substances, things said to be without qualification, also come to be from

some underlying thing, will be clear to one examining the matter. For there is *always* something which underlies what comes to be, from which what comes to be comes, for instance, animals and plants come from seed.

(Phys. 190a32-b5)

Some forms are such that they make a parcel of underlying matter *beings without qualification*, whereas in other cases this does not occur.

A being without qualification is a substance, an *ousia* in Aristotle's language. An *ousia*, literally 'a being',¹⁸ is the only sort of thing which comes into being *simpliciter*, or is generated. Aristotle regards the sorts of forms at play in this sort of change as distinct from the sorts of forms involved in qualitative change. Thus, we may further distinguish:

- x is a substantial form = *df* x is what makes what exists potentially exist unqualifiedly.
- x is an accidental form = *df* x is what makes what is potentially F , where F is not a substantial form, actually F .

This formulation takes as basic the notion of existing unqualifiedly, and then defines accidental forms negatively in terms of their not being substantial. Although the idea will receive much fuller treatment,¹⁹ for now it will suffice to say that a being which exists unqualifiedly, a substance, is the sort of thing which does not rely upon anything else for its existence, in the sense that an account of what it is need make no reference to anything beyond the thing in question. A substance is not ontologically parasitic upon any other kind of being. To appreciate what Aristotle has in mind, we might agree, provisionally, that a quantity is not a substance because a quantity is necessarily a quantity of something; a quality is not a substance, because a quality is always a quality *belonging* to something; less straightforwardly, a musical man is not a substance, since

a musical man depends upon the existence of a man for its existence, and not the other way around.²⁰

As another first approximation, developing our intuitive thoughts about statues, we may think of a substantial form as the kind of feature whose presence makes a being what it is, and which, when lost, results in that being's ceasing to exist. Accidental forms, by contrast, may come and go without threatening the existence of the beings whose forms they are. To approach Aristotle's distinction between substantial and accidental forms, think first about yourself. Plainly, you could continue to exist if you had one less hair upon your head. Thus, let us say, you at present have an even number of hairs upon your head; if you pluck one, in the interest of solidifying your understanding of the substantial/accidental form distinction, you will find that you still exist, though you have changed inconsequentially. You are now a person having an odd number of hairs upon your head. So, the form, having an even number of hairs upon your head, is an accidental form of yours. By contrast, there are other forms for which this seems not to be true, for example, *being human*. Without arguing for the distinction in the current context, it suffices to note that being human, unlike having an even number of hairs upon your head, qualifies as a substantial form of yours.²¹

This is because without being human, you would cease to exist. In any event, if you had your molecules scattered throughout the solar system by a fiendish scientist involved in a grotesque experiment, the reasonable thing to conclude would be that you had perished, not that you were now simply spread out a bit. Or, less dramatically, when a glass of wine is poured into the Pacific Ocean, at some point the wine ceases to be wine; the Pacific Ocean does not merely become an unusually diluted glass of pinot noir. In your case, it is reasonable to say that you had perished because the quantity of matter which had realized your human form has ceased to do so. A human form, unlike an accidental form, is the sort of form whose presence makes something existing in potentiality exist unqualifiedly.

So, being human is a substantial form, the kind of form which suffices for generation, rather than mere qualitative change.

For these reasons, Aristotle's hylomorphism is simultaneously complicated and enhanced by the notions of potentiality and actuality. When these notions are deployed as ranging over distinct kinds of forms, the substantial and the accidental, we can come to appreciate that substantial forms make matter into something which exists in a basic, non-derivative, independent and unqualified way, whereas the acquisition of an accidental form makes what already exists unqualifiedly change qualitatively without taking anything into or out of existence. If there are substantial forms, then their actual presence explains how generation is possible, even though everything comes to be from some pre-existing matter, as potential.

2.6 The efficient cause

Thus far we have been given reason to suppose that matter and form are features of objective explanations: they are the factors in the world explaining change, whether substantial or qualitative. For this reason, we have reason to accept them as objectively existing.

The efficient cause, it is often suggested, needs no such defence. Aristotle identifies a kind of cause which is responsible, as an active feature, for bringing about the change we witness in the world. He characterizes this cause in various ways but his language invariably makes clear that he understands the efficient cause as the kind of cause which initiates motion: the moving cause (*to kinoun*); as the source of change (*archê tês kinêseôs*), or simply as what, primarily, moved something (*ti prôton ekinêse*) (*Phys.* 194b29–32; *GC* 324b13–18; *APo* 94b233). (Note that Aristotle does not in fact use any Greek term corresponding directly to 'the efficient cause'. The entrenched practice of using this phrase in English arises out of medieval developments of Aristotle's doctrine. Because the developments are themselves unobjectionable, the continuing use of the common English name is warranted.) It is often said that the efficient cause