WHAT TENDS TO BE

THE PHILOSOPHY OF DISPOSITIONAL MODALITY

Rani Lill Anjum and Stephen Mumford

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People tend to enjoy listening to music or watching television, sleeping at night and celebrating birthdays. Plants tend to grow and thrive in sunlight and mild temperatures. We also know that tendencies are not perfectly regular and that there are patterns in the natural world, which are reliable to a degree, but not absolute. What should we make of a world where things tend to be one way but could be another? Is there a position between necessity and possibility? If there is, what are the implications for science, knowledge and ethics?

This book explores these questions and is the first full-length treatment of the philosophy of tendencies. Anjum and Mumford argue that although the philosophical language of tendencies has been around since Aristotle, there has not been any serious commitment to the irreducible modality that they involve. They also argue that the acceptance of an irreducible and sui generis tendential modality ought to be the fundamental commitment of any genuine realism about dispositions or powers. It is the dispositional modality that makes dispositions authentically disposition-like. Armed with this theory the authors apply it to a variety of key philosophical topics such as chance, causation, epistemology and free will.

Rani Lill Anjum is Research Fellow in Philosophy at the Norwegian University of Life Sciences, Ås, Norway.

Stephen Mumford is Professor of Philosophy at Durham University, UK and Professor II at the Norwegian University of Life Sciences, Ås, Norway.

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Preface

What tends to be? Quite a few things do. People tend to enjoy music and art, sleep at night and love their children. Plants tend to grow and thrive in sunlight and mild temperatures. Winters tend to be cold and summers tend to be warm. The continents tend to drift and move over vast periods of time, causing mountain formations when they collide. Knives tend to be sharp and able to cut. Computers tend to store information that can be accessed later. Everybody is familiar with tendencies and how they work. Crucially, we know that tendencies are not perfectly regular. There are patterns in the natural world, which are reliable to a degree, but they are not absolute. They have exceptions, which sometimes surprise us. Many people have trouble sleeping at night or even prefer to do so during the day. Some plants like shade and others grow without sunlight in the deep waters of the Arctic. Knives can become blunt over time. Computers occasionally crash and lose data. We also know that tendencies can be counteracted by others. Although people enjoy music, they might not enjoy it if it is played very loudly or late at night. A force in one direction can be countered by an opposite force. Even gravitational attraction can be overcome, for instance by magnets. Although tendencies are susceptible to such failures, we know that they are more or less reliable and a proper basis for our expectations. There could be a cold day in July in France but it is nevertheless rational to expect warm temperatures for the most part that month. Some people eat only junk food and still avoid getting ill, but it would be foolish to expect a poor diet to do us good.

Tendencies are everywhere, and all our actions and expectations reveal that we are aware of this and know how they work. We are comfortable with a world of tendencies. Yet, there is not nearly as much discussion of tendencies among philosophers as there is, for instance, of necessity and possibility. Is this because philosophers think that tendencies can be explained entirely in terms of necessity and possibility? Or is it because they do not see the tendencies we see? One might sometimes be led to believe that thinking of the world in terms of both necessity and pure contingency is perfectly natural, whereas tendency is mysterious and little understood. The examples above show that this is not true. Tendency, we insist, is a distinct third modal value – and is really the one that we know the best.

Why write a book on tendencies, then, if everyone already understands them so well? There are at least three reasons. The first is that tendencies are

fundamental in all aspects of life and the world, and this might not yet be fully recognised. In this book we cover a wide range of topics within metaphysics, logic, epistemology and ethics. What we hope to show is that if tendencies are understood properly, we will also gain a better insight into these issues. A reader who is not a specialist could then treat the book as a survey of various philosophical discussions from a dispositionalist perspective, a survey that shows something those topics have in common.

A second reason for writing this book is to develop a particular philosophical theory in detail. We pursue an idea that we believe is novel and we demonstrate the explanatory unity it provides, showing how it has the potential to solve a number of philosophical conundrums. While many important contributions to philosophy are largely critical, pointing out difficulties and weaknesses of other theories, we also think that some ideas are worth pursuing and developing positively. This book is such an attempt. Even though we claim that everyone grasps what we call the dispositional modality, it has provoked debate with philosophers who often express reservations. Why not stick to the already known modalities of possibility and necessity, they argue. After all, if there really were a third, in-between modality, someone would have thought of it already. In Chapter 2 we deal with this type of objection. We argue that although the philosophical language of tendencies has been around since Aristotle, there has not been any serious commitment to the irreducible modality that they involve. To see what job this modality could do in philosophy is thus the motivation for treating a range of topics in one book.

This brings us to a third reason for the book. We have found that many of the negative arguments against an ontology of dispositions are based on a misunderstanding of what dispositions are. Sometimes dispositions are articulated in terms of conditionals, for instance, or are alleged to involve the putative necessitation of their manifestations. We maintain, and hope to demonstrate, that the acceptance of an irreducible and sui generis tendential modality ought to be the fundamental commitment of any genuine realism about dispositions or powers. It is the dispositional modality that makes dispositions authentically disposition-like. Powers have to be understood as disposing towards their manifestations, as opposed to necessitating them, otherwise we don't have a metaphysics that differs significantly from the rest. In particular, we don't want our dispositions to be just laws of nature by another name. Few have really seized upon the distinctive modal character of dispositions, even those who are otherwise friendly to them. So although this book looks as if it contains a diverse range of topics, it is really about the development of this one idea, but where part of the argument for it is its considerable explanatory and unificatory potential.

Each chapter is self-contained and could therefore be read in isolation. However, we think the reader will benefit from treating them as chapters of a single book, following the order in which they are presented. The book is about the philosophical explanatory power of the dispositional modality and the argument for it is in the whole. Naturally, a reader might not be completely convinced of the power of the account by seeing it applied to just one area.

But understanding that it helps solve a number of diverse problems allows a sense of the larger appeal and unifying possibilities. We have also tried to tell a story from which the strengths and attraction of the theory will emerge.

Our thinking on this topic goes back a number of years; indeed, to before we started working together. Perhaps it is even the issue that united us, as we saw we were grappling with similar problems and thinking along the same lines, but with much detail to resolve. Stephen tackled some of the issues in the 1998 book *Dispositions*, seeing that no conditional analysis of dispositions could work because no antecedent conditions could guarantee the truth of the consequent. The suggestion there was that we could instead speak only of non-reductive 'ideal' conditions for the manifestation of a disposition. In the 2004 book *Laws in Nature*, Stephen then used a notion of dispositional possibility as another way of understanding the connection between a power and its manifestation but the issue was confused by allowing a further category of dispositional necessity. At the same time and independently, Rani was working on her doctoral thesis, *Our Conditional World* (2004). There, Rani argued that there was always some context in which a conditional could be false. Context was vital. The formal logical approach to conditionals did not seem sensitive enough to how the world was and the use for which we needed conditionals: to express hypothetical, causal and dispositional claims about some real yet unrealised potentials. The conclusion of this work was that if conditionals were to be understood properly and acknowledged as the most important form of statements in our language, then a metaphysical alternative is needed that could challenge logical empiricism. Upon our meeting, in 2006, we saw that there could be a common solution to our problems. This solution became the dispositional modality. The chapters in this volume reflect the subsequent development of the idea.

We have many people to thank. Through our participation in a number of projects, we have benefited from an extended network of collaborators, commentators and critics. We have always thought it vital to have our ideas challenged, often at an early stage, and we are very grateful to everyone who has engaged with our work. It would be impossible to name all those who have helped us in this way, sometimes because we did not know the names of people who gave useful comments on our talks, but we offer our sincere thanks nonetheless (this also includes a dark-haired guy who sat in the middle at the process conference in Exeter, who we have been unable to identify despite enquiries).

There were two significant phases in the development of the ideas in this book. The first was the Nottingham Dispositions group, which was formed as part of the AHRC-funded *Metaphysics of Science* project from 2006 to 2010. During this time, Rani held a postdoctoral fellowship from the Research Council of Norway (NFR), with the project *Causation, Dispositions and Conditionals*, spent largely at Nottingham, and we held a weekly group meeting on dispositions, with the other regular participants being Matthew Tugby, Markus Schrenk, Charlotte Matheson, Svein Anders Noer Lie and David Armstrong, plus a number of visitors. Much work discussed and tested first at these meetings has subsequently appeared in print. We are really grateful for the benefits gained from the group, which ran

mainly in 2007 and 2008, but we are still writing up ideas first considered there. The *Metaphysics of Science* project similarly allowed us to present our developing theory several times to an international network of philosophers. A second significant phase was the NFR-funded *Causation in Science* project, led by Rani at the Norwegian University of Life Sciences from 2011 to 2015. This large project allowed many fruitful interactions with experts from various disciplines, and gave us the perfect opportunity to explore the explanatory value of understanding the world in dispositional terms.

A number of friends, collaborators, critics and correspondents should be thanked for their input into this book. First, our co-authors. Without them, three of the chapters could not have been written. Svein Anders Noer Lie was an early ally in challenging what he called modal dualism, supporting the idea that dispositions shouldn't be placed within either of the existing modalities, and the dispositional modality plays a central role in his own work on naturalness. Johan Arnt Myrstad was Rani's supervisor during her graduate studies, and her early ideas on the logic of conditionals and probability were developed in close collaboration with him. He was also the one who introduced Rani to Stephen's work on dispositions, paving the way. We met Fredrik Andersen when he came to one of Rani's workshops in Tromsø in 2007. He was later hired as part of the *Causation in Science* project and became a valuable colleague for daily philosophy discussions and a good friend to the dispositional modality.

Two philosophers have taken a special interest in our work on the dispositional modality and have helped us push the idea forward through their friendly criticism. Ruth Groff and Anna Marmodoro were both initial supporters of tendencies, although they do prefer Bhaskar's and Aristotle's takes on modality, respectively, over our view.

It was Tim Rutzou who made us see that we were committed to both an external and an internal principle of tendency, as detailed in Chapter 1. In Chapter 6, the notions of a contra-conditional, and other non-causal conditionals used, were developed in collaboration with Natalie Schapanski. Bill Fish provided many helpful suggestions in relation to Chapter 7. As well as those mentioned above, we also want to thank Nancy Cartwright, Samantha Copeland, María-José Garcia Encinas, Karin Mohn Engebretsen, John Dupré, John Heil, Roger Kerry, Robin Le Poidevin, Matthew Low, Hugh Mellor, Andrea Raimondi, Elena Rocca, Eden Sayed and all our collaborators and funders.

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Collaborators

Fredrik Andersen is Lecturer in Philosophy at the Norwegian University of Life Sciences in Ås.

Johan Arnt Myrstad is Professor of Philosophy at the Centre for Practical Knowledge at Nord University in Bodø, Norway.

Svein Anders Noer Lie is Associate Professor of Philosophy at UiT – The Arctic University of Norway in Tromsø.

Part I
Modality

1 Theory

Introducing the dispositional modality

1 Modality

There is a standard basic framework for modality that every student of philosophy will know. Modality concerns necessity and possibility. Among the propositions that are true, some are also necessarily true. Among the propositions that are false, some of them are nevertheless possibly true. We call it the philosophy of modality because the addition of necessity or possibility is a mode of, or modifies, the proposition in question. Hence, it may be false that a particular door is white but we nevertheless think, on good grounds, that it is possible it is white (or the proposition that the door is white is possibly true). 2 + 2 = 4 is true. But it is not only true; it is necessarily true. It could not be otherwise. With these two basic modal values, and the addition of negation, we can also say that something is impossible. We can say that it is not possibly true or, the stronger, it's necessary that it is not true. For more on the standard framework, see Melia (2003) and the classic Hughes and Cresswell (1996). These works, and countless others, have presented, discussed and developed what we will call the received view.

We believe there to be a problem with the received view and it is a major problem. Put simply, it does not allow us to say much of what we want to say and ought to say. The standard picture, of necessity and possibility (together with the derived impossibility), is not nuanced enough to accurately capture much of what we seem to believe about the world. For example, suppose you drop a china cup onto a wooden floor. Should we say that it is necessary it will break? It seems not. We have all seen that occasionally a dropped cup survives a fall. And there may be a moment, as you see it drop, that you hope the cup will survive the impact. You wouldn't have that hope if you thought it a matter of necessity that the cup will break. So we don't want to say that the breaking of the cup is necessary.

Do we, then, want to say that the breaking of the cup is possible? Well, yes, the breaking of the dropped cup is certainly a possibility. Some call a possibility a contingency: something that could be either true or false. The problem is that it is also more than that. Lots of things are possible. Some philosophers think that anything that is non-contradictory is possible. Others say that something is possible merely if there is some possible world at which it is true. On these accounts, it's 'possible' that the cup lands safely on its base without bouncing, that it switches direction in mid-air and comes directly back to your hand, or

that instead of breaking on impact, it evaporates, or that it smashes through the floor unscathed, and so on and so forth. We want to say something much stronger than that breaking is a 'mere' possibility among all these others. The possibility of breaking seems a stronger one than all the others. It is special or privileged in some sense. It's the possibility that you really need to be concerned about. Almost all the others, you can forget. And, yet, although this is the possibility you should plan for, as we saw above, it is still short of a certainty.

The example of the fall of a cup concerns an ordinary, mundane causal process happening (or not) in the natural world. There are ample other cases, from a wide range of subject areas, in which we cannot really express what we mean by sticking to the dual modal notions of necessity and possibility. Here's an example from the moral sphere: you ought to be kind to animals. There is nothing unusual or contrived about this example. It's as simple as you get. It is no doubt true. Yet it seems hard to explain its real force in terms of the standard account of modality. Saying you ought to be kind to animals is not saying that kindness to animals is a necessity. Many people are cruel to animals, even if they've been told the moral rule. Indeed, if kindness to animals were necessary, then there would be no need to tell anyone to do it. But the rule tells us more than that kindness to animals is a possibility. The rule has a stronger force than that. It is a sort of imperative: not just that you *could* be kind to animals, but that you *should* be. Of all the possibilities, then, this one – kindness to animals – has been specially selected. It's the possibility, among many, that you should strive to achieve, or something like that.

We have given two examples, then, one concerning a physical causal process and the other concerning a moral imperative where it seems that what we want to say is something short of a necessity but more than merely possible. But what does this mean? What is it? Can something be more than contingent and yet still not necessary? This lack of philosophical resource – that is, a failing of the received view of modality to provide what we need – is our reason for developing the theory of dispositional modality. Our aim is to explain, in this first chapter, what the dispositional modality is and then, in the rest of the book, show how this proposed new modality gives us what we need to explain a range of diverse phenomena. In particular, we will argue that progress has been held back in a host of philosophical problems because of the previous unavailability of this third modal value, which is somehow weaker than necessity but more than mere possibility. This chapter, then, will provide the groundwork before we move to the applications. We aim to set out some of our basic assumptions and commitments behind the main idea of the book: that there is a third modal value whose strength lies between necessity and possibility.

Before we leave the idea of modality in general, we should make one very basic assumption clear. We take it that it is not just propositions that have a modal value; indeed, we see thinking of necessity and possibility as modifications of propositions as part of a harmful trend of linguistification of essentially metaphysical problems. That this is harmful is controversial, of course, but there is little doubt that there have been several historic attempts to eliminate metaphysics

from philosophy and that one way to do this is to treat questions about the way things are as mere matters of language. We cannot spend time engaging with this tradition here: one that has its roots in Hume, was revived in logical positivism and continues today in some extreme forms of naturalism. Within this view, there is often a considerable scepticism that modality can be a feature of things in the world. Necessity gets reduced to relations of ideas, for instance, and possibility to conceivability. The world just is what it is and we cannot say of something that is that it is also necessary, nor of something that is not that it is also possible. It is not that we don't have an answer to this challenge (see Anjum and Mumford forthcoming: chs 1 and 2, for instance), but that a convincing refutation of it would take us too far afield and use a considerable space. We have a different task ahead of us. All that we can do, then, is make it clear that we take it that things in the world – events, processes, facts, effects, and so on – can have modal features, values or properties; and it is not just propositions or statements that have these. We can wonder whether something that happened, happened necessarily (or with a lesser modal strength). We can wonder whether some state of affairs was possible even though it was not actual, and so on. There is no need to approach these issues indirectly, via their linguistic shadows. Certainly when something is possible, there may be a true statement that says it's possible. But the former does not consist solely in the latter. Indeed, the latter would not be true without the former.

2 Tendencies

We seem unable to express what we want to express if our modal notions are restricted to necessity and possibility, as there are common cases we have identified – the breaking of the cup, kindness to animals – where we want more than mere possibility but less than necessity. Our solution, which is admittedly bold, is to reject the received view. We think that the traditional dual modalities, of necessity and possibility, are not all that there is. Instead, there is a third worldly modality that we call the dispositional modality. Furthermore, we believe that this modality is not just reserved for a limited class of special cases. Rather, it's the modality that's everywhere. It's the modality that's involved in all natural causal processes, for a start, which obviously makes it far reaching. And we will see that it is found quite naturally in our epistemological practices: our reasoning and inductive inferences. It is found in our moral understanding and in attributions of free agency, thus in responsibility. It is found in many other domains, not all of which we will detail here. So, while the received view says there are only two modal values (see Vetter 2015: 4, for instance), we argue for a richer modal picture and that it is in this space between necessity and pure possibility that all the really important and natural modal claims are to be found. We are not the first to suggest more than two modal values though. Kant (1781: A80/B106) had three, but his additional one is not the same as ours. And we will see in Chapter 2 that there are a number of forebears of the main idea we want to develop. So the idea of adding to the standard picture is not new. The way in which we do so

might seem radical but this is largely because the orthodoxy is so enshrined, we believe. It is also noteworthy that the hegemony of modal dualism – the view that necessity and possibility are the only modal values – has produced its own polar opposite camps. Humeanism is associated with the view that all is contingent. The opposite view we can call Leibnizianism: that all is necessary. Is either a credible explanation of how our world works? Anti-Humeans will sometimes be necessitarians (see Ellis 2001 and Bird 2007, for example) but are either of these options credible? We think not. And is it any more credible to divide everything that happens into some things that are necessary and everything else purely contingent? Again, this is not very plausible either. We need something else: something we can locate between the two extremes. It is this intermediate modal value that we sometimes call the dispositional modality, and a more natural word to express it is tendency.

What do we mean by tendency? We find that it is hard to spell this out in a way that would satisfy a philosopher claiming that they have no idea what it is. We suspect that most people actually have a very good idea what is meant by a tendency but we will take the claims to the contrary in good faith and try as best we can to explain it as if to someone who had no prior idea of it at all. But this will not be an easy task, partly because we think the notion indicates an irreducible sui generis modality. It thus cannot be explained truthfully in other terms, so the words we use, if true, will just be synonyms of tendency. Hence, we can say that the idea of a tendency is that of disposing towards an outcome but this might not make things clearer.

We are not completely helpless, though. There are ways of explaining a phenomenon without giving a reductive account of it, and we will pursue some such attempts here. We have already stated the space that the dispositional modality occupies in relation to the two traditional modalities. It is stronger than pure contingency but weaker than necessity. This space, we say, concerns what tends to happen. But the dispositional modality is irreducible in the sense that we cannot define it in terms of the other two in the way that, for example, we can define possibly-X as not-necessarily-not-X.

Some examples could help as well. A favoured example is the striking of a match. Struck matches tend to light. We all know that there is no guarantee that they will light – there are many times a struck match fails to light. But the lighting of a struck match is more than a mere possibility. There are many mere possibilities towards which the struck match has no disposition. Struck matches do not tend to evaporate, for instance. They do not tend to dissolve or grow wings and fly. There is a definite tendency, which is more than a mere possibility, towards lighting. And it seems that we all know this. Indeed, it is a basis for action theory. People deliberately strike matches because they want them to light. Even knowing that the match might not light, it is still rational to strike it if you want it to light because, despite the lack of necessity that it does, there is a reasonably strong disposition for it to do so.

Here are more examples: cows that digest grass tend to produce milk, a light switch that is flipped tends to turn the lamp on, cuts to human skin tend to

heal. These facts are reported with an explicit dispositional vocabulary, using the word 'tend' or 'tends'. They all indicate the permissibility of exception cases, for instance. That cuts to skin tend to heal is consistent with some cases in which cuts do not heal. The dispositional force of a claim can be tacit, however. It can be said that oak trees produce acorns where this is intended to concern what tends to be the case, rather than a claim that something is absolutely the case (on generic claims and exceptions see Drewery 2000). Hence, finding an oak that does not or did not produce acorns would not necessarily be taken as a falsification of the initial claim, but could just be treated as a permissible exception. In all these cases, some outcome is possible; but it is more than merely possible. It is more than merely possible that cows produce milk: they have a definite tendency to do so, they are disposed to produce milk. But there are no grounds to say that they do so as a matter of necessity. Some cows don't produce milk, for whatever reason.

There is an initial idea of the dispositional modality, then. It is a strength of modality that is more than pure contingency and less than necessity. We also have identified a commonplace notion that is used to signify this modal strength: tendency. And we have given some examples of claims that use this term, explicitly or implicitly. There is still more that we can do to illuminate the idea and this will be discussed later in this chapter.

It is also important, however, in outlining some idea that it is distinguished from similar or related notions that are not quite the same. This will help clear up possible confusions. A major clarification, then, is that we are not simply talking about probabilistic causation when we invoke the dispositional modality. It would be easy to think that we were. Since in classical probability theory probability = 1 means that something is certain and probability = 0 mean that it is impossible, one might think that the dispositional modality indicates probabilities of some degree between these two limits. Such a view might be even more attractive when we admit that tendencies or dispositions can come in various degrees of strength, which we do admit. Hence, both a wineglass and a car windscreen are fragile but the former much more so than the latter. Might it then be thought that the extent or strength of a tendency is the same as the probability of it manifesting itself, where that probability is >0 but <1? When we first started presenting the idea of a dispositional modality, this question was often put to us, or a positive answer was simply assumed. In print, Weckend (2014: 116) has stated our position in that way but we don't want to pin the idea on her alone since we have heard so many say the same.

However, we do not think that tendencies are simply probabilistic dispositions, for various reasons, most of which we will explain in Chapter 3, 'Overdisposed'. We stated that the dispositional modality was sui generis and irreducible. This includes it not being reducible to the notion of probability either. And, if we are right, then tendencies and their strength would be fit to play the role of the truthmakers of the truths of probability; which they would not be, on pain of circularity, if they were themselves probabilistic in nature. A tendency, then, is not the same as a probability, but it might be the ground of one.

3 Causal power

We have introduced the ideas of modality and that there is an additional modal value, which we can call tendency, that is in some way between the traditional modal values of necessity and possibility. There is a third major component in our account that should be explained, which is that of a causal power. We have said a lot about powers and our commitment to them elsewhere (Mumford and Anjum 2011a; for a different view, see Molnar 2003), but they need at least some introduction here for the uninitiated.

There are various reasons why causal powers are important in our account. Crucially, causal powers are the bearers of the dispositional modality. They are the things in the world that tend towards certain types of outcome. They might even be called the tendencies themselves, though one of our jobs in the chapter (Section 6) will be to disambiguate three uses of the word 'tendency'. As well as a power sometimes being called a tendency, we can also call it a disposition, a potentiality, a potency, a capacity. We have yet to see a good reason to distinguish these notions. At best, they can be differentiated by stipulation in order to make some distinction. It can sometimes be useful to distinguish types of power or disposition, as in the case of an ability being a disposition it is useful to have and a liability being a disposition it is a hindrance to have.

We accept a thesis of pandispositionalism, which is usually taken to mean that all properties are dispositional or powerful. The claim can be misunderstood, however, so we will take this opportunity to clarify it. A pandispositionalist is not saying that everything is a power. There could be objects besides, which bear the powers, as well as events, states of affairs, processes, and so on. What makes a position pandispositionalist is the stance it takes on properties or the property-like elements of the ontology. It says that they are all powerful. There are no categorical properties besides, where 'categorical' means non-dispositional and presumably more too (we leave it to the defenders of categorical properties to explain exactly what they are). Properties themselves could be understood as clusters of powers. Furthermore, the causal role of the properties is thereby fixed. One way of saying this is that the causal role of a property is essential to it (Ellis 2001). It would not be the property that it was if it did not have its particular causal role.

There is then a further question of what the powerful properties are. Bird (2016: 498) thinks that the only genuine properties are the sparse fundamental properties invoked in an eventually completed physics, and he accepts that these are all powers. He notes, correctly, that our pandispositionalism is not limited to those. We accept macro-properties as well, such as the property of sphericity, and accept that its causal role is fixed. It thus qualifies as a power. Contrary to Bird, however, saying that our account is not restricted to the sparse properties of fundamental physics does not mean that anything goes. We do not allow disjunctive or other gerrymandered properties, for instance. Nor is there a property of being a dinosaur (kind membership is not the same as bearing an attribute; see Lowe 2006). Nor do we allow negative properties (vice Weckend 2014). Nor is

it clear we should include relational properties (which Bartels 2013 argues are non-dispositional). So we offer a theory of properties that is to an extent sparse and suitably naturalistic, though not as sparse as Bird's fundamental properties, and we say that these properties are clusters of causal powers, hence they have their modal role fixed. This modal role is essentially dispositional and is the ontological basis of the happenings in the natural world.

We also have a view of causation that comes out of our theory of powers. We call it causal dispositionalism (Mumford and Anjum 2011a). Causings are what occur when powers produce their manifestations or effects. The reader needn't accept our word on this but knowing that it is our view will make the rest of what we say easier to understand. It allows us to use power and manifestation as pretty much synonyms for cause and effect. It also allows the reader to see the far-reaching scope of the theory because we think that all causation involves the dispositional modality. A cause produces its effect, we say; but, following Anscombe (1971), it does so without necessitating it. The notions of causal production and causal necessitation are distinct: the latter is a claim, and not a particularly convincing one, as to how causal production does its work. But it does not come for free just from being a realist about causal production (more on Anscombe's argument later). There is no necessitation in causation, we say, but there is more than pure contingency. A cause tends or disposes towards its effect, and can sometimes succeed in producing it.

There have been critics of a number of aspects of our causal dispositionalism. But we will not get side-tracked by attempting to answer all our opponents here. Not everyone likes the vector model that we offer for representing causal situations, for instance Glynn (2012), Lie (2016) and Bird (2016), nor our claim that causes and effects are simultaneous (Glynn 2012, Hansson Wahlberg 2017). However, while we think that these other claims could complement the idea of a dispositional modality, the case for dispositional modality can be made without them. So we will have to engage in those other debates at some further opportunity.

What do we want powers for, then? We believe powers to be the sources of the world's modality: a distinctly dispositional modality. It is this that we will develop and defend. But it should be noted that this distinguishes our project from that of many other dispositionalists, such as Borghini and Williams (2008), Jacobs (2010), Yates (2015), Wang (2015) and Pawl (2017). Their aims were to show how, from a theory of real causal powers or dispositions, one could derive the standard modalities of the received view: necessity and possibility. We are not trying to do that. Such views overlook what we think is modally special about causal powers: their tendential nature. Such views also ignore certain evident features about the way that the world works: for even if one could derive the standard modal values from powers, what use or application do they have for the natural world around us if it works in a tendential kind of a way? If we are right that causation involves the dispositional modality in all its instances, then that would provide a very good reason for saying that the two traditional modalities are of little relevance to the natural world.

A recent attempt at a thorough, worked-out theory of modality deriving from dispositions has come from Vetter (2015), and we think we should make it clear how our aims and position differ from hers. As she makes clear (2015: 95), her task is to derive the traditional modalities of necessity and possibility from a metaphysics of dispositions. She admits in several places that there could be a lot in between these two modal limits, perhaps even a range of modal strengths (2015: 62) or, following Kratzer (1991), graded modality (Vetter 2015: 69). But she very purposefully ignores this in-between range because, in her words: 'This is a question which goes beyond the scope of the present book. In order to spell out a potentiality-based account of possibility, I will need no more than the minimal and maximal degrees, and occasionally an appeal to our intuitive judgements of comparative potentiality ascriptions' (Vetter 2015: 91). For the reasons given above, we think this means that her account ignores what is the most important modality for an account of nature. She is therefore quite wrong to dismiss our own adherence to the dispositional modality, saying 'I do not think that the claim is in any way central to their [Mumford and Anjum's] overall account' (2015b: 99 fn.). The present book will show that the dispositional modality is indeed central to our whole philosophy and the basis of our solutions to many philosophical problems.

Notwithstanding the question of whether one should attempt to derive the two traditional modalities from dispositions, there is the further question of whether you can, and whether Vetter does so successfully. We believe that her failure to do so is revealing. In the first place, she sees that she needs the notions of a maximal potentiality and a minimal potentiality to ground, respectively, the necessities and pure possibilities. But this is deliberately substituting potentiality for disposition as the key notion that is doing the work. The reason for this is that some things seem possible even though it cannot be maintained that there is a disposition for them. For example, a bridge has the potentiality to break even though it is not fragile. It has no disposition to break, because there are certain minimal thresholds that have to be passed in order for something to qualify as having the disposition at all. She specifies (Vetter 2015: 19) that potentiality is a broader notion that covers what we would call very weak tendencies. She needs this broader notion, however, in order to derive what we would call a mere possibility. This is where her account can be found to falter, however. She has resorted to this other notion of potentiality, rather than the more frequently discussed dispositionality, because she sees that there are 'mere' possibilities that the latter could not capture. So she could not derive pure possibility from dispositionality (and we would say that this is because dispositions bring with them the dispositional modality rather than pure contingency). One can then wonder whether anything is gained by the analysis of possibility in terms of potentiality, since her concept of potentiality seems to mean nothing more than the traditional possibility. It then looks as if Vetter's intuitions concerning what potentialities there are, are driven entirely by her intuitions about what is possible. And if that is right, the project is a failure. She doesn't really get possibility from potentiality.

She gets possibility from … possibility. (We have a number of other objections to Vetter's account but it is not our job here to present them.) In contrast, we are not attempting to derive the traditional modalities from powers and we are certainly not attempting a reductive analysis either. Powers exist modally laden. They bring the dispositional modality with them since their causal role is fixed and their causal role is essentially dispositional.

Having outlined three of the basic elements in our account – modality, tendency and causal power – we are now in a position to explain more thoroughly what the dispositional modality consists in and present some of the arguments in its favour.

4 The external principle of tendency

We now move on to outlining the core of our theory, which will be developed, with arguments, in the next two sections. As Glynn (2012: 1102) characterises the dispositional modality, in response to our earlier work (Mumford and Anjum 2011a), it involves directedness, intensity and the possibility of counteraction. We will explain more about these features here but we will also be able to say more, given that we will now be able to respond to those who have critically engaged with the idea. This criticism has been helpful to us and for the most part constructive, forcing us to look more deeply into the position and its implications. What follows is a result of that further reflection on the view, though to make the full case we will also need to re-present some arguments, where we think they still carry weight.

We hold what can be called a deeply tendential view of nature. This consists in a commitment to both an external and internal principle of tendency. Others seem to accept the external principle but deny that it has the radical implications that we see. There are many more who deny the external principle on the grounds that there is a fuller explanation in which it does not hold. The most serious form of this response is the conditional necessity view, which we will see has a long history (Chapter 2). When it comes to our internal principle of tendency, we have found few who accept it. We think, however, that there is only a deeply tendential view when the internal principle too is accepted.

The external principle says that we should accept the modality of nature to be tendential because while a cause is for a typical effect, any cause can be interfered with in a way that prevents its effect from occurring and this shows that causes do not necessitate their effects. The external principle has the implication that causes did not necessitate their effects even on the occasions where they succeeded in producing them.

There is an argument in support of the external principle. It is that if a cause necessitates its effect, then it should be impossible to have the cause without the effect. Yet there are occasions where this does indeed happen, or at least there are possible occasions where this does happen. This can be seen in the possibility of interference and it can also been seen in the absence of absolutely

uniform effects. For example, not every billiard ball that is struck moves away, not every match that is struck ignites, not every food that is eaten nourishes, not every price increase lowers demand, not every copulation results in pregnancy, and so on.

We can make the argument more precise than this and we will indeed need a more rigorous statement of it in order to deal with some of the criticisms we will discuss. In the first place, we need to distinguish between additive and subtractive interferers.

A subtractive interferer takes something away from a cause, as when one can extinguish a burning candle by covering it with a glass and removing the oxygen that was keeping it alight. Similarly, one could prevent a camel's back from being broken by removing some of the straw that it carries. Now subtractive interference is not what threatens the idea of causal necessitation, hence it is not what the external principle of tendency is based upon. This is because it is a kind of interference that involves removal of at least part of the cause. Consequently, one cannot say that the cause of a typical effect is present, which means that we cannot say it is a case where the cause is present without its typical effect. For the argument against causal necessitation to work, we need cases where the cause is present but without the effect.

We therefore distinguish the notion of additive interference. An additive interferer is something that is added to a cause that changes or prevents it from having its typical effect. Upon ingestion of arsenic, for example, which is a powerful poison, one could try to prevent its effect by removing the arsenic: attempting subtractive interference. But as this is far from easy, an antidote can be introduced instead, namely, dimercaprol (Bird 1998). Arsenic remains in the body but the additional agent stops it from manifesting its fatal effect. Similarly, one could extinguish a flame not by removing oxygen but by adding water, or one can counteract a force by adding a stronger opposing force. We call this the external principle of tendency because it shows that a cause, which is capable of producing a particular kind of effect, can be prevented from doing so because of some factor that is external to the cause; and it is this external factor that an additive interferer is adding.

Additive interference allows us to mount the following argument against causes necessitating their effects. Let us call a typical cause with respect to some effect C. We take C to be an active causal power: one that has become activated by meeting its mutual manifestation partner(s). Others prefer to speak of powers receiving stimuli, though we find misleading connotations in a stimulus–response model for activating powers (Anjum and Mumford 2017b). However, the argument against causal necessitation can go through whatever is taken to be the nature of the cause: that is, if you take C to be an event, or a state of affairs, a substance or a property. Let E be the typical effect of C. Both C and E are types. In our preferred theory, E will also be a property or power (where $C \neq E$), though, again, the argument can be stated even if you take both C and E to be types of event. It is also possible to state the argument in terms of tokens (given that we accept causal singularlism), that is, particular causes and effects. Finally,

let *I* be an additive interferer with respect to C's causing of E. The situation we then have is that:

1   C typically causes E

But

2   C-plus-*I* does not cause E.

From this, we conclude that a cause does not necessitate its effect. The reason is that, as necessity is usually understood, if A necessitates B, then whenever A, B. This means that if A-plus-φ, for any φ, then still B. But this constraint on necessitation seems violated in the case of causation because of the possibility of additive interferers. Another way of understanding it is that genuine necessity admits monotonic reasoning but causal reasoning is evidently non-monotonic. Further on the topic of reasoning, however, it is worth stating at this point that one should be cautious how one reads the sorts of conditionals we have invoked in our argument. They should not be read as supporting a number of classical inferences, as we make clear in Chapter 3. This will be crucial in a reply to Lowe, later in this section.

The external principle of tendency is not only saying that causes do not necessitate their effects. If it only said that, we would be subject to Sinclair's (2015) objection that we fail to say what the dispositional modality is: we only say what it is not. The external principle contains the positive component of a cause that typically has an effect, which is what Glynn (2012) identified as the directedness component of the dispositional modality. Causes are *for* their effects: they dispose towards their manifestations where, as we said, disposing is less than necessity and more than pure contingency. But the lack of necessity in causation is certainly an essential component in the case for dispositional modality. Indeed, a number of critics have chosen to attack the idea of the dispositional modality on the grounds that we have failed to show that causation does not involve necessity. They reason that, despite our argument, there are still good grounds to believe that causes do after all guarantee or necessitate their effects.

One such response, that rejects the external principle, is to argue in favour of a position known as the conditional necessity view. The view has been popular historically, as we will show in Chapter 2, but here we will focus on a contemporary presentation of it, which comes from Marmodoro (2016). The basic idea is that causes do necessitate their effects, but only when all the conditions are right; hence, the necessitation of a cause of its effect is conditional upon a particular, precise set of circumstances being realised. It might look as if there is a type of cause C that often produces a type of effect E, and that it fails to do so in certain cases. This, according to the view, is because we have not considered the cause in enough detail. So the argument goes, if we offered a fine-grained description of the cause, we would find that in all the cases where C caused E, what we really had was some particular version of C, let us call it C+, where every case of C+

successfully produces E. In the other cases where C seemingly fails to produce E, it is because, if we could look in enough detail, it would be revealed that those cases were not of the C+ variety. Looking at the precise detail then, we find that C+ always causes E, which means that there is no need to doubt the (default) assumption that C+ causes E by necessitating it. The necessitation of E is thus conditional on precisely C+ being realised.

There are reasons to be sceptical about this attempt to salvage causal necessity. If we look at Marmodoro's account, we can see the problems. She argues (2016: 213) in the following way. Consider contraceptive pill use as a cause of thrombosis, where there is an empirical truth that some women who take the pill get thrombosis and some don't. If there is a case where, for example, out of 1,000 contraceptive pill users, one gets thrombosis, according to Marmodoro this is because the (unfortunate) user was (conditionally) necessitated to get thrombosis and the others weren't. This seems to suggest that the one user had a 100% chance of thrombosis and the others had 0% chance. Marmodoro doesn't state this explicitly, as she is not offering a theory of chance in that place, but given that the other 999 pill users don't get thrombosis, their doing so would have to be a matter of (conditional) necessity. This implies a 0% chance of anything else happening other than what does happen. Marmodoro uses this case to argue that there is no evidence that there is, as we would claim instead, a (weak) tendency to thrombosis here, rather than a conditional necessity of getting it, when all the conditions have been met, as in the case of that one unfortunate user.

Marmodoro then goes on to say that the one user who gets thrombosis will have been of a specific type, w, such that if all of the 1,000 users had been of this exact type w, then they would all have gotten thrombosis. Another way of understanding this claim is to say that if one particular person is subject to this effect, then every theoretical twin would be subject to the same effect, where a theoretical twin is identical in fine-grained constitution and exposure to the risk elements.

The problem with this approach is that it will all too easily lapse into triviality. Suppose that of those theoretical 1,000 women of type w who use the pill, 'only' 999 of them get thrombosis. What must a defender of conditional necessity say in this case? Consistent with the account they must say that the one woman who does not get it is actually of some further sub-group, w*, for which it is necessary that those of that type don't get thrombosis. And if there were 1,000 women in the w* sub-group, the same reasoning would apply, and so on. This is problematic because what seems to be driving the response is the prior commitment to the view that causation involves necessity. Hence, it can be no argument for it. The response resorts to ever-more fine-grained sub-groups in order to explain away an apparent lack of necessity in causation. And it is problematic because of the likelihood that once all variations are explained then each individual ends up in a sub-group of one. It is then hard to see what could possibly support the conclusion that the behaviour of such unique individuals is a matter of necessity. One sign of necessity would be regularity, but we cannot get this if we are treating unique cases. As Russell (1913) commented in another context, if you seek more

and more fine-grained cases, the possibility of repetition is eventually reduced to zero. What this seems to show is not that we have an argument for the conclusion that effects are conditionally necessary. It shows, instead, that if we have already accepted that theory, then we will be prepared to reconceive cases in order to protect the theory.

One move to which we object generally is taking the necessity of causation as the default assumption: something that could be embraced without argument once any argument to the contrary has been dismissed. Earlier (Mumford and Anjum 2011a) we offered a test of necessity, which we called the antecedent strengthening test, and said rather than just assume that causes produce their effects by necessitating them, our opponents should instead show that causation would pass the test of necessity. We also offered the option of defending a different, better test of necessity that could be applied to causal cases, but we know of no one taking up this challenge. The antecedent strengthening test develops out of the argument we gave above. If C necessitates E, then show that C-plus-φ, for any φ, will still get you E. And we cannot emphasise enough that avoiding taking the test is not the same as passing it.

Take the world as a whole, some have suggested to us: then it is a closed system. Hence, the total state of the universe at one moment must necessitate the total state of the universe at the next moment, since there is nothing else that could interfere with such a causal process and stop its effect. But first, this is a clear attempt to avoid the necessity test. Indeed, by setting up a situation in which the test cannot be applied, it looks like our opponent is tacitly conceding that if the test were to be taken, it could be failed. Second, even if that were not true, our opponent would still be no more than assuming that the cause in question necessitated its effect. And they would not have made any effort, as far as we could see, to offer other reasons why we should say that the cause necessitated the effect, when the test of necessitation we have offered supposedly does not apply. Yet, third, it is not even clear that this avoidance strategy works. Assuming that it's a possibility that there be more than there is – as many accounts of possibility allow – then even if there is no actual thing that could interfere in the operation of this maximal cause, there is still perhaps a possible one, and this would be enough to show that the necessity test is failed, for there could be a possible additive interferer. Then, fourth (at the risk of beating an already dead horse), even if it were conceded that the total state of the universe was a closed system and, because of that, it was able to necessitate the total state of the universe at a later time, it would be an entirely singular counterexample. It would be no help in disarming our general argument, since every case of causation considered, with the exception of a few cosmologists who study the universe as a whole, occurs in an open system for which the possibility of interference is very real. As a result of these four concerns, we are not impressed by rejections of our external principle that rest upon closed systems, nor any other attempts to avoid a test of necessity.

These are still not the only challenges we have faced to the external principle, however. We will mention two more.

John Heil has put it to us (and the argument has subsequently appeared in Heil 2017) that our argument fails to show what we think it shows. The argument is that causes do not necessitate their effects because the cause, C, could occur together with an interferer, *I*, and then fail to produce the effect, E, even though it would have produced E if *I* had not been present. Heil maintains, however, that C does indeed necessitate E. But in the case where C occurs together with *I*, the conjunction of C and *I* just constitutes a different cause. C and *I* might then produce a different effect from E. Let us say that it produces effect F, where E ≠ F, then we can also say that C-plus-*I* necessitate F. In other words, Heil maintains that it is consistent to hold that C necessitates E but C-plus-*I* does not. It necessitates a different effect.

We think that this will not do and that the position is prone to a damaging dilemma. For if the conjunction or compound (we are trying to use neutral, non-question-begging language) C-plus-*I* contains C as a component, and C necessitates E, then any conjunction or compound that contains C must also necessitate E, if 'necessitation' is being used in the way philosophers usually use it. If being human necessitates being mortal, for example, then being human and wearing a hat necessitates being mortal, as does being human and being aged 33, being human and living in Oslo, and so on. The necessitation of being mortal, by being human, cannot be cancelled out by the addition of another factor. So the first horn of the dilemma we pose against Heil's position is that if C is a component of C-plus-*I*, and does not produce E, then it looks impossible to maintain that C necessitates E.

The second horn is suggested to us by a comment from Olivier Massin (in conversation). Suppose that C is not a component of C-plus-*I*. There might be credible grounds for saying this, namely if one is a holist about some wholes, accepting that some are not just an aggregation of their parts. It further seems likely that there are some cases of composition of the powers where the components undergo change, affecting each other, when they form the whole. We have ourselves allowed this, in cases of nonlinear composition (see Anjum and Mumford 2017b) and emergent powers (in Anjum and Mumford 2017a). We cannot, then, take it for granted that the whole composed of C and *I* any longer contains C as a distinct component. If it doesn't, then there is no reason to think that the whole composed of C and *I* any longer necessitates E. The whole will then be 'free' to necessitate something else that is not E, according to the line of reasoning pursued.

Although we agree with some of the assumptions employed, it is the last step to which we now object. For how can we say that this new whole necessitates F, or anything else? Again, we have offered an antecedent strengthening test of necessity. Heil is free to reject the test and offer another. But by our reckoning, he has no right to assume that this new whole formed of C and *I* necessitates F. In order to say that it does, we would want it to be shown that one could add any φ to C-plus-*I* and then one would still have F. We suspect that this would permit the possibility of F being prevented by an additive interferer, *I**, with respect to the effect of C-plus-*I*. Now Heil would then, one assumes, apply the

same reasoning as he did before and say that the new interferer with respect to C-plus-*I* does not show that C-plus-*I* fails to necessitate F. For C-plus-*I*-plus-*I** would itself be a new whole that necessitated some other effect, F*, where F ≠ F*. But no matter how many times this move can be made, in response to new, bigger wholes, no test of necessity is ever passed for any of them. In other words, no necessity is shown. It is never more than assumed. This completes the dilemma for Heil's view. Either C is a part of the whole that includes the interferer, *I*, and it seems that the necessity test with respect to C's action is failed. Or C is not part of the whole that includes the interferer, because together they form a completely new whole, in which case the necessity test with respect to C's action cannot be taken. Heil's (2017) response, then, does not salvage causal necessitation.

There is a final objection to which we must reply, which can be understood as challenging the legitimacy of the antecedent strengthening test. This comes from E. J. Lowe (2012), who points out that there are some logics of conditionals, such as his own (Lowe 1980), in which antecedent strengthening is invalid. This means that a conditional, if A, then B, can be true without entailing that if A and φ, for any φ, then B. Lowe's logic allows that "'If A, then B" can be true and "If A and φ, then B" false when "¬◇(A and φ)'" (Lowe 2012: 733), for instance. What this shows is that we must be careful about the scope of the necessity test that we claim to be applicable to causal claims. We have other things to say about conditionals (see Chapter 6) and logic generally (Chapter 5), which means that there are a number of classical inferences that we would not accept. In the case where ¬◇(A and φ), where A is a cause under consideration, we would judge that the necessity test has not been taken, for instance. What this shows is that contrary to any earlier indication, we do not take our test of necessity as having universal application within any system of logic and logic of conditionals. But it must be remembered what it is of which we are testing the necessity: naturally occurring causal processes. And for those, it looks like a reasonable test, which seems to produce the right result when applied to other worldly phenomena, such as essences and identities. Our line in the sand is that anyone who wants to maintain causal necessitarianism against reasonable arguments to the contrary must show that causation has the adequate credentials to qualify as a matter of necessity. A different test of necessity will be fine if it is at least as good as ours.

This concludes our consideration of the external principle of tendency, during which we have taken the opportunity to examine a number of the surrounding arguments. Apart from the detail, however, we must not lose sight of the basic position, which is that causes no more than tend towards their effects because there seems always to be the possibility of additive interference that can stop an effect from happening.

5 The internal principle of tendency

It is the acceptance of an internal principle of tendency that turns our tendential view into a deeply tendential one. The internal principle is striking. It means that when there is a tendency towards E, without anything necessitating that it is

so, E can be produced. It also means that there can be a tendency towards E, and yet E is nevertheless not produced, even though nothing was stopping it. Many to whom we have presented this view have been nonplussed. But why? Here is a speculation. The internal principle amounts to a rejection of the Principle of Sufficient Reason (PSR). While this was one of the basic principles in Leibniz's philosophy, it is rare that contemporary philosophers now endorse it explicitly. However, tacit acceptance of PSR might nevertheless explain some resistance to the dispositional modality view that we advocate.

To understand the internal principle of tendency, we can contrast it with the central claim of the aforementioned conditional necessity view. There, it is alleged that when all the conditions are 'right', then the effect must follow. It is a matter of necessity. We will grant the assumption that it is possible to spell out the notion of the right conditions in a non-trivial way; that is, 'right conditions' should not just mean all and only the conditions in which the effect as a matter of fact follows. The deeply tendential view that we offer suggests, in comparison, that the conditions can be non-trivially right for a certain effect, but that the effect still does not occur. This would not be because, as with the external principle of tendency, there is some external additive interferer that prevents the cause from realising its effect. With the internal principle, there is nothing that prevents the effect from occurring, but still, it need not occur, just because the modal nature of the cause is internally tendential.

This does not make effects a matter of pure contingency, as the Humean position would urge. To be undetermined does not mean that anything goes in that there can be a distinct tendency towards an effect that has a greater or lesser strength. There can be a strong tendency towards an effect, for instance, which, if it has multiple instances, can tend to manifest almost all of the time (there are several senses of tendency in play here, which we will disentangle shortly, in Section 6). Of course, some tendencies could have few instances, or perhaps just one – given that we accept causal singularism – and even then a strong tendency might just fail to be manifested. One cannot read the strength of a tendency directly from its frequency or proportion of manifestations. Rather than a matter of chance, then, the occurrence of a tendency's manifestation is produced by that tendency or causal power, but there is nothing necessitating that production. The modality at play remains irreducibly dispositional.

Why should the draw of the PSR be so strong in the philosophy of causation? One reason could be that it offers a clear and simple model of production: it purports to tell us how and when a cause succeeds in producing its effect. Consider the case of a window that is broken by a thrown stone. On the causal necessitarian view, an intuitive explanation of the way in which the breakage occurs is that when the stone is thrown, there is a high likelihood of the window breaking but its probability is still less than one. As the stone gets closer and closer to the window, the likelihood of it breaking gets higher and higher. It then impacts and cracks start to appear in the glass. However, the actual breakage occurs when, and only when (and exactly when), the probability of breaking reaches one.

Anscombe (1971) trod new ground when she argued that the notion of causal production is distinct from that of causal necessitation. They are not the same thing and the former can be accepted without the latter. That causal necessitation is the way in which causes produce their effects requires its own argument. So far it seems that the main 'arguments' are tacit adherence to PSR and lack of an alternative model. But Anscombe drew attention to new thinking in science in which the category of probabilistic causation is accepted. Our own account does not rely just on this. As we stated above, it is a confusion that we will clear up in Chapter 3 to think of the dispositional modality as just a commitment to probabilistic causation. But Anscombe opened a door for us by showing that producing an effect need not be the same as guaranteeing it. We can use, to illustrate this idea, one viable interpretation of radioactive decay. On this account, a particular kind of atom can have a propensity to decay at a certain point of time. But (setting aside the hidden variables interpretation), there is nothing that necessitates its decaying at any one particular time, which is why the time of decay has to be specified as a half-life: the point at which there is a 50/50 chance of the atom having decayed.

Here is an issue where there is a clear divide between our account of causation and any that contains a vestigial commitment to PSR. PSR was a claim that anything that happened, happened for a sufficient reason: that it was necessitated. Indeterminism would pose a clear challenge to that. But if PSR is to be maintained at least within the sphere of causation, the natural response to the radioactive decay case is to say that the decay of the atom in question was uncaused (because nothing made it necessarily so). In contrast, as we will detail in Chapter 4, the tendency account is able to say that the decay was caused, for instance, by a power or propensity for the atom to decay. The example displays another difference from the conditional necessity view, too. The latter contains the implication that two particulars of identical kinds in identical circumstances (bearing in mind that this is a fine-grained account) will exhibit identical behaviour. The deeply tendential view does not have this implication, and the case of radioactive decay gives us a precedent for such a stance. Two atoms of the same kind in the same circumstances can decay after different periods of time. Similarly, there could be two particulars with the same power, in the same circumstances. They will both have a tendency to manifest that power, and let us assume that these powers are of equal strength. Yet we allow that while both will have the (same) tendency to manifest the power, it is possible that one does and one does not – not because of any external interference but because of the internal, dispositional nature of power.

The internal principle of tendency states that causation does not require necessitation. But one shouldn't think that it tells us only that, even if this would be a striking enough feature on its own. The principle is primarily about tendencies and, thus, that ours is not a Hume world. Hume thought that anything could follow anything. He described a world of pure contingency. The tendency view says that there is more than pure contingency. Of all the infinite possibilities, only some of them are those towards which there are tendencies. It is 'merely'

possible that the struck billiard ball evaporates but there is no tendency for it. Its tendency is to roll away. We should not think of the dispositional modality as being a purely negative claim, therefore; it is a positive claim that the world contains these real modal features that are stronger than mere possibilities.

What argument is there for the positive component of the theory? Here, we have nothing to offer that is immediately original, though later in the book we will present some original ways of understanding the usual considerations. But we can initially draw on all the sorts of considerations that people raise in rejecting Humeanism. It goes against the evidence of science to suggest that anything can follow anything else. It would leave us with a problem of inductive scepticism. And the whole epistemic programme can make sense only if the world can have effects on our senses. There is a cluster of informal considerations in favour of our view, therefore. Among these is the idea that with a metaphysics that embraces tendencies, so much more can be explained. The chapters following Part I of this book show some of the issues that can be understood better by embracing the dispositional modality.

Now we cannot ignore the fact that not everyone accepts the explanatory capabilities of tendencies. Even someone friendly to a metaphysics of powers, such as Bird, denies that there is any value at all in dispositional theories of causation or free will, for instance, describing such hopes as 'moonshine' (Bird 2016: 379). As we indicated earlier, however, this is because Bird thinks that only fundamental properties have their causal roles fixed; and the reason he offers for rejecting application of the same account to macro-properties – saying that they too can have a fixed causal role – is spurious. Permitting macro-properties with fixed causal roles in no way obliges us to relinquish all constraints on what counts as a property. In particular, we do not have to admit determinables, kind memberships, disjunctive, and negative or other gerrymandered 'properties' as real. But they will not be needed for dispositional accounts of causation, free will, normativity and probability. Despite Bird's attack, we remain unapologetic dispositionalists about all of these and more.

6 Disambiguation

Now that the basic outline is in place, concerning the chief features of the dispositional modality, we are in a position to disambiguate the term 'tendency'. This is an important task because there is an unfortunate lack of clarity in the use of the term, in which tendency can be used to name three very different things that it is important be kept separate. We have already provided the resources to make that disambiguation but we will now make it explicit.

In the first place, the word 'tendency' can be used to refer to the producer of an effect: in other words the causal power or potentiality (potentiality being used in our way, and Lie's, rather than Vetter's). For example, we can note a tendency (power) within a particular magnet to stick to a metal, and the magnet may or may not manifest this tendency dependent on its circumstances, such as whether it is ever in proximity to a metal. There might be no such manifestation, but

the power is nevertheless there, capable of being manifested if the opportunity arises. In our view, developed from Martin's (2008) account, the opportunity arises when the power meets a mutual manifestation partner, which would be a magnetised metal for the example given.

But we can also use the word 'tendency' to name a particular kind of effect that is produced in some cases of powers but not all. We say that this effect, where it exists, is produced by the power. The effect in question is a distribution of repeated occurrences capable of statistical analysis. For example, there is a tendency for smokers to get certain cancers at a relatively stable and discoverable rate, and although it is unlikely to be absolutely uniform, it is consistently one which is statistically higher than the tendency of non-smokers to get those cancers. There is also a discernible and quantifiable tendency for spending to increase in the run up to Christmas in certain countries. So this kind of tendency is referring to the thing that is produced, or one of the things produced, by the first kind of tendency (the power). This second use of the term 'tendency' is also a common usage, and we cannot rule it illegitimate; but then we must make it clear how this is a very different kind of thing than the first kind of tendency. Someone might note that a particular brand of washing machine tends to break down after 2 years from new, for example, using tendency in this second way.

We can distinguish this second kind of tendency by the phrase *statistical tendency*. Earlier (Mumford and Anjum 2011a: 4), we said we were using the term 'disposition' in a non-tendential sense and we meant there, to be clear, that our dispositions did not automatically mean these statistical tendencies, since not every disposition leads to a statistical tendency. There can be very good reasons for this. A tendency (power) in theory could have a single instance – it could even exist unmanifested – in which case there is no meaningful statistical tendency to be found. This is consistent with our commitment to singularism. For a particular A to cause a particular B, it does not have to be part of a wider pattern of repetition. It can be a matter just between the particulars involved.

Another important reason to distinguish these two uses of tendency, apart from the fact that they just are ontologically distinct and different kinds of thing, is that there is no automatic connection between the first and the second. For example, the individual tendencies (powers) of things can vary within a group, and even a sub-group, such that the statistical tendency is a mere average over that group and does not apply to all (sometimes any) of the individuals. There is a statistical tendency concerning life expectancy for a population, for example, which sometimes goes up and sometimes goes down. But within the group, different people can have different degrees of health and fitness, giving them a variety of different tendencies (powers) of longevity. The statistical tendency can also be skewed in a variety of ways (Anjum and Mumford forthcoming: ch. 9.4). A low statistical incidence could be a result of a strong but rare tendency (power) or a weak but frequent one.

We have separated the producer from the thing produced, or sometimes produced. At the danger of conflation, both can reasonably be called tendencies. And now we see that there is also a third thing that can be called tendency;

namely, the modality of the production. It is this final sense of tendency that is the main topic of this present book (for more about the producer, see our *Getting Causes from Powers*; for more about the statistical tendencies that are produced, see our *Causation in Science*). It is this notion of tendency that is in use if we say something like a struck match will tend to light, or that honesty tends to be the best policy, or that a fair coin will tend towards a 50:50 distribution of heads and tails as the sequence of tosses tends to infinity. Here we mean, as explicated above, that the first thing tends towards the second in a way that is less than necessity but more than pure contingency. This third use of tendency might be less obvious than the other two. It might be ignored completely or it might be assumed that we are always talking about tendencies in the other two senses. This makes our job even more important, if so, because we think it vital that this modal connection between causes and effects be understood correctly.

The threefold ambiguity of tendency can be demonstrated strikingly in the following possible sentence, which summarises our view, though not in the clearest way, of what sometimes occurs. *Tendencies tend towards tendencies*. We can now disambiguate the sentence in the following way: a tendency (the producer) modally tends (the production) towards a statistical tendency (the produced). The statistical tendency, to repeat, is not present in every case. But where it is, we can clearly separate the three elements – the producer, the producing and the produced – even though the term 'tendency' is often used for all three. Within the context of the account presented above, however, we can nevertheless see that there is at least some good reason why each of them would bear the name 'tendency'.

7 Natural modality

We offer the dispositional modality as the modality of nature. By the natural modality, we mean the modality of everything that happens in nature: all natural causal processes. That will include nature in the broadest possible sense, so it covers the social sphere and the psychological as well, as in the case of the free will problem. Indeed, this book is an attempt to show how wide reaching is the application of the dispositional modality. As we pointed out in response to Bird, the natural is not restricted to the fundamental. Some interpret naturalism to mean commitment only to the properties invoked in an eventually completed fundamental physics, whereas we think that there are some perfectly natural macro-properties as well, and there may be natural strongly emergent phenomena too.

Is there any other source of modality in the world, other than the dispositional modality of natural causal processes? This is a question that we need not answer in order to achieve our current goal, which is to make the case for a tendential view of nature. When it comes to the question of worldly necessity, however, if there is any such necessity then the dispositional modality is not its source. We do not rule out that it might be the source of the *idea* of worldly necessity, but that is a different matter. There are candidates for sources of real worldly necessity: identity or essence, for instance. These are controversial and it is up

to their defenders to make the case for them. It is clear that if there are these kinds of worldly necessities, then they do not come from natural causal processes. This seems recognised when they are referred to as metaphysical necessities – they come from a metaphysical source – as opposed to natural modalities, which are grounded in causation. The reader will not, then, find reasons here for the existence of such worldly necessities. They are a different matter requiring further argument.

Regarding pure possibility or contingency, such as a struck billiard ball dissolving, there are again various theories. One could be a combinatorialist, for instance, but then couple it with a fictionalism about the non-actual recombinations or existing elements. Such 'pure' possibilia would, however, not then be part of the natural world, allowing us to make a distinction between what is naturally possible (made possible by the existence of a causal power) and what is a mere possibility (fictionally). However, it is again not our job here to defend any particular theory of pure contingency. But we can see the prospect that if certain stances were to be taken toward necessities and pure possibilities, there would be support for the bold claim that all natural modality is the dispositional modality.

Now the basic ideas of our book are in place. Often the best argument for acceptance of a theory is its explanatory utility and power. Accordingly, we will proceed to show how the dispositional modality can explain a range of phenomena in philosophy. What we offer is far from an exhaustive treatment of the domains in which dispositional modality is helpful. In addition to the topics covered here, in metaphysics, logic, epistemology and value, we have previously argued how dispositional modality explains a diverse range of phenomena, including play (Mumford and Anjum 2014c), responsibility (Mumford and Anjum 2013) and language (Mumford and Anjum 2011c). But what we do include here should already be enough to see the power of the theory.

2 History

Forebears of the dispositional modality

1 Origins

The idea that nature contains tendencies towards certain effects is not new. But the further thought that such tendencies are to be understood as containing an irreducible sui generis dispositional modality might be. Powers tend towards their manifestations, on this view, and causes tend towards their effects in a way that cannot be reduced to the other familiar modalities of necessity and mere possibility, nor to simple statistical facts of regularity.

This is the view we proposed in Chapter 1 but it is at least arguable that there are many historical forebears, for instance, in Aristotle, Aquinas, Peirce, Mill, Geach, Harré and Madden, Bhaskar and Cartwright. We will examine the credentials of each of these alleged precedents for the dispositional modality. In each case, however, those accounts pull up short of a commitment to dispositional modality in the fullest sense.

This is significant for a number of reasons. First, it will demonstrate that the motivation for some kind of tendential account of nature is widely acknowledged. Even if these predecessors failed to commit to a fully dispositional account of nature, they at least saw that there were tendency-like features of the world for which a philosophical explanation was required. Second, in illustrating the differences between the dispositional modality and prior views, which can be called the *conditional necessity* and *mixed indeterminism* accounts, we hope to make the distinctive features of the more recent view even clearer. Third, we will have the opportunity along the way to outline why the acceptance of an irreducibly tendential modality is superior to the other accounts. In short, the dispositional modality view, we claim, explains the tendential features of the world better than either the conditional necessity view or mixed indeterminism.

We have selected a number of our predecessors for scrutiny. These are some of the most significant philosophers of nature who have considered the same issues that we address and come closest to acknowledging the special modal features of dispositionality. The ways in which they decline to fully embrace a dispositional modality view is of historical interest in itself, though we think this can also show us what is at issue in the contemporary debate. We start by looking at the discussion in near-contemporary philosophy of science. Because a number of

those views invoke far earlier authority, we then proceed to consider the accounts in Aristotle and Aquinas: two philosophers crucial in the development of the metaphysics of causal powers. Finally, we look at two more-modern treatments of the same issues, originating from a time when the ontology of powers was out of favour. The features of nature that powers are purported to explain were nevertheless evident to the philosophers we consider, C. S. Peirce and J. S. Mill.

2 Tendencies in contemporary philosophy of science

2.1 Geach

The chief source for contemporary tendency views of nature appears to be Geach in his chapter on Aquinas (Geach 1961). We see this essay cited by Harré and Madden, for instance, and others. We will come to Aquinas in due course but are concerned first with what Geach makes of him and his notion of tendency (for which Aquinas used 'inclinatio' or 'appetitus').

In outlining Aquinas's philosophy of nature, Geach points out that scientific laws are not *de facto* uniformities, either contingent (Humean) or necessary (anti-Humean). Instead, we find tendencies towards certain outcomes. Any alleged uniformity, he states, is defeasible through prevention or interference, a point that we make use of in our own defence of the dispositional modality. When there is such a failure of uniformity, it prompts us to search for the interfering agent, which is an opportunity for the discovery of new knowledge. This is in essence why the existence of Neptune was first predicted by Urbain Le Verrier, as the interferer in the regular orbit of Uranus, and then discovered observationally only later.

It is clear from this example that tendencies can work against each other, preventing another's display in a pure uniformity. A simple but effective example is provided by Geach (1961: 102). A room can contain both a heater and a cooling system. When they are both operating, the heater tends to raise the room temperature and the cooler tends to lower it. Were they to do so to the same but opposite degree, then there would be no actual change in temperature. But tendencies always make a difference even if others might prevent their fulfilment (Geach 1961: 104). We might say that were the heater to be switched off, and everything else kept the same, then the room would get cooler. So, the heater's tendency makes a difference even if nothing is happening actually, in respect of temperature change.

Geach seems to understand tendencies as real worldly existents, akin to what we now think of as powers. He accepts a distinction, for instance, between tendencies and mere potentialities (Geach 1961: 104). A piece of wax is potentially any number of shapes, but it might have no specific tendency towards most or any of them. It 'could' take the shape of the thumb print of the King of Norway, for instance, but has no tendency to do so in itself. Similarly, a child is potentially a butcher but might have no inclination or tendency to become one. Geach also cites Mill approvingly for having noted the lack of complete uniformity in nature and interpreting laws as descriptive of tendencies only (in Mill 1843: III, x, 5). This is a view to which we will return later.

Thus far, Geach's account would be perfectly compatible with the dispositional modality view, which interprets tendencies as disposing towards their manifestations in a less than necessary but more than contingent way. However, Geach also makes a number of statements that suggest he would not favour such a view if pushed. Rather, he seems to think that tendencies reduce to a form of necessity in nature. A tendency, he says, is a 'would happen if' (Geach 1961: 104). He fills this out saying that the tendency's fulfilment 'will happen this way unless something interferes' (op. cit.: 103) and he defends this sort of statement against vacuity. Use of the terms 'would' and 'will' suggests a modal force stronger than that evoked by the dispositional modality. In similar vein, he makes the epistemic claim that 'given all the tendencies involved, we know what will actually happen' (op. cit.: 103). Again, this indicates that while Geach may have begun by using the language of tendencies, when he tries to explicate the idea he does so in terms of necessity: what must, will or would happen. Clearly the necessity has to be qualified in some way, given that the tendency can be prevented from realising its typical effect. We will return to this issue. But it seems that Geach thinks the tendency will or must be fulfilled unless it is interfered with and prevented from doing so. Aristotle and Aquinas discuss this point in more detail and have a view about where this leaves necessity.

2.2 Harré and Madden

Harré and Madden (1975) also invoke the language of tendencies in their philosophy of science, citing Geach as an authority. 'Tendencies' is the title of their relevant subsection (1975: 98–100) and they are more explicit than Geach about their commitment to the reality of causal powers. They accept, for instance, that it is its relation to its powers that makes something what it is. The distinction is followed from Geach between the real tendencies of things and their mere potentials.

However, the same notes of caution apply to Harré and Madden that were raised against Geach. They provide little detail that would entitle us to make a specific attribution of the dispositional modality to them, despite their use of the notion of tendency. And while they speak as if tendency is the crucial term to use, there is other evidence that shows they are not completely serious about it. The book, for instance, is subtitled 'A Theory of Natural Necessity', which suggests the hypothesis that, like Geach, they think tendencies are ultimately explicable in terms of the other modality. Is there any further evidence to support this interpretation? There is. Again, like Geach, Harré and Madden appeal to the idea of 'countervailing powers or tendencies which interfere with or prevent the action of powerful particulars' to claim that there can be a non-trivial sense of 'what principles of necessitation are true of natural things' (op. cit.: 99). How and in what way we can have a principle of necessitation that can at the same time be countervailed, they don't say. As we (Mumford and Anjum 2011a: 58–9) point out, there is an obvious prima facie tension between something being necessary and being capable of prevention and interference. Mill (1843: III, v, 6) says the

very meaning of necessity is unconditionalness. Why then cling to a notion of necessity at all? Why not admit that a tendency doesn't necessitate its effect but nevertheless disposes towards it, in a more-than loose and separate way? This would make the view adequately anti-Humean for the realist about powers but without having to explain away the clear tension between necessity and possible prevention. We will see, however, that others have addressed this question and defended the view that there is still some kind of necessity to powers.

2.3 Bhaskar

Bhaskar (1975) speaks of tendencies as constituting the 'generative mechanisms' of causal laws, where those tendencies can act 'transfactually'. There is again ample use of the term tendency and Bhaskar's notion of a generative mechanism seems to be something a dispositionalist should take seriously. Bhaskar offers more detail than either Geach or Harré and Madden on how we should understand the operation of tendencies and how they relate to necessity.

It is first worth explaining generative mechanisms and the notion of the transfactual. These are notions that have not fallen into popular usage outside Bhaskar scholarship yet seem to be along lines acceptable to anyone who affirms the reality of powers and their operation. We can think of the transfactual as something that underpins and generates the factual. The factual is understood as the actual events and occurrences that Humeans invoke: that form Lewis's Humean mosaic, for instance (Lewis 1986b: ix–x). A Humean regularity would be a regularity in what factually occurs. But consider Geach's heater and cooler working in tandem again. In this case, the room temperature does not change so there is no new occurrence when the effects of the heater and cooler counterbalance. But transfactually – underlying that lack of change – there are operating tendencies. The lack of change is generated by those mechanisms. Hence, for a realist about tendencies, there is a big difference between the cases in which the heater and cooler are both switched off and where they are both switched on, even though in both cases the room temperature remains unchanging, let us suppose. The two cases differ transfactually even though they are the same factually.

One can also understand these distinctions in more explicitly Aristotelian terms and contrast them with the Andersonian naturalism of Armstrong (1981: 149, for instance). Armstrong asserts that there are no degrees of being (see Mumford 2007: ch. 1). Everything either exists or it doesn't. There is nothing half way. The non-actual is then equated with the non-existent. But Aristotelians have a threefold division whereas Armstrong's is only twofold. Aristotelians need not equate the non-actual with the non-existent. Among that which exists, a further distinction can be drawn between that which is actual and that which is potential (see Feser 2014: ch. 1), an unexercised power falling into the latter category. Note that this use of potential contrasts with the usage above where real tendency was set against a mere potential. Potential here is akin to a real existent power. A power exists – it is real – even if it is not actualised. Aristotelians thus have a richer conception of reality than a sharp actual/non-existent

divide. Bhaskar's transfactual mechanisms can thus be accepted as real, by an Aristotelian, even though they are not actualised. They can be operating even though they don't reach their fulfilment in a factual change.

Thus far, this looks extremely promising for a proponent of the dispositional modality. Can't we say that these mechanisms tend towards their outcomes in a way that is short of necessity but significantly more than Humean contingency? However, we find that again, when Bhaskar explains how his tendencies work, he lapses quickly and explicitly back into talk of necessity. Of course, this might be deliberate on his part. It might not be that Bhaskar was aiming at a theory of dispositional modality and failed. He could have had a very different notion in mind when he invoked the term 'tendency'. We can't claim a trademark on use of that word. As with all the authors we discuss here, however, we consider Bhaskar to see whether he anticipated our view and we conclude that it's unlikely he did.

The first sign is that Bhaskar uses the language of natural necessity to contrast his view of science with that of Hume's and the Humeans (e.g. Bhaskar 1975: 14 and ch. 3.3). What is more, this does not seem to be a mere slip or unintended phraseology because much of what Bhaskar says indicates a necessitarian view: what we call a conditional necessity view.

Tendencies may be exercised without being manifest in any outcome, for instance, but nevertheless, he says, they provide an ontological basis for 'necessity in nature' (Bhaskar 1975: 14). Tendencies are potentialities that can be in play without being realised or manifest in an outcome but, crucially, 'It is the idea of continuing activity as distinct from that of enduring power that the concept of tendency is designed to capture' (op. cit.: 50). So, it is not tendency as irreducible sui generis modality that is Bhaskar's point. It is the continuing-activity-possibly-without-manifestation: that is, the transfactuality.

There are ample cases where Bhaskar commits to necessity as the modality that is in play. For example: 'there must be a reason why, once a tendency is set in motion, it is not fulfilled. … Once a tendency is set in motion it is fulfilled unless it is prevented' (op. cit.: 98). So, if undisturbed, the generative mechanism *would* result in the tendency's manifestation. We later get some very explicit confirmation along these lines:

> When such tendencies are realized the events describing the stimulus or releasing conditions for the exercise of the tendency and its realization may be said to be necessarily connected.
>
> (Op. cit.: 214)

Followed by a concrete example:

> If a thing is a stick of gelignite it must explode if certain conditions materialize. Since anything that did not explode in those circumstances would not be a stick of gelignite but some other substance.
>
> (Loc. cit.)

This suggests a picture in which there are various natural necessities in play but where they are able to cut across and thwart each other. That something necessary can nevertheless be thwarted is a view we wish to reject. Bhaskar thinks he can explain the apparent tension, however. When all the conditions are propitious, it is then necessary that they manifest themselves. We agree with Bhaskar that the powers can be exercising even if they are 'unfulfilled' or unmanifested due to a countervailing tendency in operation. This feature of powers is certainly in the view that we defend. But what we add is that those powers exhibit an irreducible sui generis modality of dispositionality or tendency, which Bhaskar's account lacks.

Now is Bhaskar right to rest with necessity and avoid invoking the sui generis modality? The problem is that in his argument for necessity there is a similar elision that we find in Harré and Madden (1975: 126) and in Ellis (2001: 7). The elision is from it being necessary that natural kind-k members have a tendency T to m, as part of the essence of k-membership, to it being necessary that k-members' tendency T manifests m. We see this in Bhaskar immediately before the gelignite example cited above where he first says 'a thing must tend to act the way it does if it is to be the kind of thing it is' (Bhaskar 1975: 214). We agree with this claim. It is just the quasi-essentialist claim that what qualifies something as a member of a particular kind is that it has one or more specific tendencies. Gelignite is essentially explosive, for instance. But one cannot infer straight from this, as Bhaskar does in his very next sentence, quoted above, that those things then necessarily manifest those tendencies (even with the qualification, when conditions are propitious). Clearly something could be gelignite, and thereby be explosive, but without necessarily exploding. Instead, the dispositional modality view says that in virtue of being explosive, gelignite will 'only' tend to explode when the conditions are right; not that it must do so. Bhaskar presents his necessitarian view as if it simply follows from a natural kinds dispositional essentialism, which it clearly does not. It is one thing to possess a tendency necessarily; another thing completely for that tendency necessarily to be manifest or to manifest itself by necessity.

It seems then that despite his use of the term tendency, Bhaskar has not in this place presented a deeply tendential view of nature, in the sense we outlined in Chapter 1 (Section 5). He offers a necessitarian one. But it is worth noting that he has not offered any compelling reason for his necessitarian take on tendencies and also that he has not offered any good reason to rule out an irreducibly tendential view of the modality in nature.

2.4 *Cartwright*

The final contemporary philosopher of science we shall consider is Cartwright. Cartwright has many writings on the related issues of laws, causes and capacities. She is not a metaphysician, though, so usually avoids the sorts of questions that we want to press here. Nevertheless, she does have a philosophy of science that coheres with that of Harré and Madden and she also speaks approvingly of Aristotelianism.

There is a host of sources from which we could choose in discussing Cartwright's view but it is in *The Dappled World* (Cartwright 1999) that tendencies, and the modality they involve, are considered most directly. In a discussion of Aristotelian Natures and *ceteris paribus* laws she says that it is in the nature of a force to produce an acceleration and it will 'try' to do so (her scare quotes) even when other causes are at work, presumably interfering. She explains:

> To ascribe a behaviour to the nature of a feature is to claim that that behaviour is exportable beyond the strict confines of the *ceteris paribus* conditions, although usually only as a 'tendency' or a 'trying'. … The point here is that we must not confuse a wide-ranging nature with the universal applicability of the related law. To admit that forces tend to cause the prescribed acceleration (and indeed do so in felicitous conditions) is a long way from admitting that F=*ma*, read as a claim of regular association, is universally true.
>
> (Cartwright 1999: 28–9, see also p. 82)

We should pause here and consider the notion of 'trying' that Cartwright uses. Unlike the other accounts considered thus far, Cartwright does not immediately bring necessity in to the putative rescue as the redeemer of tendencies. She admits that 'the concealed *ceteris paribus* conditions will always have modal force' (Cartwright 1999: 141), though she doesn't say what this modal force is. It might be dispositionality. But when she uses a term such as 'trying', she is deploying an intentional vocabulary apparently to explain how tendencies relate to their effects. Both Molnar (2003: ch. 3) and Place (1996b) have developed this idea, effectively offering intentional explications of dispositionality. Dispositions are intentional states, as Place says, directed towards their manifestations. In the passage above, however, Cartwright also explains the relation between the tendency and its effect in terms of the latter being 'prescribed' by the former, this time invoking a normative language. Again, this is a connection that has been developed: by Lowe (1980, 1987, see also Mumford 2000) in his normative conception of nature. Certainly, there are parallels between tendencies and intentionality and between tendencies and normativity. But we argue in Chapter 9 that the direction of explanation should not go the way Cartwright, Molnar, Place and Lowe have in turn suggested. On the contrary, the reason that these notions are connected is because both intentionality and normativity work in a tendential way; that is, they exhibit the dispositional modality. If we consider what ought to be the case, for example, then we would not say that what is necessary ought to be, for then the *ought* is redundant. But nor would we say that what ought to be is simply that which can possibly be, which fails to single out the *ought* as in any way distinguished from all else that is merely possible. Normativity, and likewise intentionality, seemingly exhibit the middle modality between necessity and pure possibility that we claim to be the realm of dispositionality.

One might conjecture that the notions deployed by Cartwright, of trying and prescribing, are attempts, typical of Modern and contemporary philosophy, to say what needs saying without openly evoking final causes. The latter is enshrined as

one of Aristotle's four causes. If Feser (2014: ch. 2) is right, one of the great struggles of Modern philosophy, and since, is to get by with efficient causation alone: with all three of material, formal and final causes jettisoned. Restricting ourselves to just efficient causes, we then have to find other ways to fill in the explanatory gaps left, the appeals to intentional and normative notions being cases in point. Why not instead grant the four causes and have rich enough explanatory resources to begin with? At this point, therefore, it seems worthwhile engaging with Aristotle's account directly. Perhaps there the true roots of the dispositional modality can be found.

3 An ancient and medieval threefold modal division?

3.1 *Aristotle*

Given that Aquinas saw his task as to reconcile Aristotelian philosophy with Christian doctrine, we cannot really understand Thomistic philosophy without seeing first what Aristotle said. The philosophy of tendencies is no different in this respect.

   There is some hope that the theory of dispositional modality should get confirmation in Aristotelianism. But a closer inspection reveals again that matters are more complicated. Aristotle is known for emphasising what is the case 'for the most part', which sounds like it should be conducive to a tendential view, and there is some evidence that this was intended in a purposeful and systematic way. Famously, Aristotle stated a threefold modal division:

> First then, we observe that some things always come to pass in the same way, and others for the most part. … But as there is a third class of events besides these two – events which all say are 'by chance' – it is plain that there is such a thing as chance and spontaneity.
>
> (Aristotle 1930, *Physics* 196b: 10–15)

The claim might look even clearer in the Waterfield translation (*Physics*[W]): some things happen of necessity, some things happen usually, and some things happen by pure chance. This looks to be a clear statement that we should divide things not just into the necessary and purely contingent but that there is an intermediate: what is true for the most part or usually. The distinction seems deliberate as it appears elsewhere in Aristotle's writings too:

> Some occurrences are universal (for they are, or come-to-be what they are, always and in every case); others again are not always what they are but only as a general rule: for instance, not every man can grow a beard, but it is the general rule.
>
> (Aristotle 1928, *Posterior Analytics*: II, 12, 96a, 8–11)

Here, Aristotle makes use of the notion of a 'general rule' but it is clearly not expected to be absolute and universal. Men generally can grow beards but there

could be a few men nevertheless incapable of doing so. The term 'generally' can be used in English in this way, for instance: 'generally, if you strike a match it will light, but there may be a few occasions where it doesn't'. It is similar when we speak of what usually happens for the most part. In his commentary on the *Physics* (cf. 199a: 1–2), Charlton suggests snow in winter as an example of what usually happens, which is less than necessary but more than pure chance (Charlton 1992: 105).

Before the dispositionalist proclaims Aristotelian precedent, however, we must first consider two issues. In the first place, could these notions of 'for the most part', 'usually' or 'generally' be the same as the sui generis dispositional modality? Second, did Aristotle really see the notions as requiring a distinct modality of dispositionality? After all, there could be other explanations of how things came to be for the most part, which don't require an additional modal category.

Regarding the first issue, the defender of the dispositional modality is entitled to object that their account should not be reduced to statistical facts about what mostly, usually or generally happens. The Aristotelian account seems to be appealing to what is true in the majority of cases: for instance, that the majority of men are capable of growing beards. But the idea of the dispositional modality is not shackled to this commitment for it permits tendencies that come in degrees of strength, some more powerful than others. In other words, a power can tend very strongly towards its realisation, which might well result in a majority of cases successfully manifesting, but it can also tend towards its realisation only weakly. A well-known example is the weak tendency of the contraceptive pill towards thrombosis, which it tends to cause in only around one in a 1,000 cases. Of course, even a weak tendency is a highly significant matter if its fulfilment is a drastic concern. Suppose some food only very weakly tended towards death, say in one in 5,000 people who ate it. There is no doubt such a tendency could be scientifically acknowledged and doubtless would be treated as such a major risk as to see the food banned. But it would be very far short of delivering its fatal outcome for the most part. Tendencies are gradable and it seems perfectly right that we acknowledge such gradations, capable of a continuous range of degrees of strength, rather than a simple division of what is for the most part and what is not. This gives us an initial reason to doubt that Aristotle's notion of 'for the most part' is the same as what is meant recently by the dispositional modality.

Second, however, there is some reason to suspect that Aristotle did not even intend his notion to appeal to irreducible dispositionality for we see that when he gives further detail on the working of nature, he consistently appeals to a form of necessity. The necessity in his account is qualified, and we can push the point of whether it counts as any kind of necessity at all, but there's little doubt that this is the stated position of Aristotle.

We should follow Marmodoro (2017), then, in attributing to Aristotle a conditional necessity view of the workings of tendencies. There are a number of passages in which he seems to make this kind of commitment, which we will first present. Again, in the *Physics*:

> Starting from a given source of change does not result in the same end in
> every case, but it is not just any chance end either; there is in fact always a
> tendency towards the same end, unless something intervenes.
>   (Aristotle 1996, *Physics*^W: II, 8, 199b, 15–19)

In this case, there is benefit in seeing a different translation of the same passage:

> For those things are natural which, by a continuous movement originated
> from an internal principle, arrive at some completion: the same completion
> is not reached from every principle; nor any chance completion, but always
> the tendency in each is towards the same end, if there is no impediment.
>   (Aristotle 1930, *Physics*, loc. cit.)

There are also two relevant passages in the *Metaphysics*, the former being the
evidence Marmodoro cites in attributing the conditional necessity view:

> [A thing] has the potentiality in question when the passive object is present
> and is in a certain state; if not it will not be able to act. To add the qualifica-
> tion 'if nothing external prevents it' is not further necessary; for it has the
> potentiality . . . on certain conditions, among which will be the exclusion of
> external hindrances; for these are barred by some of the positive qualifica-
> tions [for the potentiality in question].
>   (Aristotle 1998, *Metaphysics*: IX.5, 1048a, 15–20)

> A definition of what comes to be in fulfilment by thought from what is
> potentially, is that when it is wished it comes about, if nothing external
> prevents it, and on the side of what is healed, when nothing in it prevents
> it. Similarly, also with what is potentially a house; if nothing in this and in
> the matter prevents the coming to be of a house, nor is there anything which
> needs to be added or taken away or changed, this is potentially a house.
>   (Aristotle 1998, *Metaphysics*: IX.7, 1049a, 5–11)

The idea seems to be, then, that once all the impediments are removed, and
similarly everything else is correctly set up, then the outcome of the tendency is
necessary. This is said of the source of change or internal principle in the *Physics*.
It is a feature attributed to the workings of nature and it describes not what always
happens, nor what happens by pure chance. It is a tendency towards some end
that will be realised as long as there is no impediment or, what we would call, a
preventer. The two passages from the *Metaphysics* again suggest that the end of
potentiality will or must come about as long as there is no preventer or inter-
ferer. Again, once everything is right, it seems that the outcome follows and
there seems to be little other option but to read this as saying that tendencies
will necessitate their outcomes, when the circumstances allow them to do so.
Some things are indeed for the most part, therefore, but it is only because the

conditions in those cases are not always ideal for their realisation. No third modal category is invoked in this explanation.

It is questionable, however, whether necessity 'in the circumstances' should properly count as necessity at all. As we (Mumford and Anjum 2011a: ch. 3) have argued, a prima facie tension ought to be acknowledged in the very notion of a conditional necessity, recalling Mill's point, above, that the meaning of necessity is unconditionalness. But, even if we permit the coherence of a concept of conditional necessity, it can also be wondered what reason there could be for asserting it to be the case.

It was conceded by Aristotle, as it seems to be by the contemporary philosophers of science that we considered, that the manifestation, end, realisation or fulfilment of the tendency can be prevented. Usually, when a philosopher calls something necessary, they mean that it must always be. And if A necessitates B, then whenever A is the case, B is the case. Our causal reasoning, concerning natural causal processes, seems to allow that a typical cause of B could occur, accompanied by some interferer, and then not result in B. The fact that our causal reasoning is non-monotonic reflects this. But what, then, is the argument for assuming that when there is no impediment, the tendency necessitates its outcome? And is there any good reason for assuming, similarly, that where the tendency did indeed succeed in realising its fulfilment, that it did so by necessitating it? To maintain a necessitarian stance while accepting this is seemingly to allow that the realisation could indeed have been prevented and would not have occurred had things been different. So, in what sense was the outcome necessitated? In such cases, the necessitarian seems merely to assume necessity rather than have an argument for it. And it is an assumption that seems contrary to common conceptions of necessity. One might think ordinarily, for instance, that one could test whether something was necessary by trying to prevent it, and if it can be prevented then we know it is not necessary. In contrast, one cannot prevent someone who is a bachelor being at the very same time an unmarried man, which is then a ground for believing it a necessary truth.

Aristotle did elsewhere discuss some of these issues; yet the conditional necessity thesis survived those considerations. This was in *De Generatione et Corruptione* (DeG) (1930: II, 11), where he starts by saying:

> Hence we must investigate whether, amongst the consecutive members; there is any whose future being is necessary; or whether, on the contrary, every one of them may fail to come-to-be. For that some of them may fail to occur, is clear.
>
> (Aristotle 1930, DeG: 337b, 1–3)

For instance, a man might be about to walk and yet not walk (op. cit., 337b, 6). Of this kind of example, he says: 'in other words, their coming-to-be will not be necessary' (op. cit., 337b9).

At 337b, 15–18, Aristotle seems to distinguish between something being a necessary condition for something else (such as when foundations are a condition

of a house being built) and something being necessary given a prior condition (such as once there are foundations, a house is necessary). Aristotle accepts cases of the former, *sine quibus non* conditions, but the latter apparently only 'when the being of the consequent is necessary' (337b, 24). Clearly, something could go wrong in the latter cases. The builder could fail to see through the project and the building plot be abandoned. And someone may have every intention of taking a walk but be distracted before fulfilling the intention. Unless the consequent is itself a matter of necessity, then clearly it might not happen.

However, Aristotle again is willing to use a notion of 'conditionally necessary' (1930, DeG, 337b, 26), though here the conditionality consists only in: 'it will always be necessary that some other member shall have come-to-be before "this" as the presupposed condition of the necessity that "this" should come-to-be' (337b, 26–8). But in a final unequivocal statement on the matter, he concludes that we can never say that an effect is *absolutely* necessary: that if foundations are built, the house is absolutely necessary, for instance (227b, 30–1). This latter admission is significant. Even someone who defends the conditional necessity view ought to concede that the necessity of their account is at the very least tempered and, if they follow Aristotle, have to admit that they are not invoking necessity in any absolute sense.

Given the questionable appeal of a notion of conditional necessity, we think the onus is on its defenders to explain in exactly what sense necessity is a part of their account and, most importantly, whether there is an argument for their view or whether it is mere supposition.

3.2 Aquinas

As we began with a claim from Geach that Aquinas had a tendential view of nature and, as Geach outlined it, it looked at times like it involved an irreducible dispositional modality, we ought to consider the Thomistic account separately. Unfortunately, Geach made no specific citations in support of his interpretation so we are left to look for the textual evidence ourselves. This task is not assisted by the fact that, at eight million words, Aquinas is thought to have the largest written output of any philosopher. We cannot, therefore, be sure that we are not missing some passage that was crucial in the formation of Geach's interpretation of Aquinas.

In the *Commentary on Aristotle's Physics* (CP) Aquinas describes the seeming threefold modal division in Aristotle, which we have considered already (CP: 108). Some things always come to be, such as the rising of the sun. Some things happen frequently, for example men are born with eyes. And some things happen by pure fortune or chance, for instance if a man is born with six fingers. But Aquinas does propose an amendment to this division, which highlights our earlier charge that the intermediate case is not about genuine tendencies but is a purely quantitative division. Aquinas says that we should add a fourth category, following Avicenna, of things that happen only occasionally, for example, that Socrates sits. The necessary, Aquinas says, should be understood as that which

cannot not be (rather than which cannot be impeded) and the contingent as that which cannot be (rather than that which can be impeded) because whether something is impeded is itself contingent (CP: 108).

In the context of this sort of division, should we understand Aquinas as holding a genuinely tendential view of nature or does he think that nature works through necessity? There is ample discussion of tendency-like action in nature, for instance, when Aquinas argues that every agent acts for an end in *Summa Contra Gentiles* (SCG) (SCG: III, 2). Agent is taken in a broad sense to mean everything that acts, and it is easy to see how this account applies to powers or tendencies of ordinary objects – unknowing beings – even though Aquinas thinks that their agency ultimately derives from something else. Aquinas's discussion makes tendency a central notion and the account contains a credible way of understanding the action of powers. A key passage is the following:

> In the case of things which obviously act for an end, we call that toward which the inclination of the agent tends the end. For, if it attain this, it is said to attain its end; but, if it fail in regard to this, it fails in regard to the end intended. … As far as this point is concerned, it makes no difference whether the being tending to an end is a knowing being or not. For, just as the target is the end for the archer, so it is the end for the motion of the arrow. Now every inclination of an agent tends toward something definite. A given action does not stem from merely any power, but heating comes from heat, cooling from cold. Thus it is that actions are specifically distinguished by virtue of a diversity of active powers. … Now, if an action does in fact terminate in something that is made, the inclination of the agent tends through the action toward the thing that is produced.
>
> (Aquinas 1956, SCG: III, ii, 2)

This is followed by a further useful comment on how we should understand the end towards which an active power is directed:

> Again, with reference to all things that act for an end, we say that the ultimate end is that beyond which the agent seeks nothing else; thus, the action of a physician goes as far as health, but when it is attained there is no desire for anything further.
>
> (Aquinas 1956, SCG: III, ii, 3)

These passages reveal a strong commitment to powers as the true vehicles of change. What is more, it is clear that they should be understood as tendencies or inclinations towards some end, the end being understood as the point at which the power seeks nothing further. There is also the crucial insight that the inclination continues through the action, a point that can be brought to bear usefully in both action theory (see Chapters 9 and 10) and in the debate between endurantist and perdurantist theories of persistence (Mumford 2009). The point can also be deployed against conditional analyses of dispositions. Real dispositions cannot

be understood merely in terms of a conditional relationship between stimulus and manifestation because the inclination towards the end must be present throughout the process that gets us from one to the other (see Chapter 5, Section 7). The points above look, therefore, useful to a powers approach and also to the idea of a tendential modality.

However, when we inspect other texts, it again appears as though Aquinas has necessity in mind – conditional necessity – as the underlying modality of nature. Feser explains Aquinas's view this way, for example. Although he uses the word tendency in doing so, when he gives the detail of the account he reverts to talk of necessity. In contrasting Thomism with the approach of Modern philosophy, for instance of Hume, he says:

> puzzles … seem to arise only if we deny that causes are inherently 'directed towards' their effects as towards a final cause. In particular, it has been notoriously difficult for modern philosophy to account for the necessary connection that common sense supposes to hold between cause and effect.
>
> (Feser 2009: 43)

Feser's characterisation of cause and effect being related by necessity does have backing in Aquinas's writing. In *The Principles of Nature* (PoN) Aquinas distinguishes, like Aristotle in the *Posterior Analytics*, between absolute and conditional necessity (Aquinas 1965: §26). There is absolute necessity when it concerns material and efficient causes, for instance: the necessity of death, which stems from matter. This is 'absolute because there is no impediment to it' (loc. cit.). Conditional necessity is said to come from 'causes posterior in generation'. The birth of a man is conditional upon conception taking place, to use Aquinas's example. There remains something problematic about calling this conditional necessity, however. It suggests that once conception has taken place, then the man must be born, which is clearly not an inevitability. With conception plus some further interferer, natural or otherwise, there might be no birth at all.

Geach must surely have known this work of Aquinas and it does little to support an idea of irreducible tendencies. And Geach, we saw, lapsed into talk of necessity himself. It looks, therefore, as if Aristotle, Aquinas and Geach had a conditional necessity view rather than allowing a dispositional modality. Their talk of tendencies was superficial in the sense that they saw the ultimate explanations, of why something holds in nature for the most part, in terms of the necessary operation of causes with occasional impediments. Although the plausibility of a conditional necessity view is considered elsewhere (Chapter 1), we have said enough here to indicate that we do not see it as an illuminating way to understand the modality of nature.

4   Modern acceptance of tendencies

Modern philosophy saw commitment to causal powers largely expunged and along with it an ignoring of tendential phenomena in nature. A possible exception

was Spinoza, who still talked of powers, but these were strongly necessitating and actualist (Viljanen 2007, 2009). More representative, however, were Hume (1739, 1748), who famously disempowered causation by reducing it to constant conjunction (with contiguity and temporal priority) and Boyle (1666, 1674) who replaced talk of active powers with a mechanistic philosophy. This left us with a philosophy in which laws of nature played the central role, though such laws reduced to regularities. Thus, we no longer permitted talk of something being A involving a power or tendency to produce B. Instead, we were supposed to accept as an adequate substitute that everything that is A is merely followed by something that is B. A was not causally productive of B. Rather, it is the mere regularity of As being followed by Bs that leads us to believe the former causes the latter.

   This generally Humean metaphysics held sway and in some circles still does. There is no doubt that it remains attractive to many as a general world view. However, it is also clear that its appeal to constant conjunction is problematic. Both Peirce and Mill saw that the idea of regularity was not well confirmed empirically, quite apart from any metaphysical consideration. It was simply not the case that one phenomenon was always followed by another. Perhaps here we can find a revival of the notion of tendency and even an appeal to a distinctly dispositional modality.

4.1 Peirce

There is one issue in particular discussed in Peirce that is relevant to our concerns. This is his denial of the universality of regularity in nature. In his view, there is an element of regularity but also an element of irregularity. He explains:

> Those observations which are generally adduced in favour of mechanical causation simply prove that there is an element of regularity in nature, and have no bearing whatever upon the question of whether such regularity is exact and universal, or not. Nay, in regard to this *exactitude*, all observation is directly *opposed* to it; and the most that can be said is that a good deal of this observation can be explained away. Try to verify any law of nature, and you will find that the more precise your observations, the more certain they will be to show irregular departures from the law. We are accustomed to ascribe these, and I do not say wrongly, to errors of observation; yet we cannot usually account for such errors in any antecedently probable way. Trace their causes back far enough and you will be forced to admit they are always due to arbitrary determination, or chance.
>
> (Peirce 1892: 304–5)

Peirce began this 1892 paper by quoting Aristotle's threefold division from the *Physics*, between what is always the case, what is for the most part, and what is by pure chance. When he then identified an element of regularity in nature, though one with the possibility of irregular departures, this might have seemed an ideal opportunity for a notion of tendency or dispositional modality to enter

the analysis. However, the opportunity was lost. The irregularity is attributed to an 'arbitrary determination'. If it were not clear already, Peirce went on to state that what he meant here was an element of chance:

> I must acknowledge that there is an approximate regularity, and that every event is influenced by it. But the diversification, specificalness, and irregularity of things I suppose is chance. A throw of sixes appears to me a case in which this element is particularly obtrusive.
>
> (Peirce 1892: 306–7)

This suggests a different kind of view from both the conditional necessity account of Aristotle and the new theory of dispositional modality. Peirce seems to be allowing that there are *approximate regularities*, which look like our tendencies, but rather than being a sui generis new mode, approximate regularities are formed by a mixture of necessity and chance, where chance is ever present in nature. Confirmation is in the following passage:

> From these broad and ubiquitous facts we may fairly infer, by the most unexceptionable logic, that there is probably in nature some agency [meaning chance or 'pure spontaneity'] by which the complexity and diversity of things is increased; and that consequently the rule of mechanical necessity meets in some way with interference … By thus admitting pure spontaneity or life as a character of the universe, acting always and everywhere though restrained within narrow bounds by law, producing infinitesimal departures from law continually, and great ones with infinite infrequency, I account for all the variety and diversity of the universe.
>
> (Peirce 1892: 308)

We can think of this as a mixed indeterminism view. Although there is much that the supporter of tendencies would like, it is also clear that Peirce does not appeal to tendencies to account for the 'approximate regularity' he has identified. Rather, he believes that such a phenomenon of nature can be explained in terms of a mixture of necessitating laws of nature with occasional chance elements thrown in. Peirce accepts a degree of indeterminism. It is not a complete indeterminism, because there are laws of nature. But there are the occasional occurrences of chance events that are contrary to law. Peirce does not accept powerful tendencies, disposing towards a certain type of outcome, so the departures from law have some other source: pure spontaneity.

There are at least two problems with this view, which might also be offered as reasons to prefer a metaphysics of irreducible tendencies. First, pure chance can hit anywhere at any time in equal measure. What Peirce's account doesn't explain is how there come to be distinct measurable, stable and reliable tendencies of a certain kind, in varying strengths in different things, towards certain outcomes. If it were a matter of pure chance striking, frequency of outcome wouldn't be roughly steady over time and reliably variable for different kinds of cases.

In short, the account leaves too much unexplained. We know, for instance, that a car windscreen and a wineglass are both fragile but the latter more so than the former. There is no necessity in either. Both can survive an impact and the windscreen is more likely to do so. Do we really want to say that whether or not these things manifest their powers, with one more likely to do so than the other, is down merely to spontaneity?

   The second problem also suggests not. If elements of pure chance are introduced – merely added to necessitating laws – it seems to have the consequence that the outcomes subsequently produced are in that respect uncaused. They occurred for no reason. To say they happen because of pure chance is another way of saying that they had no cause (see Aristotle 1930, *Physics*: 196b, 13–17). The tendency view, in contrast, does not have this consequence. Tendencies indeed produce their manifestations even if they don't guarantee them. On the occasions where a tendency issues in an event, it is very much a caused event: caused by the tendency. So Peirce's attempt to handle the issue produces the wrong result on one of the central issues.

   Perhaps, however, we are wrong to assume Peirce has this view of chance. He later states: 'I make use of chance chiefly to make room for a principle of generalisation, or tendency to form habits, which I hold has produced all regularities' (Peirce 1892: 310). This sounds less like a spontaneous uncaused happening; so, did he believe in powers after all? Fortunately, he discussed chance in more detail in a later paper, which we ought to acknowledge. There, he draws attention to a promising parallel between inanimate probabilities and habits and develops his notion of a 'would be'.

> I am, then, to define the meanings of the statement that the *probability*, that if a die be thrown from a dice box it will turn up a number divisible by three, is one-third. The statement means that the die has a certain 'would-be'; and to say that a die has a 'would-be' is to say that it has a property, quite analogous to any *habit* that a man might have. Only the 'would-be' of the die is presumably as much simpler and more definite than the man's habit as the die's homogeneous composition and cubical shape is simpler than the nature of the man's nervous system and soul; and just as it would be necessary, in order to define a man's habit, to describe how it would lead him to behave and upon what sort of occasion – albeit this statement would by no means imply that the habit *consists* in that action – so to define the die's 'would-be', it is necessary to say how it would lead the die to behave on an occasion that would bring out the full consequence of the 'would be'; and this statement will not of itself imply that the 'would-be' of the die *consists* in such behaviour.
>
> (Peirce 1910: 169)

We can see as Peirce develops the notion of 'would be' that it looks less like a tendency and more like a form of necessity. If we take 'would' to denote necessity, contrasted with 'could' to denote contingency, then 'tends' is the missing third

modal value. Peirce seems to grasp towards it in a few places but the notion slips through his fingers, as it did with Aristotle, Aquinas and others.

4.2 Mill

John Stuart Mill's work is highly significant in being the first in the Modern philosophy tradition to understand well the need for a notion of tendency in describing the workings of nature (there are earlier precedents, such as Descartes (1664: 96), who spoke briefly of a stone in a sling, moving in a circle, still having a tendency to move in a straight line). Mill acknowledged that regularities or constant conjunctions can be only part of the story and perhaps a very small part. He had a perfectly good explanation of this in his *System of Logic* in terms of effects typically having many different causes (Mill 1843: I.x.1). By this he means not only that an effect can have multiple causes – that is, causal complexity – but also that the very same type of effect could have different types of causes in its different instances. Because he understands that there is this complexity, he takes it that the 'Intermixture of Effects', and the interference of causes with one another – is 'the principal part of the complication and difficulty of the study of nature' (Mill 1843: III.x.3,439).

The core case for Mill is where there are two or more concurrent causes which do not produce their individual effect because they interfere with each other. There are two varieties (Mill 1843: III.x.4, 440):

a   Composition: like the joint operation of forces where they are compounded and disappear into one total.
b   Transformation: like chemical action where the separate effects cease entirely and are succeeded by something altogether different, governed by different laws.

Composition of causes is where two or more laws interfere with each other, frustrating or modifying the operation of the other. Mill understands both as really fulfilled (Mill 1843: III.x.5, 443) though as Cartwright points out, this can't be true literally; equilibrium forces might produce no motion at all and Mill only asserts it is *as if* the body first moved to one place and then back to the same place (cf.: 443). But for purposes of predicting or explaining, such an understanding *as if* works (Mill 1843: 444). At this point, Mill invokes the notion of tendency in explanation:

> To accommodate expression of the law to the real phenomena, we must say, not that the object moves, but that it *tends* to move, in the direction and with the velocity specified. We might, indeed, guard our expression in a different mode, by saying that the body moves in the manner unless prevented, or except in so far as prevented, by some counteracting cause. But the body does not only move in that manner unless counteracted; it *tends* to move in that manner even when counteracted; it still exerts, in the original direction,

the same energy of movement as if its first impulse had been undisturbed, and produces, by that energy, an exactly equivalent quantity of effect.

(Mill 1843: III.x.5, 444–5, italics in original)

This looks to be one of the most serious commitments we have yet seen to tendencies as a specific variety of force. The qualification that it will move unless prevented looks like some concession towards a conditional necessity view. But Mill is famous for having applied this notion of tendency across the board, stating boldly:

These facts are correctly indicated by the expression *tendency*. All laws of causation, in consequence of their liability to be counteracted, require to be stated in words affirmative of tendencies only, and not of actual results.

(Mill 1843: III.x.5, 445)

This brings us full circle, being a claim that Geach cited in support of the Thomistic account and a thought to which Cartwright also appealed. Mill thinks that the sciences perfectly understand the tendential nature of their laws, when using terms such as pressure and force. And it follows that laws have no exceptions, because the law is only that such and such *tends* to happen (Mill 1843: 445–6), which is an idea developed more recently in Mumford (2011a and see Mumford and Anjum 2011a: 154). It is only the prejudice that laws are about absolute generalisations that leads one to then talk of their exceptions.

While Mill perhaps comes closest to acknowledging a nature in which there are irreducible tendencies in the operation of laws, we know nevertheless that elsewhere in the same work he leans more towards a necessitarian outlook, when all factors are taken into account. When he defines his notion of total cause, for instance, he tells us:

The cause, then, philosophically speaking, is the sum total of the conditions positive and negative taken together; the whole of the contingencies of every description, which being realised, the consequent invariably follows.

(Mill 1843: III, v.3, 332)

Similar to the conditional necessity view, then, once everything – the total cause – is in place, Mill seems to think the effect follows necessarily. It may be, therefore, that Mill was not wholly consistent in his treatment of tendencies and causes.

4.3 Recent tendencies

There has been a small but growing interest in the notion of tendency in recent and contemporary metaphysics. Johansson took the notion from his reading of Bhaskar, pointing out that the key feature of tendencies was that 'they *need not* reach their goal … Tendencies can be annihilated or counteracted' (1989: 162).

This was a useful start in an account that is also notable for favouring a representation of tendencies as vectors. The claims stand in need of further development, however. The explanation of how powers come together to form resultant powers is limited to vector addition without acknowledgment of non-additive, nonlinear composition, which seems to be required in many cases (Anjum and Mumford 2017b). The account of tendencies that need not reach their goal is very promising but is open to interpretation. We have seen that there are at least three explanations of this phenomenon: conditional necessity, mixed indeterminism, or the dispositional modality, and Johansson's remarks seem neutral between them. We cannot therefore say for certain that he was an advocate of the latter view.

Shortly after came a more detailed study of tendencies by Champlin (1991), replete with instructive insights. However, the approach places heavy emphasis on ordinary usage of terms such as 'tending' and 'tends to' and it is not clear to what extent any serious metaphysical conclusions can be drawn, especially relating to modality. The following passage gives a flavour:

> Although I have argued that 'A's tend to be B's' can, depending on the example, be glossed either as 'Most A's are B's' (e.g., 'Trade-unionists tend to vote Labour') or as 'All A's tend to be B's' (e.g., 'Wars tend to upset money markets'), I do not wish to suggest that this difference is attributable to two separate kinds of tendency. In my view, 'to tend to' works in the same way in both these examples, it acts as a modifier, indicating that there is a shortfall in either frequency or extent in comparison with the unmodified claims.
>
> (Champlin 1991: 132)

Thus, Champlin recognises that the key modification produced by adding tendency talk is the 'shortfall' from absolute uniformity, and he thus provides a discussion of the 'frequentative' issues with tendency. But the lack of direct metaphysics means that he avoids handling any question as to whether tendencies are marked by a distinct dispositional modality. At least he sees, however, that there is some tension between the notions of tendency and necessity.

Mumford's own early work wrestled with some of these same questions of tendency but also without a full commitment to a dispositional modality. When discussing the circumstances in which a disposition would manifest itself, the notion of 'ideal conditions' was utilised (Mumford 1998: 88–92). Such conditions were ideal for a disposition's manifestation but could only be specified in relation to that manifestation type and thus could not be used for purposes of a reductive conditional analysis. A notion of the disposition tending towards its manifestation would have been a better way to say the same thing. Mumford also employed a notion of 'dispositional possibility' in a later work, indicating that one property could 'dispositionally make possible' another (Mumford 2004: 177). Only in work with Anjum (Mumford and Anjum 2011a, 2011b, 2014b) does the idea of a sui generis, irreducible dispositional modality become clearly articulated and an explicit commitment.

There has been considerable recent interest in a theory of modality based on the reality of powers, for instance Borghini and Williams (2008), Jacobs (2010) and Vetter (2015), to name but a few. Dispositions as the grounds of modality is not, however, the same as a distinctly dispositional modality. Taking Jacobs (2010) as an example, powers are offered as the truthmakers of modal truths of the usual two kinds: truths of necessity and truths of possibility. There is no commitment to powers having their own distinct modality, even though it seems recognised that there are at least some problems with powers grounding necessity. An alleged necessary truth is offered that 'smoking necessitates (or at least probabilifies to some degree x) cancer': for instance, the bracketed clause indicating that there is a problem with unqualified necessity. And the counterfactuals made true by powers are acknowledged to be context sensitive. But Jacobs is happy to deal with that issue in the assertion conditions of the counterfactual. In contrast, we see the issue as indicative of a need to acknowledge the dispositional modality.

Another closely related but distinct project is the one of basing a theory of causation on powers or tendencies. We indeed think that causation can be so based (Chapter 4). However, that alone does not automatically involve commitment to a distinct dispositional modality in nature. For instance, Chakravartty (2005) offers a process theory of causation in terms of causal properties, which confer dispositions on things but he does so in an attempt to defend causal necessity against Humeanism (unlike our own process account, Anjum and Mumford 2018). In slight contrast, von Wachter (2009: ch. 5) gave an account of causation explicitly using the terms 'tendency' and 'bias', where a tendency is something that produces effects but can be prevented from doing so. We have seen that such a view, while correct, does not automatically count as a commitment to a 'deep' dispositional modality. Like all those we have discussed, it does come close, and perhaps von Wachter comes closest, describing tendency as a primitive. However, he also employs the notion of a deterministic tendency, which must be realised unless something interferes, which sounds closer to a conditional necessity view than we want.

5   True tendencies

We cannot claim to have offered a comprehensive survey of every philosopher who has ever considered tendencies and their mode of operation (see also Sinclair 2015, who discusses the contributions of Maine de Biran and Ravaisson). Instead, we have looked at some key thinkers who have recognised similar issues to those we used in motivating appeal to a distinct intermediate modality, which is less than necessity but more than pure contingency. In each case, we have seen that the problem received a different kind of solution, mostly in terms of a notion of conditional necessity but in the case of Peirce what looks like a mixed indeterminism explanation. This might be thought so much the better or so much the worse for us. Better, because it suggests our idea is novel; worse, because others did not take the step we took. However, this might be because the notion of the dispositional modality was not on offer at the time. The writers we have considered did

not seem particularly sensitive to a distinction between dispositional modality and conditional necessity, for instance. Such lack of sensitivity might explain why those predecessors at times spoke the language of tendencies and seemed to mean it seriously, but then, when pressed to explain in more detail, lapsed back into a notion of necessity that they found more familiar. Now that dispositional modality is on the table, however, a new kind of discussion ought to take place. We should no longer allow philosophers of nature simply to assume as their default that necessity is the mode of operation for causes. Such a claim – causal necessitarianism – should be argued for, and we have yet to see compelling arguments. Regarding its rival – the dispositional modality – positive arguments have been offered for its acceptance, which can be both direct (Chapters 1 and 2) and indirect, appealing to the explanatory power generally of adopting the modality (Chapters 3–10).

Our immediate task in this chapter is concluded, however. We have seen that among the chief candidates to be the forebears of the dispositional modality, while they have all acknowledged appeal to tendencies within nature, none of them seem to have endorsed a fully blown sui generis dispositional modality of the kind that we have offered. Showing the ways in which these accounts have differed – the dispositional modality, conditional necessity and mixed indeterminism accounts – we now have a clear sense of what stands between them. We have, along the way, explained why we prefer the dispositional modality to its alternatives. Finally, we hope that the discussions have shown more of what is distinctive about the dispositional modality view.

Part II
Metaphysics

3   Chance
Overdisposed

1 Are tendencies probabilities?

Is tending towards some end the same as probabilifying it; in other words, making the end probable to some degree? It might be thought so because there are similarities between tendencies and probabilities. Tendencies are less than necessities; for instance, they dispose towards their effects without guaranteeing them. And when we give a probability of something happening, we usually do so to indicate that it is short of a necessity. Tendencies are also distinct from pure contingencies. There are many mere possibilities, given some natural set of causes, but a tendency towards only a subset of them. And powers or tendencies comes in degrees, some stronger than others. Perhaps all tendencies are in some sense probabilistic, then, making the chance of their effects greater than zero but less than one. The chance of a power producing its effect could then be a way – perhaps the definitive way – to understand the strength or intensity of the power.

Introducing probability into the discussion could give a familiar basis to tendencies and might explain why the dispositional modality is something that is between pure contingency and necessity. If so, each power would be understood in terms of a probability of the occurrence of a certain effect, which is given a specific value. The fragility of a wine glass, for instance, might be understood to be a strong disposition towards breakage with as much as 0.8 probability, whereas the fragility of a car windscreen probabilifies its breaking to the lesser degree 0.3. Furthermore, it is open to a holder of such a theory to state that the probability of breakage can increase or decrease in the circumstances and, indeed, that the manifestation of the tendency occurs when and only when its probability reaches one (see Popper 1990: 13, 20 and Mellor 2005: 36, 59 for instance). This might be thought an attractive move since it clarifies how and why tendencies come in degrees and also why a power does not always succeed in producing its effect, namely, where its probability of doing so is less than one. In addition, it could allow us to assign propensities to classical cases of probability, if we wish for a propensity interpretation of the calculus of probability (Popper 1957, 1959). A fair coin is usually understood to have a 0.5 probability of landing heads if tossed and a 0.5 probability of landing tails, and this would permit us to assert that there is a

0.5 propensity towards each of the outcomes. By thinking of tendencies as being probabilistic in this way, we have seemingly avoided both the necessitarian view and a world of Humean contingencies, such a middle path being the professed aim of the theory of dispositional modality.

We nevertheless want to resist this probabilistic interpretation of dispositionality, despite the superficial attractions. Humphreys (1985) has already given one reason why probabilities and propensities are not the same. His paradox illustrates how propensities do not have one of the features of classical probability theory. We will not repeat the detail of his argument here. We have a different reason for supporting the same conclusion. Probability theory does not reflect how tendencies really work. Unlike probabilities, tendencies can overdispose. Overdisposing is where there is a stronger magnitude than what is minimally needed to bring about a particular effect. There is more than enough. This shows that there is a difference between our notion of having a power to some degree and the classical probability of the power's manifestation occurring. Among other conclusions, this also shows that the dispositional modality does not reduce to probability, preserving its apparent sui generis status.

We are not denying that there is a link between tendencies and probabilities. But one legitimate question concerns which of the two is more basic. We say tendencies are. The facts of probability are best explained in terms of propensities, constituted by the tendencies, which are apt to be the truthmakers for the probabilistic truths. A propensity is a real intrinsic tendency, to some degree, that comes when a particular is in possession of a power. So instead of understanding powers and their degrees of strength as probabilistic, we take worldly powers and their tendencies towards certain manifestations as the basic grounds of probabilities. The reason why the head and the tail are equally probable statistically, when a coin is tossed, is that the coin is equally disposed towards those two outcomes. It has equal worldly propensities for them.

Before proceeding, we need to clarify our choice of terminology. Unlike Mellor, we use the notions of 'power', 'disposition' and 'tendency' more or less interchangeably. We then think of a propensity as the having of a tendency to some degree, where degree is non-probabilistically defined in a way we will outline shortly. Things can be said to have the power of solubility, *simpliciter*, but when we think of the having of that power to a degree then we are thinking of it as a propensity. Mellor (1971: 70) puts it a different way. He says that a propensity must be grounded in dispositions and not in tendencies. This is not only a terminological matter. Like us, Mellor (1971: 69) takes tendencies to admit of degrees of strength. Unlike us, however, he maintains that dispositions invariably manifest under suitable conditions: 'A glass that does not break when so dropped is at that time not fragile. A glass that sometimes breaks when dropped and sometimes not … is not "disposed to be fragile"; sometimes it is fragile and sometimes it is not' (Mellor 1971: 68). For our account of propensities, it is essential both that they come in degrees and that they are not necessarily invariably manifested. They 'only' *tend* to manifest. The reasons for this will be clearer as we explain how tendencies are able to overdispose.

2 Some powers know no limits

Within the calculus of probability, of which Kolmogorov (1933) gives the classic presentation, a probability is always within a bounded inclusive range between zero and one. There cannot be a greater than one chance of something occurring, as one is taken as a maximal value. Furthermore, for a coin, the chance of landing heads and the chance of landing tails cannot together add up to more than one. This is more than mere stipulation. We can understand such probability assignments as concerning proportions of parts compared against a whole, where the whole is the unit: the one. The probability is thus given as a ratio or proportion of part to whole (Laplace 1814: 6–7), such as 1 in 3 (the part is a third of the whole), which can also be given as a percentage. In no case can a real part be greater than the whole, hence a perfect contraceptive, which would always prevent pregnancy, would be 100% effective. But it cannot prevent pregnancy more often than 100% of the time; in other words, the unity – chance =1 – is the limit. The biggest proportion of cases is all of them. In many other instances, of course, the proportion that concerns us is less than unit: 1 in 2, 1 in 5, and so on. For example, some see that laws of nature can concern not what always happens but also what in a more or less reliable proportion of cases happens, and thus such laws might then be understood probabilistically (Armstrong 1983: ch. 9). While there is room for many different philosophical interpretations of the probabilistic calculus, it also seems quite natural to understand the chance =1 as indicating necessity. So, where the chance of A is one, this can be understood as indicating that A is necessary. Humeans, who deny worldly necessities, are nevertheless at liberty to offer a frequentist interpretation of chance in which chance =1 means only that something happens all of the time – but not that it is necessary for it to do so. The regularity might just be an unnecessary, though universal, truth. If one were considering a probabilistic interpretation of propensities, however, a frequentist interpretation is obviously unattractive because propensities are typically offered as the alternative to an empiricist frequentism.

Despite the temptations of using this existing framework, however, one should not be tempted to think of the magnitude of tendencies as given by the relative success of a power to produce its outcome. First, that would misrepresent tendencies as a part–whole matter, where zero means that no case has produced the effect and one means that all cases have, and it would mean that there is a maximal strength of tendency. There is something about the magnitude or degree of a power that is vitally missing here.

Second, which will require some elaboration, to say that there is a probability =1 of an effect would indicate that the effect was necessitated, which we argue never applies in the case of powers. Powers dispose towards their effects and often succeed in producing them. But even where they do succeed, they don't do so through necessitation. A power, represented by arrow *a* in Figure 3.1, then, should not be read as a classical probability =1 of the threshold effect (=T) being produced, even where *a* meets T, since that would automatically commit one to saying that T was necessitated by *a*. (For more on this model for representing causes, see Mumford and Anjum 2011b.)
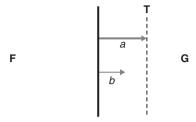
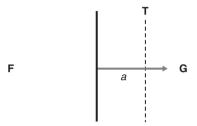*Figure 3.1* A power (a) tending towards but not necessitating the effect = T.

Figure 3.2 A tendency beyond a threshold.

    Tendencies do not work like this. They can be counteracted by the presence of other powers operating at the same time, the possibility of which means that the classical probability of an effect would always be less than 1. This would indeed be another way of expressing the claim that powers do not necessitate their manifestations. Perhaps even more significantly, however, for any outcome, there can be more than enough power to produce it, which is what we mean by overdisposing. We can again show this in the vector model. Figure 3.2 illustrates a power, *a*, which goes beyond the extent of the threshold T. Let us call the effect that tends to be produced 'T of G' (the threshold effect of G). We could say that *a* disposes towards T of G with a stronger tendency than what is minimally required to produce it. In other words, T of G could have been produced with less, if the power had been of a lower strength. The part of the power that disposes beyond the threshold is in that case redundant with respect to T of G. The effect is over-disposed in that it could still have occurred without this redundant element. The mismatch between probabilities and tendencies occurs because, while there is a maximal limit to degree of probability (=1), the intensity of a tendency is some-times *unbounded*, much like the magnitudes of other properties such as length or weight. We do not, and need not, say that all tendencies have a maximal value. Some might not. There might be a maximum solubility; for instance, a tendency for all of the solid to go into solution. But we also maintain that there are clear cases where strength of power knows no limit, and that is enough for us to say that tendencies are not the same as probabilities.
    Figure 3.2 thus illustrates what overdisposing is in the abstract but a concrete example will help to show how commonplace this is as a natural phenomenon. Consider being trapped in a burning room where the only escape from the blaze

is to break out by smashing a window. The threshold effect to be aimed at in this case is exertion of enough stress on the glass that it breaks. Let us suppose that with smoke quickly filling the room, there is time only for one attempt at escape. There are two alternative courses of action that would both bring about the effect. You could throw something that is just hard enough, heavy enough and with just enough force, that it ought to break the window. A chair might be used, and let us suppose that it would be enough to succeed – but only just. It seems quite likely in the circumstances, however, that you would not want to take any chance of failure. The safer alternative would be to use more than enough force, given that life is at stake, and thus reduce the chance of failure were you to have miscalculated or something unexpected interferes. Instead of throwing a chair, therefore, you should throw a table, use an axe or hammer and swing it towards the window with as much force as you can possibly gather. In this second case, you again succeed, but some of the effort was in effect unnecessary.

The important point to note is that in cases of overdisposing there still cannot be a greater than one chance of the outcome, as classically defined. In terms of probability theory, that would be an inadmissible value. So, as we understand it, overdisposing might be a way of getting the chance of the window breaking as close to one as you practically can get it, but it cannot exceed one even if you overdispose. Rather than explaining overdisposing in terms of probability, therefore, we have to accept it as a variety of causal redundancy.

The most familiar kind of causal redundancy is overdetermination. This is where there is more than one cause at work, where each alone would have been enough to produce the effect. As it has been put elsewhere:

> Ordinary overdeterminers are properties/events/states of affairs which are individually sufficient (IS) for their effect but are not individually necessary (¬IN) insofar as the effect would still occur had one or more ordinary overdeterminer been absent, as long as at least one ordinary overdeterminer is present.
>
> (Mumford 1995: 56)

An effect is thus ordinarily overdetermined if it has multiple sufficient causes and thus counterfactually depends on none of them individually. Overdisposing is slightly different from ordinary overdetermination. Instead of involving a number of different causes, one or more of which is redundant, overdisposing requires only that a part of one single cause, or power, is redundant for the effect: meaning that the effect in question would still have been disposed to happen with only a part of the cause. The tendency is therefore more powerful than what is needed to produce the effect. Of course, we are not talking about concretely separable parts where we are dealing with a single, overpowered cause. Powers are often a holistic unity, such as the force that breaks the window. It is for this reason difficult to maintain that there is an unexercised part of the power as well as the exercised part, for how could one possibly identify two such parts distinctly? But where the force is twice as much as required for the breakage, there is still a coherent sense

in which half of that force was effectively redundant with respect to the breakage. We hope the sense is obvious: half the force of the impact would also have been enough for that same outcome.

There is a third reason why we do not want to conflate the intensity of a power with its probability of manifesting, which is the possible ambiguity it would introduce with respect to specification of a power's strength. Given that powers can be manifested to some degree then it would be possible to confuse the degree of manifestation with a lower chance of a manifestation of a stronger power. This is simply a warning not to automatically represent the intensity of a power as a probability. If a heater has a power to warm a room to 21°C, this is not the same as it having a power to heat a room to 42°C with 0.5 chance, which says something quite different. The latter suggests a genuine power to heat a room to the warmer temperature but with only a half chance of doing so, whereas in the former case, 21° may well be the maximum temperature the heater is capable of producing.

There are thus at least three reasons why we should avoid reducing the less-than-necessitating nature of tendencies to probabilities and this shows that there is a mismatch between probability theory and the notion of having a power to a degree. The case of overdisposing is the one that we think really brings this point home.

3 Why overdispose?

We have seen one case where overdisposing arguably seemed to be a rational option. If you can have only a single attempt at escaping a burning building, it would be better to give your all rather than what is minimally required in the situation. There's no point in saving energy if you might not live to enjoy it. Given that overdisposing involves a form of redundant causation, however, one might wonder whether, on the whole, overdisposing is rational or not. Is it something we should usually seek to avoid?

This is a question that certainly deserves an answer, yet we should also point out that overdisposing is such a regular phenomenon that it is not a matter concerning the rational actions of agents exclusively. It is not as if our distinction between the intensity of a power and its probability of manifesting is ad hoc, based on a single special or suspect agential case that suits us. Consider a rock that falls from a cliff and crushes an ant. The rock might have been 100 times larger than it needed to be in order to crush the poor creature. The effect was thus overdisposed by an a-rational, non-conscious cause.

When it does come to human agency, however, this form of causal redundancy is something that we often try to avoid, all else being equal, since it is essentially a wasted effort. Take economic theory, for example, which is premised on an idea that rational equals selfish. Such 'rational' agents should avoid overdisposing in their financial transactions. Suppose an employer is looking to resolve a strike over the issue of pay. The employer's 'rational' calculation should be along the lines of what is the minimum pay increase she must offer at the present

time in order to end the strike. And, if she offers 10%, while successfully ending the strike, she may have overdisposed, if a 3% offer would have been enough. The employer has overdisposed more than what was necessary to secure exactly the same outcome. This is assuming that the gaining of a very happy workforce is not seen as a relevant or worthy goal in itself. Rather, a 'price' should have been fixed on Keynesian principles of supply and demand with each party seeking to maximise utility.

We should not conclude from this, however, that overdisposing is always undesirable. In some cases, overdisposing might be a reasonable demand, for example where it concerns safety measures. When building a bridge, there should be a tolerance built into the engineer's design. Suppose the planner told us that there had been a very reliable calculation of the maximum usage of a new foot-bridge and at most there would be 200 people on the bridge at any one time. Would we be happy that the bridge was built strong enough so that it could hold up to 200 people, over a deep ravine, but no more? Since the outcome of a bridge collapse is a disaster, an adequate 'tolerance' surely must be allowed. Perhaps this bridge ought to be able to hold twice as many people as ever likely to be walking on it at one time; that is, overdisposing x2. A tolerance of 20 times such a number seems unnecessarily cautious, for while it no doubt could be achieved, the expense might be both prohibitive and unnecessary. Some degree of overdisposing seems required, though, in case of extraordinary circumstance or even just to give peace of mind to the users. We could run a similar account for other cases where safety is a concern. In the design of a nuclear power station, for example, one might not want just one safety system, capable of shutting the reactor down when there's a danger of criticality. What if the safety mechanism failed, as any mechanism can? It seems better to have at least one back-up safety system, or perhaps two. Likewise, an aeroplane can fly on one engine but it's nice to have two, just in case. It even seems right to land as soon as safely possible if one engine fails. One probably could complete the journey on a single engine but then any further failure is catastrophic. When it comes to safety, we actively want over-disposing. Yet we acknowledge that even when some outcome is overdisposed, this still doesn't make it guaranteed. How this can be non-paradoxically so is the topic of Section 4, below.

It ought to be noted, however, that there are some cases with the appearance of overdisposing that shouldn't strictly be ruled so, as we have defined it. While overdisposing is commonplace, it is not everywhere. Consider the following example. A sofa needs moving so you invite ten friends to come help lift it. Clearly a sofa can be lifted by fewer than ten people. Two might be able to do it. But if ten lift it, the required contribution from each is reduced, with less back strain, and so on, for each. The difference between this case and overdisposing is that the same force to raise the sofa is exerted whether it is two doing the lifting or ten. But in the latter case, that extent of exercised power is shared between more contributors. It is not as if the ten are together exercising more power than necessary – perhaps thereby throwing the sofa into the air. Rather, they each exercise less power than they would have, had there been fewer helpers.

A second kind of case is where more than enough power to have achieved one particular effect is exercised but it thereby means that the power has a different effect, as in an overdose case. Think of this as 'too much' power. In the right quantity, some drugs relieve pain. Taking more of them does not relieve more pain, nor relieve the same amount of pain, but can have the opposite effect of causing pain. We thus do not mean the same things by overdisposing and overdosing. Overdisposing is, to put it more precisely, where an effect is realised that could have been achieved with less, whereas this latter type of case is one where in exercising too much power we alter the effect to a different one.

4 Getting probabilities from propensities

We have seen how the possibility of overdisposing shows that tendencies are not probabilities. But to pin down the exact relationship between tendencies and probabilities, we need to disambiguate the notion of probability, which is sometimes used and understood in different ways. And we should then consider the question of how, if at all, one can derive probabilities from propensities. We will see that this is a complicated matter.

In our view, tendencies are more fundamental than probabilities in that tendencies can ground the facts of probability. They do so when they come in degrees of strength or magnitude, where this is non-probabilistically defined, and a power that has such a degree is what we call a propensity. Note the importance of the strength of power being non-probabilistic. This is what allows us to say that propensities are not probabilities, but it also allows that propensities can ground facts of probability, which they could not, on pain of circularity, if propensities were themselves already probabilistic in nature.

This shows that we are understanding probability in a certain way, which we have to acknowledge. Because we are taking probabilities to be ontologically grounded in worldly propensities, it is clear that our subject matter is an objective view of probability instead of subjective probability or credence (e.g. Ramsey 1926 and de Finetti 1974: 62). A number of philosophers have already suggested a propensity reading of probability (Peirce 1910, Popper 1934/1959, 1990, Mellor 1971, Giere 1973, Suárez 2013, 2014). Our view is positioned within this latter tradition. But our stance can be differentiated from those other objectivists because of our recognition of overdisposing cases, which gives us a greater distance between propensities and probabilities.

How, then, do we get probabilities from propensities? Is there an existing model that adequately accommodates the possibility of overdisposing into the facts of probability? We think not. But the disparity between strength of tendency and degree of probability needs to be explained. We have to square the facts, to take one vital example, that condoms seemingly overdispose – they need to hold only a few drops but can actually contain up to two litres – and that they nevertheless are said to be only 97% reliable. How can there be more than enough, in the overdisposing case, and yet still no guarantee of success?

Consider some existing accounts of how to get probabilities from propensities, or other worldly facts. How would they cope with overdisposing cases? A common view is that probabilities are fixed by frequency of occurrence (early Popper 1957,1959, Gillies 1973) but, of course, nothing can be more frequent than all of the time. Similarly, if we make the same point in terms of ratios of cases (Laplace 1814), no ratio can be greater than 1:1. An alternative approach is to explicate probabilities in terms of degrees of belief (Mellor 1971, Skyrms 1977, Lewis 1980), but within such models you cannot have a >1 degree of belief.

We saw how ascriptions of probability have to conform to the rules of mathematical probability calculus, where there is never a greater than one chance of an outcome. Probability is on a bounded scale. Propensities, we claim, cannot always be measured in a bounded way. The problem, then, becomes how to compress unbounded quantities into the boundaries of zero and one. The first two attempts on our list, in terms of frequencies and ratios, try to derive facts of probability from occurrences. This is in principle acceptable to Humeanism and thus leans too far in favour of frequentism (Venn 1876, Reichenbach 1949, von Mises 1957) for a strong realist about powers to accept. One can see, apart from any other problem with frequentism, that this immediately leads us to a bounded scale, where the most frequent is always, and the highest ratio of positive cases to all cases is 1:1. The facts of overdisposing, where there are such examples, cannot then be captured. For instance, information is lost in the putative conversion of propensities to probabilities, information that at least supports different counterfactuals. In an overdisposing case, it may be true that the effect in question could have been produced with slightly less power than there was; a counterfactual truth that is not sustained in a minimally disposing case, where there is enough, but only just enough, for the effect.

Degree of belief might be a different matter depending on how one understands degree of belief. In standard accounts, there is no >1 degree of belief. Suppose one understands degree =1 to mean that one believes some proposition P completely, without reservation. However, there is a question of whether overdisposing can apply to belief. Is there really an upper limit to strength of belief? What if there is more than enough evidence for *a*'s belief that P, such that there would still have been sufficient evidence for *a* to believe P unreservedly even with less evidence? That sounds like *a*'s belief that P is overdisposed by the power of the evidence (for a more detailed discussion, see Anjum and Mumford forthcoming: ch. 19). Such cases are easy to envisage. Isn't there more than enough evidence for the belief that smoking causes cancer? However, if one accepts a measurement of degree of belief that admits overdisposing, and thereby permits its measurement on an unbounded scale, the problem is, it seems, that it can no longer be used for a simple mechanical conversion of propensities to probabilities. The problem would remain of compressing an unbounded scale into the bounded probabilistic one.

Thus, these prior accounts cannot handle all the phenomena in the sense that overdisposing blocks any simple algorithm that would allow us to calculate probabilities in these cases. Unfortunately, there is no calculation that we can offer in place of those prior failures. But we can nevertheless say at least some things that

allow us to understand how propensity and probability relate. The following two rules are sustainable, we argue:

a   The more something disposes towards an effect e, the more probable is e, *ceteris paribus*; and the more something overdisposes e, the closer we approach probability Pr(e) =1.
b   There is a nonlinear 'diminishing return' in overdisposing. E.g. if overdisposing e by a magnitude x2 produces a probability Pr(e) =0.98, overdisposing x3 might increase that probability 'only' to Pr(e) =0.99, and overdisposing x4 'only' to Pr(e) =0.995, and so on.

Together, rules A and B tell us that while probability increases with strength of propensity, it must do so in an asymptotic, nonlinear way. And it is rule B that allows unbounded measures of power to produce bounded truths of probability. This can be depicted as in Figure 3.3, where the curve approaches an asymptote. Probabilities are always between zero and one but degree of power can be increased indefinitely, where the probability of some natural event never reaches one. This works, and dispels any danger of paradox, because there are always more numbers and thus, for any probability <1, it is always possible that it be more likely if strength of power is increased.

        The fact that there are always more numbers does not, however, warrant a claim that probabilities are thereby effectively unbounded, where one just needs to use more maths. For some powers, it is possible always to double them. Consider the paperweight example. Someone very concerned that his papers don't blow away might use a paperweight that is far more than is needed for the job: using a brick as the paperweight for instance. Now it will always be possible to double the extent of power, the power in this case being the gravitational force pinning down the papers. Just use two bricks. And one can always double that by using four. But there is no meaningful sense in which one can double a 0.8 probability of something happening. Thus, although there will always be more numbers, this
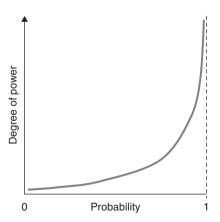
Figure 3.3 A nonlinear covariation of propensity and probability.

does not collapse the distinction between the unbounded scale for propensities and the bounded scale of probabilities. Indeed, our account exploits the fact that there are always more numbers <1.

Let us return to the aircraft safety example to illustrate the plausibility of the theory. Aircraft provide good examples of overdisposing as we actively want their safety mechanisms to overdispose, there are always to be back-ups and 'more than enough' to keep the craft in the air, and yet we also accept that no matter how safe the aircraft is, there is always a slightly less than one chance of the flight being safely concluded. We know that air travel is very safe, but we also know that accidents can happen and indeed have done. We know that twice as much could be spent on an aeroplane to make it overdispose towards safe flying even more, but with rule B – the rule of diminishing return – it will make a safe journey only very slightly more likely. Hence, we are unwilling to pay twice the price of an air ticket in order to get a flight that it only slightly safer than it would be at half the price. The rationality of such an attitude is defensible.

One might complain that prior theories at least offered us simplicity, and a decidable way of calculating exact probabilities from propensities. Introducing the notion of overdisposing has caused a problem for that project. Perhaps it should be said, then, that this is so much the worse for overdisposing. After all, if an additional thesis causes havoc with a theory, shouldn't one reject that addition rather than the theory? In some cases, perhaps yes. But we hope to have shown that there is nothing ad hoc about overdisposing. It is a perfectly natural and regular phenomenon that some powers have a degree that is measured on an unbounded scale and more than enough to produce their effects. So, it seems that while classical probability theory has a virtue of simplicity, it is too simple to model some aspects of reality. We need a notion of propensity in addition to probability, therefore, so we certainly cannot reduce the former to the latter.

5 Chance, probabilistic powers and what must be

It remains to make a number of crucial distinctions, which thereby tidies up the theory of tendencies as propensities. These are the distinctions between chance and probability, regular and probabilistic propensities and between determinism and indeterminism within this account.

First: chance. Mellor (1971: 70–6) draws a useful distinction between chance and propensity, which we are happy to borrow. And given that we think propensities are the grounds of the truths of probability, we can also use this to distinguish probability and chance. A propensity is a disposition or tendency to a non-probabilistic degree that belongs to the bearer and grounds a certain probability towards an outcome. A person's propensity to die can vary along with the changes in her properties during the course of a year; for instance, if she gets a serious disease. At some times, the propensity for death is low, grounding a probability of only 0.0001. Once the disease is contracted, the probability might become as high as 0.3. The chance of death during the whole year is somewhere between 0.0001 and 0.3, even though this person at no point had a propensity of

the intermediate value (Mellor 1971: 73). Thus, propensity and probability are both different from chance. But an even simpler case illustrates the difference bluntly. A coin has a 50% propensity to land heads when tossed. It retains that propensity even if it is not tossed during the passage of an hour. But the chance of it landing heads within one hour does depend on whether it is tossed – and also how many times – during that hour. If it is not tossed at all, it has no chance. If tossed once, it has a 50% chance of landing heads. If tossed twice, it has a 75% chance of landing heads at least once, and so on (Mellor 1971: 72). We still take it that those facts of chance are based ultimately in the propensities of things, which dispose towards certain outcomes or patterns of outcome. But they are at a further distance removed depending on propensities of things, their circumstances, parameters, and so on.

Propensity is an intrinsic matter because a propensity is a property of a particular. But we cannot treat probability as an isolated matter. Powers interact with other powers, and the probability of any real outcome will almost always be a matter involving many powers, which can influence each other's exercise. Popper (1957: 67) was right to think about probability in terms of whole situations ('experimental arrangements') but we side with Mellor (1971: 75) in taking propensities to be intrinsic matters. We can explain the complexities of probability in terms of the result of all the operating propensities taken as a whole. Such a resultant propensity will be a product – often a nonlinear one – of all the component propensities in play. Chance then is an additional matter, dependent on the circumstances that allow those propensities to display, or not, within prescribed confines. The chance that you will die within the next ten minutes is no doubt much lower than the chance that you will die within the next ten years, even if your propensity for death were to remain consistent throughout that whole time.

The second distinction is between (regular) propensities and probabilistic propensities. Our main point has been that just because propensities can come in degrees, this does not mean that they are probabilistic. Their magnitude is non-probabilistically defined. Nevertheless, it is necessary – or at the very least useful – to make a distinction between regular, non-probabilistic propensities and probabilistic ones. But a probabilistic propensity might not mean what it is usually assumed to mean.

Probabilistic propensities are important to distinguish because they have a different kind of manifestation from the tendencies involved in 'regular' powers. Regular powers, as we use the term, involve a tendency towards some manifestation, F, where there can be greater or lesser propensities towards F. The only manifestation of such a power is F; otherwise it fails to manifest. What we call probabilistic powers, in contrast, manifest in a distribution over multiple outcomes. The simplest examples are the power of a coin to land on either heads or tails or a dice to land on any number from one to six. In both cases, we have equally likely outcomes, but with loaded coins or dice not all outcomes need be equiprobable. The propensity in all such cases is towards a distribution over possible outcomes. Hence, a fair coin tends to manifest a 50:50 distribution of heads

and tails over a long-run sequence of trials. The dispositional modality is very apparent here as outcomes other than 50:50 are of course possible.

In ascribing such propensities – certainly usefully – we are indeed appealing to the part–whole relation and proportion that are distinctive of the mathematical theory of probability, in the sense that the outcomes together add up to one. So, while non-probabilistic propensities can overdispose, probabilistic ones cannot because they are tendencies towards a distribution within a whole that is constituted by results of a sequence of trials. This may seem to undermine the theory that the modality of nature is the dispositional modality. It looks as if there is at least the necessity of a disjunction of possible outcomes here. The coin must land heads or tails, it appears, because their joint probabilities =1. But not all is as it seems.

We allow that there certainly can be a 50/50 probabilistic propensity in the coin case, for this is just a tendency towards a distribution. But such a tendency does not necessitate a distribution over the two outcomes that equal 100% of all the outcomes. Reality itself does not have the constraints of the mathematical model. Saying that there are only six possible outcomes from a die throw, for instance, and their probabilities must add up to one, is already an idealisation. This is very clear in Kolmogorov's axiomatisation, which treats probability as part of an abstract, deductive system. When a die is actually thrown, as opposed to an idealised one, it is so within an open system in which there are clearly more than six possible outcomes. The die might break apart, land in a crack, be struck by lightning, balance on one corner against an obstacle or even be caught by someone before it lands. So, the imposition of the constraints of mathematical probability theory onto reality is already an artifice, which is a point rarely acknowledged even in our everyday talk of probability. There is no necessity that one of the six outcomes about which we talk the most has to occur. Thus, there is no necessity of their disjunction. There is always a <1 probability of the real dice landing 1–6. To claim that the probability of a 1–6 outcome =1 would be to say that nothing additional could stop the occurrence of one among those specified outcomes, which is to treat that set of outcomes as if it is a closed system. Mathematised probability theory assumes an artificially shielded set of possibilities, therefore, that add to up to one within a model, for ease of intellectual grasp. This model should not be mistaken for reality. It is a corollary that even with a limit case – a 100% probabilistic propensity towards F – there is no guarantee that F will occur all of the time: only that it will tend to do so.

On the distinction just made, between probabilistic and non-probabilistic propensities, it may seem an embarrassment that radioactive decay, frequently understood as a good example of a probabilistic propensity, comes out on our account as just a regular non-probabilistic one. A particle with this propensity either decays or it doesn't. There is only one manifestation type, which either occurs or not, so this is not a probabilistic propensity by our lights because it doesn't tend towards multiple possible outcomes. However, this is not the problem that it seems. The reason it is tempting to think of radioactive decay as probabilistic is that there is certainly a distinct tendency to decay that varies in strength for different kinds

of particles, where that strength is specified in terms of a half-life (the time at which there is a 50/50 chance of decay having occurred). But note, first, that half-life is itself an unbounded measure. There is no upper limit of the extent of a half-life, and it is thus not obviously best to call radioactive decay probabilistic just because the propensity to decay can come in different strengths. What we are really trying to capture when we call radioactive decay probabilistic is some sense in which decay is indeterministic. Nothing seems to make a particular particle decay at any particular time, if we discard hidden variable theories. But this is not an issue of probability. It is an issue of strength of tendency taken together with a claim of indeterminism. (For more discussion of this example, see Chapter 4).

Hence, we come to the third distinction: deterministic and indeterministic propensities. Saying that powers tend towards their manifestation, and have a degree or strength or propensity towards them, is not saying that powers are indeterministic. What we do reject, however, is a view we call causal determinism. This is the view that causation is the vehicle of determinism in the sense that causes necessitate their effects. In contrast to ours, this account seemingly does offer an a priori theory in which every caused event is deterministic. We also consider previous attempts to explain stochastic or chancy causes to be inadequate, where they say that a chancy power produces its effect only when its probability =1.

What then do we mean by an indeterministic propensity and a deterministic one? It is possible to make the distinction in the following simple way. Indeterministic propensities in exactly the same circumstances need not produce the same outcome, whereas deterministic propensities do. Again, we are not judging on the truth or falsehood of determinism here but merely looking for a statement of it, and we think it crucial that such a statement be independent of the theory of causation itself. With such a statement, it is open for someone to argue whether all propensities are deterministic, all are indeterministic, or some are and some aren't. (For our view on determinism, see Chapter 4.)

We have thus offered three distinctions: between chance and probability, probabilistic propensities and non-probabilistic propensities and between deterministic and indeterministic propensities. These three distinctions are no doubt in part stipulation. They might not reflect exact ordinary usage of the terms. Perhaps there is not any coherent and consistent ordinary usage in any case. The terms are at least semi-technical, so we can be forgiven if our meaning is only loosely anchored to common use. But we do claim that the distinctions we make are theoretically useful because they pick out worldly differences in phenomena, and that is what counts for a distinction to be useful.

6 An overview of the whole

We have said that the dispositional modality is sui generis. It cannot be reduced to necessity or contingency. Nor can it be reduced, as we have now seen, to probability. While probabilities and tendencies both admit degrees, probability theory requires a maximal value because it measures ratios of parts to wholes.

We measure the strength of a tendency in a different way, on an unbounded scale, exemplified by the common phenomenon of overdisposing, where there can be more than enough for the production of a particular outcome.

While the distinction between probabilistic and non-probabilistic powers has been drawn elsewhere (Mumford and Anjum 2011a: 77ff), the possibility of over-disposing has given us a better understanding of how exactly these different types of tendency relate. Non-probabilistic powers can overdispose. Probabilistic powers do not since they are tendencies towards a distribution within a series, and thus bound by the part–whole constraints of probability theory. The propensity account presented here is perfectly compatible with causal singularism and, we claimed, can be an ontological basis for assignments of real and idealised probabilities. Propensities also ground the facts of chance. Each propensity gives the same input to any causal set-up of which it is a part, but the probability of the outcome depends on all the propensities and their interaction.

Our account of probability has a number of novel features. Primarily, we have shown how the notion of tending towards an effect to a degree is not the same as the probability of that effect. This means that propensities are not probabilities but are, instead, apt to be the ontological grounds of the truth of probability. We have also argued that, given the possibility of overdisposing, there is no simple path from propensities to probabilities, permitting, for instance, a calculating algorithm. But we have instead offered two rules of covariance of propensities and powers, where increase in strength of propensity *ceteris paribus* produces an increase in probability, in a nonlinear, asymptotic way, such that no matter how great an increase in tendency, the probability of an effect is always <1. We have thus countered the commonly held view, even among friends of powers, that effects occur only when their probability =1. In a world of what tends to be, we think probability =1 is never the case except in a factive, usually retrospective, sense. Once something has actually happened, we deem its probability =1. But this is trivial and cannot of itself be an argument that the probability of that occurrence was =1 at the moment it started to happen. An independent argument would have to be given for that, which we doubt could be convincing.

4 Causation

Causation and quantum mechanics

With Fredrik Andersen

1 The challenges of quantum mechanics

Quantum mechanics introduces us to an unfamiliar and at times puzzling reality. Experimental results suggest that sub-atomic particles can behave in ways that violate classical laws of physics: in quantum entanglement, wave–particle duality, quantum jumps and superposition, to mention a few. A number of interpretations and theories have been offered as attempts to explain such phenomena. Sometimes those interpretations remain openly perplexing, perhaps suggesting that we have to be content with a theory of the world that is deeply counterintuitive. In the extreme case, it might be admitted that the theory makes no sense but is nevertheless true.

Philosophers are interested in quantum mechanics but perhaps not primarily because of the challenges it poses for the classical laws of physics. On a more fundamental level, quantum mechanics confronts some of our most basic beliefs about the world. If things can move without passing through intermediate places, or affect one another instantaneously over vast distances, then we must seriously reconsider our assumptions about identity, continuity and causation. If we adopt the naturalistic approach to metaphysics, as more recently defended by Ladyman and Ross (2007), and conclude directly from physical theory to metaphysics, then quantum mechanics seems to challenge some core tenets of our basic ontology. Against such scientific naturalism, we maintain that the physical theory comes already equipped with metaphysical assumptions that we have reasons to reject (see also Andersen and Becker Arenhart 2016).

This chapter focuses specifically on the notion of causation. There is a line of argument that quantum mechanics is not a causal theory (for one example, see Feynman 1967: 147, though we offer more below). In contrast, we argue that this is not a purely empirical matter but an ontological and conceptual one. To say what causation is would then be a task for philosophy. Certainly, this does not mean that the philosopher can ignore the debates in physics. If a notion of causation has no real application, our ontology might be better off without it. Some do indeed argue that the concept of causation is too confused or ambiguous to be applicable to exact quantum phenomena (Skyrms 1984: 284, Healey 1992: 193). Here, we will first take a closer look at the original

debate over causation from classical quantum mechanics. This is because, before accepting quantum mechanics as a counterexample to the central role of causation in science, we should be clear about what it is exactly that is at stake. We then move on to present our preferred theory of causation, based on an ontology of dispositions, and show how this remains unchallenged by arguments from classical quantum mechanics. The dispositional modality plays a crucial part in this argument.

2 Responses to the problem of causation in quantum mechanics

We have said that quantum mechanics poses some ontological challenges. Historically, there are two main responses to this. One is the ontological response, which says that we should keep the physics as it is and instead change some of our ontological assumptions, even if these are common sense. To get rid of the notion of causation would be one such ontological revision. The second type of response is to say that we should keep our basic ontological assumptions, including those concerning causation, and instead improve our physical theory. One way to do this is to continue developing the theory until it matches our preferred ontology. This is a theoretical response.

Proponents of quantum mechanics, in this case, Bohr (1937) and Heisenberg (1959), argue that the problem of causation is an ontological one; that is, that the nature of the quantum world shows that causation cannot be universally applied. The theory completely describes the relevant phenomena, but not through the standard application of explanatory tools such as causation, spatiotemporal tracking, identity, position, momentum, and so on. The universal application of these tools is thus a mistaken ideal, on their view. Critics of quantum mechanics typically argue for the reverse (see for instance Einstein 1936, de Broglie 1929, Schrödinger 1933 and Bohm 1957). That causation cannot be applied in quantum mechanics is then treated as only one of many symptoms of the physical theory being incomplete. This means that there are relevant aspects of reality that remain unaccounted for within the existing theory. The problem with this is that it would violate the completeness criterion of Einstein, Podolsky and Rosen, which states that '[e]very element of the physical reality must have a counterpart in the physical theory' (1935: 777). If causation is part of physical reality but not included in the theory, then the theory would be incomplete in this sense.

This second type of response – that the physical theory must be developed – has motivated a number of alternative theoretical approaches to quantum physics (many outlined by Healey 2009). A common aim for these is to preserve a unified ontological foundation for the whole of physics. We will not go into any of these theories here, but only note that at least some of these interpretations are causal: the hidden variable theory (e.g. Bohm 1957) and the permission of backwards causation (e.g. Price 1996, Price and Weslake 2009).

The rejection of causation in quantum mechanics has been accepted by many philosophers. Some might even welcome it, for instance if they think

that causation plays a purely explanatory role but without any ontological grounding (Price and Corry (eds) 2007, Reiss 2015). Physicists, on the other hand, are generally reluctant to make this move. This may be because of the essential role that causation plays in classical physics and relativity theory. So, unless a causal interpretation can be given of quantum mechanics, there is a fundamental discontinuity between the quantum realm and everything else in the world. Such a division is generally regarded as problematic because it violates the thesis of scientific unity, a philosophical idea that goes back to the pre-Socratics and which still guides scientific development. One philosophical strategy to avoid violating scientific unity would be to reject causation universally, which Russell famously did in his 1913 paper, but later withdrew (Russell 1948). This is not our preferred strategy. Our response to the challenge of quantum mechanics is different from both the ontological and the theoretical response. Independently of this divide, there is one thing upon which all the physicists in the classical debate seem to agree, namely what causation is. They all seem to accept the orthodox view of causation, which has largely been influenced by Hume, but also by the mechanistic philosophy of Descartes, and reinforced by some of Hume's opponents. We will argue that this is a systematic mistake in the debate, which ultimately led prominent physicists to deny that there is room for causation in quantum mechanics.

We will show why this discussion cannot be settled by scientists alone, but must be informed by the philosophical understanding of causation, which is a matter of controversy. If it turns out that the debate in classical quantum mechanics is not over causation as such, but instead over one specific understanding of causation, then there might be other understandings that could still allow for a causal interpretation of quantum mechanics. While we are not asserting the truth of any such causal interpretation here, we do propose that an alternative understanding of causation in terms of the realisation of tendencies or real dispositions could be such a candidate. But before we do this, it is vital that we look at the concrete features that motivated many of the prominent physicists to exclude causation from the realm of quantum mechanics.

3   Challenges to causation in quantum mechanics

On Hume's analysis, the causal link is itself not directly observable, but must be derived from something that is itself observable and he famously presented three such observables: constant conjunction, temporal priority and contiguity (Hume 1739: 73ff). These are not the only types of observable features that causation could be thought to have. Others have focused on different features, such as counterfactual dependence (Lewis 1973a, 1973b), energy transference (Fair 1979, Salmon 1984, Dowe 2000, Kistler 2006) or manipulability (Woodward 2003). We will not treat any of these theories here, but instead look at those features of causation that were explicitly discussed and dismissed by physicists in the context of classical quantum mechanics: necessitation, determinism, predictability and separability.

3.1 Non-necessitation

We saw that Heisenberg opted for an ontological response to the challenges of quantum mechanics: to keep the physical theory as it is and instead change one or more of the ontological assumptions. In *Physics and Philosophy*, he argued that quantum mechanics proves that Kant was wrong in assuming causation as a fundamental principle for any metaphysics of science. The a priori law of causality, Heisenberg said, does not fit atomic physics and 'is no longer applied in quantum theory' (Heisenberg 1959: 82). But what exactly is this law that cannot be applied to atomic physics? Heisenberg discusses causation in different places in the book, often with explicit reference to Kant.

> As example we take the law of causality. Kant says that whenever we observe an event we assume that there is a foregoing event from which the other event must follow according to some rule. This is, as Kant states, the basis of all scientific work.
>
> (Heisenberg 1959: 81)

Heisenberg here mentions two assumptions about causation. The first, to which we will return later, is that all events have a cause. The second is causal necessitation: that the effect *must* follow the cause. The latter is a feature that Hume famously denied to be part of causation, though he also denied the first assumption (Hume 1739: 78–9). To him, causation does not include a necessary connection between cause and effect because none such is known in experience. But despite his denial of causal necessitation, Hume's formulation of this principle has remained influential and is often what anti-Humeans want to add to their accounts. But as Hume said of necessity: 'Such a connexion wou'd amount to a demonstration, and wou'd imply the absolute impossibility for the one object not to follow, or to be conceiv'd not to follow upon the other' (Hume 1739: 161–2). We agree with Hume that it does seem to follow that necessitarians are committed to this being true of causation, or at least the first part of it.

Heisenberg could not find any causal necessity in quantum mechanics. We will come back to his reasons for saying this in the next section. What is worth noting now, however, is that he concluded from this that there is no causation to be found in quantum mechanics, *simpliciter*. Another physicist who discussed causation in detail was Bohm, especially in *Causality and Chance in Modern Physics* (Bohm 1957). He took a more radical stance than Heisenberg and argued that not only is there no causal necessity to be found in quantum physics; there is no causal necessity anywhere in nature. We have thus been wrong to assume such necessity, also in classical physics. According to Bohm, any causal law might be interfered with by external factors and must therefore be taken as conditional upon a number of unforeseen events.

> the necessity of a causal law is never absolute. For example, let us consider the law that an object released in mid-air will fall. This in fact is usually what

happens. But if the object is a piece of paper, and if 'by chance' there is a strong breeze blowing, it may rise. ... Hence, we conceive of the necessity of a law of nature as *conditional*, since it applies only to the extent that these contingencies may be neglected.

(Bohm 1957: 2)

Similar concerns have been posed by philosophers (e.g. Peirce 1892: 304ff, Cartwright 1983, and 1999, Dupré 1993, Mumford and Anjum 2011a: ch. 3). But a common response is that if one takes all these contingencies into account, then the cause would necessitate its effect after all (Chapter 2). All one has to do is to include in the cause all the positive and negative factors that might affect the outcome and hold these fixed. The idea is then that the effect will be guaranteed by this total cause (Mill 1843: 332). Now there might not be a finite list of such factors, so instead of listing them all, one could instead say that a cause necessitates its effect under some ideal conditions, or *ceteris paribus*: all else being equal. A worry concerning this move is that it can be used to make any causal claim trivially true. If the effect does not follow the cause, then the conditions simply weren't ideal, which seems an unfalsifiable claim.

The total cause response might work for classical mechanics, which is generally thought to be a deterministic system. At least Bohr (1928: 584) seems to accept that the strict necessities, although they are abstractions, are still justifiable in classical mechanics because quantum effects can be neglected there. In quantum mechanics, however, such a response would not hold, since even a theoretical abstraction could not make an outcome necessitated, neither strictly nor conditionally.

3.2 Non-determinism

That causation involves necessitation is not a new idea, but one that has philosophical roots going back to Aristotle, Spinoza and Kant, among many others. One reason why necessitation is thought to be an essential feature of causation is the central role it plays for determinism. Both in philosophy and physics, there is a frequent assumption that causation is the provider or vehicle of determinism, via causal necessitation. If the cause guarantees its effect, and every event is caused, then from any given state of the universe, there could be only one possible future (Laplace 1814, Popper 1958). In principle, this would mean that everything that happens in the history of the universe was already fixed by its initial state immediately after the Big Bang.

According to Heisenberg, this type of determinism is not part of quantum mechanics, and he took this to mean that there is thus no causation either. In the following quote, we can see how he explicitly identifies causation with determinism:

Even there [in the science of psychology] one tried to apply the concepts of classical physics, primarily that of causality. In the same way life was to

be explained as a physical and chemical process, governed by natural laws, *completely determined by causality.*

<div style="text-align: right">(Heisenberg 1959: 169, our emphasis)</div>

This assumption is not unique to Heisenberg and should not be read as a mere slip of the tongue. As shown by Suárez and San Pedro, it has been an almost universal idea that causation and determinism amounted to the same thing. And, as they say, 'even those who regretted the demise of a causal picture attempted to restore a causal understanding of quantum mechanics precisely by restoring determinism' (Suárez and San Pedro 2011: 173). A failure to save determinism is thus a main reason as to why the theory of quantum mechanics has been understood as non-causal, for instance, by Heisenberg (1959) and von Neumann (1955).

One philosopher who explicitly denied the link between causation and determinism, however, was Anscombe (1971), arguing that causation is consistent with indeterminism. For instance, it allows genuinely probabilistic causation. So, if determinism were to be true, then this would have to be some extra fact over and above the facts of causation. We agree with Anscombe but will return to the reasons why later.

Some philosophers have offered probabilistic theories of causation (Reichenbach 1956, Suppes 1970), but a more common view in philosophy seems to be that probabilistic causation occurs only when the probability of the effect collapses or resolves to one (Armstrong 1983: 132–3, Popper 1990: 13, 20; Mellor 1971: 65–9). Consider, for instance, what Bohm (1957: 21) thought to be a chancy case: a traffic incident. The chance of a pedestrian being hit by a car on an empty road might not be high but the closer the car gets to the pedestrian, the closer the chance of being hit gets to one. In the exact moment that the probability reaches one, causation happens. But if this is how causation actually works, then any apparent stochastic element is effectively reduced to a deterministic one. This shows how strongly determinism is linked to causation, even by those who are inclined to treat them as separate.

We saw how Bohm (1957) rejected necessitation both in quantum mechanics and in classical physics. In the same context, he rejected determinism, and argued that any deterministic assumption is a result of theoretical abstraction and causal isolation:

> Very often we may for practical purposes isolate the process in which we are interested from contingencies with the aid of suitable experimental apparatus and thus verify that such an abstract concept of the necessity of the causal relationship is a correct one. Now, here it may be objected that if one took into account *everything* in the universe, then the category of contingency would disappear, and all that happens would be seen to follow necessarily and inevitably. On the other hand, there is no known causal law that really does this. ... In other words, every real causal relationship, which necessarily operates in a finite context, has been found to be subject to contingencies arising outside the context in question.

<div style="text-align: right">(Bohm 1957: 2–3)</div>

Bohm refers to the strategy, mentioned earlier, of fixing all the factors that might influence the outcome in order to guarantee causal necessitation. But here the strategy is taken a step further to include the whole universe. The idea seems to be that determinism can be secured by making an artificially closed system, thus shielding off all possible contingencies. Bohm argues that this strategy is based on a mistaken mechanistic perspective on the world:

> the inadequacy in the microscopic domain of the mechanistic form of determinism into which causality was restricted by classical physicists helped to provoke a very strong reaction in the opposite direction, and thus helped to encourage modern physicists to go to the opposite extreme of denying causality altogether at the atomic level.
>
> (Bohm 1957: 34)

So, by assuming determinism to be provided by causation, physicists had no other choice than to deny the existence of causation in quantum mechanics since no such determinism can be found there. This means that they must also deny the principle from Kant that we mentioned earlier: that all events must have a cause. Since there is no causation in quantum mechanics, there are events that don't have a cause. An example of such an event could be radioactive decay, which seems to happen without prior causes. We will return to this example in Section 4 when we present an alternative understanding of causation.

3.3 Non-predictability

In classical physics, determinism is a central notion and philosophers have gone to great lengths to defend causal necessitation and determinism at least here. The main reason why determinism is regarded as so important, besides its supposed link to causation, is that it provides an ontological basis for our predictions. So even though perfect predictions remain a practical challenge, because we cannot take into account everything in the universe, determinism would make reliable predictions possible at least in principle. Laplace explains this idea by imagining a creature, or a super-scientist, that has enough brainpower and knows all the initial conditions and laws.

> Given for one instant an intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it – an intelligence sufficiently vast to submit these data to analysis – it would embrace in the same formula the movements of the greatest bodies of the universe and those of the lightest atom; for it, nothing would be uncertain and the future, as the past, would be present to its eyes.
>
> (Laplace 1814: 4)

This creature, commonly referred to as Laplace's demon, would be able to predict with perfect accuracy any future event. But it could do so only under the

assumption of determinism, which cannot plausibly be defended for quantum mechanics. Without determinism and causal necessitation, there is no guarantee that the same event would follow from two identical sets of initial conditions or states. Perfect predictions are thus not possible, even in principle, in quantum mechanics, and Bohr took this to mean that there could thus be no causation either. The reason was that he thought causation was somehow dependent on predictability:

> In physics, causal description, originally adapted to the problems of mechanics, rests on the assumption that the knowledge of the state of a material system at a given time permits the prediction of its state at any subsequent time.
> (Bohr 1948: 141)

In classical physics, our predictions can be improved by performing more experiments. But this is not the case in quantum mechanics because of the extreme sensitivity of the system in quantum physical experimentation, where even the instruments used can interfere with the result. Again, Bohr says:

> It must not be forgotten, however, that in the classical theories any succeeding observation permits a prediction of future events with ever increasing accuracy, because it improves our knowledge of the initial state of the system. According to the quantum theory, just the impossibility of neglecting the interaction with the agency of measurement means that every observation introduces a new uncontrollable element.
>
> (Bohr 1928: 584)

Predictions are not entirely impossible in quantum mechanics, but they must be spelled out in terms of probabilities. According to Bohr, this is because 'the specification of the state of a physical system evidently cannot determine the choice between two different individual processes of transition to other states' (Bohr 1948: 142). Heisenberg raised similar concerns to Bohr when dealing with the apparent spontaneity in radioactive decay for an atomic particle:

> the law of causality is reduced to the method of scientific research; it is the condition which makes science possible. Since we actually apply this method, the law of causality is 'a priori' and is not derived from experience. Is this true in atomic physics? Let us consider a radium atom, which can emit an a-particle. The time for the emission of the a-particle cannot be predicted. We can only say that in the average the emission will take place in about two thousand years.
>
> (Heisenberg 1959: 81–2)

We here seem justified in concluding that one of the reasons physicists had for rejecting a causal interpretation of quantum mechanics is that predictions in the quantum realm cannot be more precise than probabilistic ones.

3.4 Non-separability

The fourth disputed issue is not whether quantum mechanics deals with genuinely non-necessitated, non-determined and non-predictable phenomena. Rather, the question is what this implies for the understanding of causation. Given the classical notion of causation, these are alone very good reasons to exclude causation from the quantum realm. In the next section, we argue that this move is not justified given any notion of causation. But Bohr also discusses a fourth problem for causation, related to the separability of cause and effect. This alleged feature of causation comes directly from Hume's analysis, unlike necessity, determinism and predictability, although these have become parts of the standard notion (what Norton 2007 and Kutach 2007 call the 'folk theory of causation'). On his theory, causation is a relation between two events or objects. But this requires that the two relata can be clearly separated. For Hume, the cause and effect were what he called distinct existences. It had to be possible, in principle at least, for one to exist without the other. This was an essential aspect of his theory, as it ruled out, for instance, that logical relations could qualify as causal ones. After all, if A logically entails B, there will be a regularity of As followed by Bs, but we do not think of it as a causal regularity. Hume thought that we gain the notion of causation where, although A and B could exist apart, as a matter of fact, A is always followed by B. This is what gives us an expectation of B whenever A. Thus, causation for Hume has to be a relation between distinct existences, where logically connected existences do not count as distinct.

   If the cause and effect are to be distinct existences, however, they must also have some form of individuality, which Bohr (1937) says cannot be found in quantum mechanics.

> The renunciation of the ideal of causality in atomic physics which has been forced upon us is founded logically only on our not being any longer in a position to speak of the autonomous behaviour of a physical object, due to the unavoidable interaction between the object and the measuring instruments which in principle cannot be taken into account, if these instruments according to their purpose shall allow the unambiguous use of the concepts necessary for the description of experience.
>
> (Bohr 1937: 87)

The general problem that he refers to is this. In the quantum mechanical set-up one cannot talk about an atomic system in isolation. Instead, the system also includes the whole experimental context, including the measuring apparatus. However, this makes the experimental context a part of the definition of the target system, which means that a strict separation between the experimental set-up and the target system cannot be drawn. In a quantum mechanical experiment, it is therefore impossible to determine what exactly it is that caused the effect, since this is produced partly by the measuring itself.

Since full separability is impossible in quantum mechanics, Bohr concluded that we must also reject universal causation. He repeated this point several times over a 20-year period and with slightly different formulations (see for instance Bohr 1928: 580, 1935: 75, 1938: 95–6, 1948: 141–2), so it was clear that he saw non-separability as a crucial argument against causation.

3.5 *A change of framework: from Newtonian to Aristotelian*

For Bohr (1948: 142–3) a description of physical objects must be given within the classical conceptual framework of Newtonian physics. This would include a Cartesian metaphysics and all the usual mechanistic concepts. Within this framework objects are understood in the classical sense, having a clear individuality. That a classical object has such individuality may be taken to imply that we can give distinct values for its momentum, mass, position, velocity, shape, spin, angular momentum, and so on. In quantum mechanics, on the other hand, objects do not carry such values for all elements of a description at an instant. Either we can measure the position, or we can measure the momentum, but we cannot measure both. If we ascribe momentum to an atomic system, this excludes the possibility of ascribing a position to it, and vice versa.

According to Bohr's complementarity thesis, position/momentum is an example of a conjugate pair of variables. These are variables that complement each other. There are many such pairs and the central one for our discussion is the spacetime/causation pair. An atomic system has clear values for only one of these variables at a time. We cannot, therefore, talk of a universal application of spatiotemporal location and causal interaction. We can only talk of partial or complementary descriptions of the system. We can interact with the quantum object either in such a way that the object gets a clear spatiotemporal position, or in such a way that it has clear causal interactions. We cannot do both simultaneously. The Newtonian ideal of a full-blown causal *and* spatiotemporal description of a single object is therefore no longer tenable and should no longer be treated as an explanatory ideal.

In contrast to Bohr, Heisenberg (1959) suggested that a way to understand the nature of a quantum object in isolation is to understand it as energy, where energy is a substance. This substance in isolation is best understood as pure potentiality. Heisenberg thus proposed to move away from the classical Newtonian concepts and instead adopt an Aristotelian framework with unformed energy, which seems similar to Aristotle's *materia prima*.

> All the elementary particles are made of the same substance, which we may call energy or universal matter; they are just different forms in which matter can appear. If we compare this situation with the Aristotelian concepts of matter and form, we can say that the matter of Aristotle, which is mere 'potentia', should be compared to our concept of energy, which gets into 'actuality' by means of the form, when the elementary particle is created.
>
> (Heisenberg 1959: 139)

Potentialities, or potencies, would according to Heisenberg give a better description of the quantum phenomena. Rather than having a specific nature that is independent from the experimental context, what exists before the experiment is a potential that is actualised through the experimentation. The experiment thus creates a novel phenomenon. This means that one cannot infer from the outcome of the experiment what was there before the experiment, which one could have done had the experiment involved classical objects. Instead, one can say something of the potencies that were there. This also gives us a different understanding of the seemingly dual nature of quantum objects.

> A clear distinction between matter and force can no longer be made in this part of physics, since each elementary particle not only is producing some forces and is acted upon by forces, but it is at the same time representing a certain field of force. The quantum-theoretical dualism of waves and particles makes the same entity appear both as matter and as force.
>
> (Heisenberg 1959: 139–40)

Heisenberg's suggestion to replace the Newtonian framework with an Aristotelian one, clears the way for an alternative understanding of causation in quantum mechanics that is neo-Aristotelian in essence. We will now offer an alternative, dispositional model of causation that accords with the Aristotelian notion of potentiality. The aim is to show that this model differs substantially from the notion of causation that has been rejected in classical quantum mechanics. What this means is that there might still be some room left for a notion of causation in quantum mechanics, if this does not include the problematic features discussed above.

4 An alternative notion of causation

In the previous section we saw that quantum mechanics leaves us with some phenomena that cannot be fitted neatly into the classical Newtonian worldview. While the systems of classical physics are deterministic and predictable with universal laws, quantum mechanics involves genuinely chancy events that are not predictable even in principle. A further complication is added by the fact that there is no way to treat atomic objects as classical objects. To pick out the cause and the effect as two spatiotemporally separated entities is therefore not possible. What we are left with, then, is a part of reality that behaves in a very different way from the rest. But does it also lack causation? Once we have taken out strict laws, determinism, predictability and separability, we seem to have lost everything that characterises causation, as it was assumed to be by Bohr, Heisenberg and others. As a result, they rejected the presence of causation in quantum mechanics. But is this rejection justified? That quantum mechanics lacks certain features is a problem for causation only if these features really are essential parts of causation. And one might ask what could possibly be left of causation without them.

We now move on to argue that there is still ample room left for a notion of causation, even with the restrictions discussed above. We will show that there is at least one plausible theory of causation that includes none of the features that those physicists thought of as problematic for a causal understanding of quantum mechanics. But this does not mean that we are left with a causal notion that has no application outside quantum mechanics. Importantly, the same theory we outline allows us to account for classical causal phenomena just as well as more messy and indeterministic ones. A further strength of this theory is that it can include and explain features that are often treated as problematic by other theories, including causal complexity, context-sensitivity, nonlinear interaction and the possibility of prevention and interference. The move we recommend has a degree of novelty. It is not among the options directly considered by Healey (2009), for instance.

We will now offer a brief outline of the most relevant features of this theory, which we refer to as causal dispositionalism. The aim is not to argue for the truth or details of the theory, but to show that it is possible to have a useful notion of causation without the features of necessity, determinism, predictability and separability, which is thus apt for an understanding of causation in quantum mechanics.

4.1 A neo-Aristotelian framework

Aristotle thought that there were real potencies in the world and that these can be actualised under certain conditions (see *Metaphysics* Θ in Makin 2006, and *Physics* II). For every new actualisation, however, new potencies emerge. We agree with Heisenberg that the Aristotelian terminology of potencies is better suited for describing quantum phenomena than the Cartesian mechanistic language. But we take the Aristotelian framework to have a more universal application than quantum mechanics. In the last decades a neo-Aristotelian ontology of dispositions, or causal powers, has been developed by a number of philosophers (see for instance Harré and Madden 1975, Cartwright 1989, Mumford 1998, Molnar 2003, Martin 2008 and Marmodoro 2017). One motivation for taking dispositions as fundamental parts of reality is that they are thought to provide an ontological basis for causation, laws, natural kinds or even modality. Causal dispositionalism, as developed by Mumford and Anjum (2011a) is a recent attempt to provide a comprehensive theory of causation based on an ontology of dispositions.

Causal dispositionalism is a neo-Aristotelian theory in a very concrete sense. Every time a potency gets actualised, causation happens. In other words, causation is the manifestation of dispositions. The ontology of dispositions offers a different perspective on reality than the classical Newtonian or Cartesian one. Instead of explaining physical events in terms of governing laws that determine their behaviour, a dispositionalist looks to the thing's properties (Mumford 2004). The idea is that objects behave the way they do, not because of some external laws that push them around, but because of their own intrinsic dispositions and

their interactions. Dispositions can be ascribed to particular objects, but also to events, fields or processes.

Take for instance an autumn leaf falling from a tree. Within an idealised context, the leaf will fall straight to the ground in accordance with classical gravitation. But in a natural context, this fall will be influenced by a number of things: the weight and shape of the leaf itself, the direction and intensity of the wind and rain, the heat from the ground, the draft from an industry fan, and so on. The gravitational attraction on the leaf is thus only one of the causally relevant factors for its behaviour. The actual movement of the leaf is impossible to predict from the laws of physics, as has been duly noted by Cartwright (1999: 27). But if we understand the situation in terms of dispositions, instead of external and strict laws, we can still make perfect sense of the fall as caused. Causation should not be thought of as a perfect fall that is interfered with by the wind, the fan or the rain. All these aspects of the causal situation contribute to the outcome with their own causal powers.

Rather than deriving causation in concrete cases from exceptionless laws of closed systems and idealised conditions, causal dispositionalism motivates us to look at how things are naturally disposed to behave in virtue of their own properties. This behaviour will typically be a complex matter including a number of factors, some of which will interact in nonlinear ways. In any open system, the potential interactions that can affect the outcome will be infinitely many.

We will not offer a full argument for this dispositional theory of causation here and we concede that it is far from universally accepted. The reality of causal powers is rejected by Humeanism in particular. What we can do, however, is show how this neo-Aristotelian conceptualisation gives us an understanding of causation very different from the classical notion that we got from Descartes, Newton and Hume. Furthermore, because it does not contain the features that were problematic for quantum mechanics, it is quite possible for it to be applied there.

4.2 Non-necessitation

We saw that Heisenberg and Bohr rejected causation partly because they could not find any necessitation in quantum mechanics. On the classical notion, this would be a good reason to reject causation, since causal production is there collapsed into causal necessitation. A cause then produces its effect by necessitating it. On causal dispositionalism, however, there is no such necessitation. Instead, there are irreducible tendencies. A cause is, in this view, something that disposes or tends towards its effect. Often the cause will produce its effect, but there is no guarantee that it will do so. And even when the effect was produced, it was not through necessity.

It is easy to see that the external principle of tendency (from Chapter 1) can be applied in physics. An effect can be interfered with in two ways: either by subtracting or adding further dispositions. Subtractive interference is to remove something from the causal set-up that tends towards the effect. One might remove friction from a fall by creating a vacuum, for instance. Additive interference

means that one adds something to the causal situation that tends away from the effect. One might add friction to interfere with a fall by introducing air, wind or water. This latter form of interference shows that causes don't necessitate their effects. Something could always have been added that prevented the effect from occurring. A cause is then never in itself sufficient for its effect, even when it succeeds in producing it. This is why we adopt the dispositional modality view specifically, rather than conditional necessity, for instance.

The possibility of causal prevention is a problem for the classical understanding of causation, and we have already mentioned some of the strategies to avoid any interference: adding *ceteris paribus* clauses or ideal conditions to the causal claim. On causal dispositionalism, however, the possibility of causal interference is not something that we need to treat as problematic. Instead, it is an essential feature of causation that it can be counteracted in this way. The possibility of interference is thus a symptom of the irreducibly tendential nature of causation, and thus a more reliable symptom of causation than necessitation. Indeed, our account of causation does not require even that constant conjunction accompanies causation, let alone constant conjunctions that are also necessary.

4.3 Non-determinism

A second reason for rejecting causation in quantum mechanics was the indeterministic behaviour of quantum objects. Instead of strict laws, there seem to be some irreducibly probabilistic phenomena. Since causation is often linked to determinism, this behaviour was taken to challenge a causal interpretation of quantum mechanics. We saw that even those who allow some probabilistic causation in their ontology, usually end up analysing it into a non-stochastic matter, where causation happens once the effect reaches probability =1.

Causal dispositionalism is an alternative to both classical determinism and classical indeterminism. A tendency is less than necessity, so the effect is not guaranteed by its cause. This gives us less than causal determinism. But it is also offers more than a pure indeterminism, if by that we were to mean that the effect is entirely random, chancy or spontaneous. On causal dispositionalism, an outcome can be caused even if it is probabilistic because it allows genuinely probabilistic causation in addition to the more common non-probabilistic instances. In both cases, causation is grounded in dispositions, but in different types of dispositions. Probabilistic causation happens when a probabilistic disposition manifests itself (see Chapter 3). A typical example of a probabilistic disposition is the 50:50 propensity of a fair coin to land heads or tails if tossed, while a non-probabilistic disposition could be the propensity of a vase to break if dropped onto a hard surface.

It's a philosophical controversy whether set-ups involving coin tosses, roulette tables or decks of cards should count as genuinely probabilistic or deterministic cases. For a determinist, these cases will only appear to be probabilistic, but the initial conditions plus laws will still determine the outcome. Regardless of this debate, quantum mechanics presents us with phenomena that seem irreducibly chancy in nature. Radioactive decay is one such example that has been widely

discussed in philosophy. In quantum mechanics, this is usually offered as an event that is stochastic, in the sense random, but that can be given a probabilistic prediction of half-life. On causal dispositionalism, radioactive decay would be the effect of a propensity or disposition manifesting itself. It would have to count as causation because it is the manifestation of the atom's propensity to decay. We will return to this example shortly. But what is important to notice in this context is that on causal dispositionalism, determinism is not provided by causation. Instead, the claim of determinism would have to be an extra claim that must be justified separately from the presence of causation. A worry about stating a non-causal determinism, however, is that it could in principle be applied to any system. Even a Humean world of pure contingency could thus be a deterministic one in this sense, for instance, if all the contingencies were fixed or pre-determined. Popper (1958: 6–8) refers to this as metaphysical determinism, and it is not the type of determinism about which philosophers and scientists usually worry. It is also not what is at stake in quantum mechanics.

We have seen, then, that on causal dispositionalism there is no determinism that comes for free with causation. A dispositionalist can be a determinist or an indeterminist, depending on considerations other than causation. Such independence from determinism and indeterminism should be taken as a marker of the credibility of a theory of causation rather than a weakness. We will now look further at the type of indeterminism that quantum mechanics involves.

4.4 Non-predictability

The indeterminism of quantum physics leaves us with a more practical concern about causation. If the effect is not determined by its cause, we seem to have no ontological basis for our causal predictions either. We will now look at some different ways in which we might lack predictability in quantum mechanics. For this purpose, we will take the case of radioactive decay, which seems to be unpredictable because of its indeterministic behaviour. According to quantum mechanics, such decay is stochastic, random and spontaneous. All these features are commonly linked to indeterminism, but they seem to relate to causation in slightly different ways. It will therefore be useful to treat them separately. This is important for our purpose, which is to show that there could still be some place for a notion of causation in quantum mechanics even if it includes indeterministic features.

We begin with the *stochastic* element. One way to understand an event as stochastic is that there is some genuinely probabilistic element involved. In other words, the event is chancy. This is an ontological interpretation of probability, which contrasts with the purely epistemic notion of credence. We have already seen how dispositionalism is able to allow chanciness as a case of genuinely probabilistic propensity (Chapter 3) and therefore also as a matter of causation. We therefore move on to the next indeterministic element: randomness.

That an event is *random* could mean that it is unpredictable on the individual level, while still displaying a clear tendency over a sequence of trials.

Bohm (1957: 21) illustrates this phenomenon with the example of a traffic accident where two cars collide. On the individual level, he argues, this outcome was not predictable, since there could be infinitely many contingencies that could causally affect the outcome. If one of the drivers had received a text message before starting the car, or stopped to buy a newspaper on the way, then the cars might not have collided. But despite the randomness on the level of the individual, on the statistical level we often find clear tendencies. For instance, there might be a high statistical tendency towards traffic accidents at a particular crossroads, among a specific age group or linked to certain types of behaviour. On causal dispositionalism, such tendencies could be emergent, higher-level dispositions of traffic systems and their users. This means that there could be dispositions on the individual level that increase one's propensity to be involved in a traffic accident: lack of observation skills, alcohol consumption, speeding, and so on. But there could also be some dispositions that belong to the infrastructure itself, and that makes it more likely that risky behaviour results in an accident. An individual event could therefore still be caused, even if it is random to some degree and not predictable.

The third feature of *spontaneity* might represent a greater challenge for causation. On the classical notion of causation, there is a set of (ideal) background conditions, a stimulus (efficient cause) and a response (effect). Typically, causation will then happen when the effect is triggered by the right stimulus and under the right conditions. When no such trigger is found, we call the effect spontaneous. Since the trigger is thought of as the cause, the most obvious conclusion is that the event was uncaused. On causal dispositionalism, however, this does not follow. There could be dispositions that manifest spontaneously. Something that is very explosive might, for instance, explode without any extra stimulus, and a poisonous gas won't need any trigger to poison those who go near it. To prevent such dispositions from manifesting, one will often add something to contain or counteract them. But for a dispositionalist, causation happens once the disposition manifests itself, whether or not it was triggered.

So, while the indeterministic nature of quantum phenomena threatens predictability, it does not necessarily threaten the presence of causation. On the contrary, the fact that effects cannot be predicted with certainty is something that a dispositionalist sees as an essential feature of causation, not as a problem. A feature of causation that makes our predictions fallible is that causal processes are extremely sensitive to a change in context. Any difference in the causal setup might also change the outcome. And even a tiny change in the cause might result in a vast change in the effect because dispositions often interact in nonlinear ways. All causal truths are also vulnerable to the so-called problem of induction, as famously pointed out by Hume. In our context, this is because we will never know if we have taken into account all relevant factors, unless we make our prediction within an artificially closed and deterministic model.

Instead of attempting to save predictability by stipulating closed systems and strict laws, which is not possible in quantum mechanics anyway, we should take it as a symptom of causation that our causal predictions are fallible and vulnerable

to the problem of induction (Chapter 8). Still, this doesn't mean that we cannot predict anything. We can predict how something will tend to behave given the factors that are taken into account. A good prediction will therefore tend to be right. And, if there is a stochastic disposition involved, the prediction will be irreducibly probabilistic.

4.5 Non-separability

We saw that Bohr had an extra worry about causation in quantum mechanics, concerning the separability of quantum objects from the experimental set-up. In the classical model of causation, the cause and effect have to be clearly separated, both in time and space. Hume's perfect instance of causation was two billiard balls colliding, which has inspired the neuron diagram as the preferred model for causal representation (e.g. Lewis 1973a). This model is perfect for the classical understanding of causation, according to which causation is a relation between two distinct objects or events. But it does not help us much in quantum mechanics, where the typical autonomous behaviour of physical objects is not found. Instead, there are contextual interferers even on the level of the instruments used in the experiments.

In contrast to the classical model, a causal dispositionalist should think of causation not as a relation between two separate events or objects, but as a continuous, unified process that typically takes time to unfold (Anjum and Mumford 2018). A causal process will begin once a disposition meets its appropriate partner(s) and starts interacting. During this process some properties will be lost, and new properties and new interactions might be introduced. Imagine for instance salt dissolving in hot water. This is surely a typical example of causation. On the classical understanding, placing the salt in the water counts as the cause, and the dissolved salt is the effect. But on a dispositional account, we will represent the situation differently. Causation starts once the salt gets in contact with the hot water. The salt has the dispositions of being soluble and salty and the hot water is an appropriate solvent. They are what Martin (2008: 48) calls mutual manifestation partners, meaning that they can produce an outcome together that neither of them could have produced alone. In this case, that outcome is a saline solution, which we think of as the effect.

But the saline solution is only the end product of the causal process. The causal interaction between the salt and water is a continuous process in which the cause and the effect seem to happen simultaneously (Mumford and Anjum 2011a: ch. 5). The causal process is thus gradual, starting with the two dispositions in separation, but eventually fusing into something with different dispositions – the salty liquid. Other examples can be used. Firewood is flammable but the process leading up to it burning requires a number of manifestation partners: a suitable fireplace, a proper ignition, enough oxygen, and so on. Once all these dispositions meet, causation happens. The firewood might then burn until it has run its course, or it might be interrupted, for instance if a damp log is added, or the ventilation is closed, preventing sufficient access to oxygen. In the classical

view, we might think of the firewood as the cause, the ignition as the stimulus and the oxygen and the stove as background conditions. In contrast, a dispositionalist will treat them all as more or less equal partners and causes merging into and becoming the effect.

Another point is worth noting in this connection. Within the dispositionalist theory, change and flux is the default and any stability is a result of counteracting dispositions producing a state of equilibrium. Sometimes dispositions or powers cancel each other out, and the result is that nothing happens. Think of the thermostat in a refrigerator that is set to four degrees. Whenever we open the door and warm air comes in, the temperature rises. To counteract this, the fridge will start cooling down, thus keeping the temperature stable. Similar systems of equilibrium are found in any object or system that is kept relatively stable. On the surface, nothing seems to happen, and we might think that there is no causation going on. But on the micro-level we often see the complexity of powers involved to keep it in a stable condition. The stability is thus the effect of multiple causal powers balancing each other out, which means that it is as good an example of causation as one involving change (Mumford and Anjum 2011a: 37). From this perspective we see that, rather than thinking of cause and effect as spatiotemporally distinct, causation often happens within one particular object, system or process, and simultaneously. A system is kept stable only as long as the counteracting dispositions are doing their causal work. What we pick out as the cause and the effect might just be different stages of a continuous causal process.

On dispositionalism, no strongly ontological distinction is drawn between properties belonging to the object undergoing change and the contextual properties in this process. They are all causes of the outcome. So, whenever we pick out something as a cause in isolation from its context, this will usually be a result of an abstraction and not a description of what actually happens in real causal processes. The genuine interaction of multiple factors should therefore be seen as a symptom of causation rather than as something that needs to be analysed away by theoretical abstraction.

5 The way forward

Heisenberg suggested that we adopt an Aristotelian framework in order to describe what happens on the quantum level. We have here offered one such framework involving an ontology of dispositions. This ontology does not require necessitation, determinism, infallible predictions or strict separability, which we saw were the main concerns about including causation in the quantum realm. There are of course challenges to other basic ontological categories that come from quantum physics, such as to notions of continuity and identity (see French and Krause 2006). Without these, we will struggle to understand dispositions and causation, but we will also struggle to understand fundamental ontological notions including substance, process, change or even time. In this chapter we have restricted our discussion only to the notion of causation and what were believed – mistakenly so, we have argued – to be its essential features. In place of those alleged

essential features we have offered an alternative characterisation of causation. In this view, causation (i) involves irreducible tendencies, not necessity, (ii) is independent from, not the driver of, determinism, (iii) supports predictions of what tends to happen, not what will happen with certainty, and finally, (iv) causation is a continuous, unified process, not a relation between two distinct events.

What we have tried to show is that there is a defensible notion of causation that could in principle be applicable in quantum mechanics. Significantly, this is a causal notion that could be applied generally, to any scientific realm. We need not treat causation in quantum mechanics as a special case, therefore. At the very least, we hope to have shown that there should be no rush to judgement on whether there is causation in quantum physics, because that depends on what we take causation to be.

Part III
Logic

5 Conditionals

Carnap and the Anglo-Austrian conspiracy against dispositions

1 Introduction: the spirits of Carnap and Hume

During the mid-twentieth century, dispositions were treated as philosophical objects of suspicion. Attempts were made to reduce or eliminate them away, with the first serious effort of the modern age coming in the form of Carnap's (1936) reduction sentences. The spirit of Carnap lives on in the conditional analysis of dispositions, which retains adherents.

Carnap saw the importance of the dispositional idiom to science but also that there was something problematic about the modal connection between distinct existences that real dispositional properties would bring. Such a modal connection was unobservable and thus no legitimate part of empirical science. While Carnapian motivations could easily be mistaken as scientific and logical, however, we argue that the true source of this anti-dispositional philosophy has a deeply metaphysical motive that the defenders of dispositions can tackle on purely metaphysical grounds.

We contend that there is a metaphysical bias towards Humeanism within extensional logic. This logic is perfectly suited for a metaphysics of discrete, distinct existences of the kind developed by Hume (1739, 1748), which is where the true roots of this approach to dispositions lie. All is loose and separate; there are no necessary connections in nature. No powers. And the philosophy of science that goes with this view of the world is one based on observation of events where scientific statements have only a truth-value but no modal value. Anti-Humeanism such as ours, in contrast, commits to connectedness through a real this-worldly dispositional modality. This should be the principal ontological commitment of any dispositionalism, we believe. Understood in this way, disposition ascriptions could never be properly captured within an extensional logic, therefore, and any conditional analysis of dispositions is doomed either to falsehood or circularity.

2 Metaphysics and logic

Many who use the apparatus of classical logic, and other logics that build upon it, may do so in the belief that it is an innocent tool: one that carries no

metaphysical theory with it, for instance. Indeed, because this tool is considered entirely neutral, the use of a logical analysis might be brought to bear upon different metaphysical theories and systems as a reliable and authoritative way of adjudicating between them. Logic is a codification of reason, one might say, and as metaphysics has to be reasoned through, then all theories must be answerable to logic. Without our reasoning, how else can we choose the best metaphysics?

Within contemporary metaphysics, for example, there is an on-going debate between the neo-Humean metaphysics of discrete, distinct existences, where at best events might be conjoined but never connected, and the neo-Aristotelian metaphysics of real causal powers in which there are real-worldly connections between powers and their effects. Representative of the neo-Humean view is Lewis (1986a), whose metaphysics of causation (Lewis 1973a) depends upon conjunctions of events where in the closest possible world in which the first event did not occur, the second did not either (cf. Hume 1748: §VIII, 56). More recently, an anti-Humean rival has been developed, accepting the reality of dispositions or powers, for instance Mellor (1974), Harré and Madden (1975), Cartwright (1989), Mumford (1998), Molnar (2003), Martin (2008) and Groff (2013) (see also Marmodoro (ed.) 2010, Groff and Greco (eds) 2013 and Jacobs (ed.) 2017). In terms of simple numbers of adherents among contemporary metaphysicians, it would seem as if the neo-Humeans currently have the upper hand (see Collins, Hall and Paul 2004), though few are as ready as Lewis himself to endorse the plurality of concrete other worlds in the position known as modal realism.

However, we do not accept that this battle between rival ontologies is always a fair fight. In particular, the classical logical framework, in which virtually every analytic philosopher is schooled, is one inherently suited to the Humean metaphysic. One might then speculate that in adopting such a logic, its users should indeed find neo-Humeanism more intuitive, despite containing many of what Hume himself, writing before the establishment of classical logic, thought of as counterintuitive aspects (1739: Bk I, Pt IV, §vii). A less speculative finding, if it is established that logic contains Humean commitments, is that it clearly cannot be used as a neutral and fair tool in deciding between neo-Humeanism and neo-Aristotelianism. There are things that those who believe in real causal powers or dispositions simply cannot express within a classical framework, nor indeed in any logic that builds on a classical foundation, such as various systems of modal logic. Simply to modally strengthen classical logic will not do. There are some major assumptions at the very core of all classically based systems that, if one believes in neo-Aristotelian causal powers, one should never accept.

Our aim, therefore, is to expose the metaphysical assumptions – neo-Humean assumptions – within the classical framework. This will require some historical work as we uncover the root commitments of the view. This work would count as confirmation of a further well-known Aristotelian claim: that metaphysics is First Philosophy, prior even to logic. And from that it would follow that one should first choose one's metaphysics and then choose one's logic, rather than the other way around.

3 Carnap, dispositions and science

Carnap is the pivotal figure in this debate due to his recognition of the importance of disposition terms but also his commitment to the extensional apparatus of classical logic. It is in Carnap that we find the clash between dispositions and logic, resulting – we would say inevitably – in a failed attempt to define the former in terms of the latter using the material conditional. Attempts at a conditional analysis of dispositions still appear from time to time (Gundersen 2002, Choi 2008).

Carnap realised that science is filled with dispositional vocabulary but also that the standard logical tools could not accommodate a modal connection between distinct existences. Such a modal connection was unobservable and thus not a part of empirical science (see Carnap 1936 and 1956), with Carnap's verificationism being asserted. This unobservability claim for dispositions, we have argued, is contestable (Mumford and Anjum 2011a: ch. 9). The modal force of dispositions is arguably observable once we understand correctly our own roles as causal agents and patients, proprioceptively aware of the world. But the modal connection is not observable if one follows Hume's account of causation and volitional agency.

This is where we venture a historical hypothesis, though clearly one we cannot prove with any certainty. Carnap was taught by Frege at Jena, and Frege, we know from the engaged discussion in the *Grundlagen* (Frege 1884), read J. S. Mill's (1843) *A System of Logic*. Mill in turn was developing the empiricist programme of Hume (before that, Locke) and although Frege is critical of Mill in relation to the foundations of arithmetic, his own logic of *Begriffsschrift* (Frege 1879) is perfect for a general Humean outlook in which all is loose and separate. We thus have a hypothesis concerning key influences on Carnap. But we can also think of the lineage going forward in time from Carnap. Carnap's ideas spread, following his move to the United States, through his interactions with Quine (who had completed his PhD with the co-author of *Principia Mathematica*, A. N. Whitehead), and then from Quine to his sometime pupil Lewis. If all this is plausible, we have a line of influence connecting Hume to Lewis that moves crucially through Carnap. And Lewis, we ought to note, was willing to engage precisely in Carnap's project of reducing disposition ascriptions away, with his revised conditional analysis (Lewis 1997).

The true source of this anti-dispositional philosophy – anti-dispositional insofar as the dispositional idiom ought to be reduced away – is really a deeply metaphysical motivation prior to the logic. Resistance to the modality of dispositions arises from a commitment to extensionalism: an entirely philosophical commitment, though one shared by prominent logical positivists. Extensional logic was adopted by logical positivists without acknowledgement of its metaphysical basis, and why should such a basis be considered by them, in any case, given that they reject metaphysics on the same grounds Hume does at the end of the *Enquiry* (Hume 1748: §12, 120)? Despite superficial appearances, Lewis's project is certainly within this tradition. There are no intra-world modalities for Lewis, but a

theory of modality is gained through the plurality of worlds and the inter-world similarity relation. Our version of Anti-Humeanism, in contrast, commits to connectedness through a real, this-worldly dispositional modality.

4 A backwards history of logic

We have made some broad-ranging claims already, the significance of which hardly needs emphasising. More detail should now be added if we are to have a persuasive case. We should start by explaining the commitments of the standard logic and then how dispositions have to be treated once such commitments are adopted. We will do this through a roughly backwards history of logic. This reverse-historical approach assists us in understanding the conceptual ordering of the key claims of classical logic.

First, what do we mean by extensionalism? Extensionalism would be the view that the language of an extensional logic is adequate to provide us with a 'canonical notation' sufficient for all the purposes of scientific discourse (the term 'canonical notation' is from Quine 1960: ch. 5 – a book dedicated to Rudolf Carnap). So, what is extensional logic? To quote Ayer (1972: 44): 'An extensional system of logic can be characterised by the essential feature that replacement within it of one proposition by another which has the same truth-value always leaves the truth-value of the proposition in which replacement occurs unchanged'.

This is exactly the logic a Humean would want. If we restrict our considerations for the moment to classical propositional logic, then any proposition is capable only of truth or falsehood and nothing more. A proposition cannot have a modal value in addition, for instance. The business of science can then be exactly as Hume sees it in the *Treatise*. Our experience of the world tells us only what there is: not that something true is also necessary. And it is thus wholly appropriate within such a Humean framework that one can substitute any one truth for another, and nothing should matter as to the truth of the whole within which that proposition occurs. The importance of this point will be clear when we come to the material conditional and its attempted use in defining or reducing disposition terms.

To get to that point, we should spell out some more of the logic. Next should be a notion of compositionality, understood here as a purely syntactic operation. Wittgenstein's (1921: 4.21) 'elementary propositions' are the simplest things that are either true or false. Complex propositions can be composed out of elementary propositions using connectives that are truth-functions of the elementary ones they connect (1921: 4.41). Hence, <the cat is black> is an elementary proposition because it is capable of truth and falsehood although no part of it is capable of truth or falsehood (here adopting Armstrong's (2004) use of angled brackets, <, > , to isolate propositions). The proposition <the cat is black and today is Sunday> is complex because it has components that are capable on their own of truth and falsehood – in this case two such components – which in the complex proposition are conjoined.

Crucially, Wittgenstein says that the composition of complex propositions is performed using propositions that are truth-functions of elementary propositions. Truth-functionality is perhaps now taken for granted by many who are taught the standard logic, but it is an absolutely crucial feature for an anti-Humean to oppose. We should be sure, therefore, we understand exactly what it means. A striking account is provided by Russell, who uses the term 'molecular proposition' for a complex formed out of elementary propositions:

> I call these things truth-functions of propositions, when the truth or false-hood of the molecular proposition depends only on the truth or falsehood of the propositions which enter into it. The same applies to 'p and q' and 'if p then q' and 'p is incompatible with q'. When I say 'p is incompatible with q' I simply mean to say that they are not both true. I do not mean any more. Those sorts of things are called truth-functions, and these molecular proposi-tions … are instances of truth-functions. If p is a proposition, the statement 'I believe p' does not depend for its truth or falsehood simply upon the truth or falsehood of p, since I believe some but not all true propositions and some but not all false propositions.
>
> (Russell 1918: 210)

Thus, the truth-values of propositions p and q entirely determine the truth-value of any molecular proposition that has only p and q as its elements and uses only truth-functional connectives. Classical propositional logic will take it as defini-tive of a proposition that it (i) is that which is true or false, (ii) can only be true or false and (iii) must be either true or false; so, there are no undetermined truth-values for anything that is really a proposition.

Now there is one truth-functional connective in particular that will concern us. This is because it is the connective that usually plays the major role in any attempted reductive account of a disposition term, namely, the material con-ditional. Although we sometimes think of this connective in terms of Frege's *Begriffsschrift* of 1879, it is of course an ancient way of understanding a condi-tional that Frege reintroduced. Bochenski explains its ancient origin:

> Philo (of Megara, c.300 BC) said that the connected (proposition) is true when it is not the case that it begins with the true and ends with the false. So according to him there are three ways in which a true connected (propo-sition) is obtained, only one in which it is false. For (1) if it begins with the true and ends with the true, it is true, e.g. 'if it is day, it is light'; (2) when it begins with the false and ends with the false, it is true, e.g. 'if the earth flies, the earth has wings'; (3) similarly too that which begins with the false and ends with the true, e.g. 'if the earth flies, the earth exists'. It is false only when beginning with true, it ends with false, e.g. 'if it is day, it is night'; since when it is day, the (proposition) 'it is day' is true – which was the anteced-ent; and the (proposition) 'it is night' is false, which was the consequent.
>
> (Bochenski 1961: 116)

If one simply began from a consideration of conditionals, it is not clear at all that the material conditional would be the account that suggested itself. So why should it be adopted? Peirce gives one reason:

> The utility of this is that it puts us in possession of a rule, say that 'if A is true, B is true', … The hypothetical proposition may thereby be falsified by a single state of things, but only one in which A is true and B is false. States of things in which A is false, as well as those in which B is true, cannot falsify it.
>
> <div align="right">(Peirce 1885: 218)</div>

The material conditional is then defined as true unless falsified by having a true antecedent and false consequent. Of course, if one is creating a system of logic, as Frege was, this asset of the material conditional is a considerable advantage. The rival Diodorean conditional, for instance, 'is true when it begins with true and neither could nor can end with false' (Bochenski 1961: 117–8). But this does not give us a rule for deciding the truth or falsehood of the whole based simply on the truth of falsehood of its antecedent and consequent components. Such simplicity is what truth-functionality in general gives us. Indeed the material conditional can even be understood simply in terms of conjunction and negation, since $A \longrightarrow B$ (where $\longrightarrow$ marks the material conditional) is equivalent to $\neg(A \& \neg B)$. The language is thus perfect for dealing with mere occurrence and non-occurrence. With the Diodorean conditional, one would have to know, in addition to the truth of the antecedent and consequent, whether the consequent, even if true, could be false, and nothing is said about the truth of conditionals whose antecedents are false.

But there is a further factor to consider. Simplicity alone is unlikely to have attracted Frege, nor anyone else, if it comes at considerable cost to the logical system: if the material conditional were so far removed from the world or our reasoning so as to render that logical system useless, by which we mean without application. However, as we have already said, for a Humean what more connection could one want in order to describe the world than the material conditional? As Hume had argued, to say that A causes B is to say nothing more than that A is always followed by B (they are constantly conjoined, contiguous and A is temporally prior to B). Notoriously, Hume argued that we absolutely could not say in addition that A necessitated B. A and B were conjoined but never connected. It is entirely adequate, therefore, for neo-Humeans to adopt the material conditional when making causal claims. That A causes B could plausibly then be understood according to the truth-table of the material conditional; that is, false only when A is true and B is false, true otherwise. After setting out the conditions of the material conditional, Frege said exactly this: 'We can thus translate: "If something has the property X, then it also has the property P.", or "All X's are P's." This is how causal connections are expressed' (Frege 1879: 134).

5 Dispositions and the material conditional

As already indicated, a realist about dispositions is someone who believes the world contains real causal powers, alleging the kind of connection-over-and-above-conjunction that Hume denied. A power brings about its manifestation when it is in appropriate conditions: it tends towards it, makes it happen. There would be, in this causally powerful world, strong modal connections between powers and their manifestations, hence it is not the case that all is loose and separate. A power or disposition bears a more than purely contingent connection to the manifestation it brings about, which we have argued is an irreducibly tendential connection.

Cleary such things are not part of the Humean's ontology. How, then, is an extensionalist to treat dispositions? One can hardly deny that we have and use freely a dispositional vocabulary. What is more, a scientific naturalism, such as logical positivism, cannot deny that this dispositional vocabulary is used in science. Even in fundamental physics, we ascribe properties such as spin, charge and mass, which look dispositional in character. One possible response from an extensionalist is to say that we appeal to dispositions in current science only because such a science is not yet complete or ideal. Quine says, for instance: 'So, if I were trying to devise an ideal language for a finished theory of reality, or any part of it, I would make no place in it for the general dispositional idiom' (Quine 1974: 11). This suggests an eliminative approach to our dispositional vocabulary: for instance, that the ideal language of reality would be free of disposition terms.

Another possible approach, however, is reductionist. One could try to reduce disposition terms to occurrent, non-disposition terms using only truth-functional connectives. If successful, such an account would be entirely acceptable to the extensionalist. Indeed, there is something quite important at stake here. The neo-Aristotelian claims that dispositions constitute an irreducible feature of reality; a feature that Hume's description of the world omits to its detriment. But, if the reduction goes through, it shows that the Humean can account for everything that the dispositionalist claims is additional. No modal connections would be needed; truth-functional connectives would alone have been adequate.

Carnap recognised, however, that contrary to the spirit of Frege's claim, quoted above, one cannot define a disposition predicate with a simple extensional conditional analysis using the material conditional. One cannot say that x has disposition D simply when it is that case that $Fx \longrightarrow Gx$, as is suggested by the simple conditional analysis (SCA) of dispositions. Such a conditional is true whenever the antecedent is false. Something might then satisfy the definition for both soluble (S) and insoluble (I), if never tested, where Fx,t means x is placed in liquid at t and Gx,t means x dissolves at t:

$$(S): \quad \forall x\, \forall t\, \big(Dx \leftrightarrow (Fx,t \rightarrow Gx,t)\big)$$

$$(I): \quad \forall x\, \forall t\big(\neg Dx \leftrightarrow (Fx,t \rightarrow \neg Gx,t)\big)$$

Using the material conditional, it follows that anything not placed in liquid (¬Fx) is merely in virtue of that fact, soluble (Dx) but at the same time insoluble (¬Dx). We might think of this as a paradox, though of course it is a perfectly natural consequence of adopting the material conditional and is thus entirely acceptable to the consistent extensionalist.

Carnap thought that this was a problem, though. His response was to concede that dispositions cannot be defined in extensional terms but to argue that this did not matter as long as they could be reduced to a non-equivalent extensional sentence that was constructed out of observation sentences. 'Testability and Meaning' (Carnap 1936) is an attempt to integrate this project into the larger one of constructing a language for science based on observation. It attempts to show that 'all scientific terms could be introduced as disposition terms on the basis of observation terms either by explicit definition or by so-called reduction sentences, which constitute a kind of conditional definition' (Carnap 1956a: 53).

The explicit definition is forgone, and the *reduction sentence* replaces it. The reduction sentence for a disposition term is given as (Carnap 1936: 440):

$$\text{R.} \quad \forall x \, \forall t \Big(Q1(x,t) \rightarrow \big[Q3(x) \leftrightarrow Q2(x,t) \big] \Big)$$

where Q3 represents the disposition term. In the case of solubility, the reduction sentence would be read as 'If any x is put into water at any time t, then, if x is soluble in water, x dissolves at the time t, and if x is not soluble in water, it does not' (Carnap1936: 440–1).

When Carnap goes into more detail, the reduction sentence R turns out to be a special case. As the unified science seeks to introduce a new disposition predicate, Q3, into the language, it does so through characterising the positive and negative test cases that form the truth-conditions for application of the predicate. Carnap gives these test cases as:

$$\text{R1.} \quad Q1 \rightarrow (Q2 \rightarrow Q3)$$

and

$$\text{R2.} \quad Q4 \rightarrow (Q5 \rightarrow \neg Q3),$$

where Q1 and Q4 are the antecedent experimental conditions for the test and Q2 and Q5 are possible results, which would confirm or disconfirm the presence of the disposition. We can see that 'Q1 & Q2' is a sufficient condition for application of the predicate Q3, while ' ¬(Q4 & Q5) ' is a necessary condition for Q3. Together, R1 and R2 are the 'reduction pair' for Q3. We are told that 'By the statement of R1 and R2 "Q3" is reduced in a certain sense to those four predicates' (1936: 441).

The case of R was a special one. This is called the 'bilateral reduction sentence' and is simplified to (1936: 442):

Rb. $Q1 \rightarrow (Q3 \leftrightarrow Q2)$

which occurs when Q1 and Q4, and Q2 and ¬Q5, of a reduction pair, coincide. Hence the same test can be used for both confirmation and disconfirmation of the disposition's presence and only one reduction sentence is needed to reduce the meaning of Q3.

The problem with the material conditional is that whenever an antecedent is false, that is, whenever the test conditions are left unfulfilled, the material conditional is true and the disposition can be ascribed. Reduction sentences do not fully eliminate this difficulty, however, rather they sidestep it with the clause that whenever an antecedent is not true for any time *t*, in untested cases, then it is meaningless to ascribe the disposition. The presence of the disposition is neither affirmed nor denied; rather, the predication of such a disposition is deemed meaningless because it lacks any confirmed empirical content. Thus, Carnap has to include the clause that R1 and R2 constitute the reduction pair for Q3 provided it is not the case that ' [(Q1 & Q2) v (Q4 & Q5)] is not valid [i.e., true]'; that is, provided at least one test case has been confirmed. Similarly, the bilateral reduction sentence Rb reduces the meaning of Q3 provided that ' $\forall$x (¬Q1 (x)) is not valid [true]'. This leaves a large area of indeterminacy, for the reduction of Q3 is conditional upon the realisation, at some time, of the antecedent test conditions of the reduction sentence. Because the meaningfulness of the term is conditional upon the truth of the antecedent test conditions, the reduction sentences are also known as 'conditional definitions'.

But does this entail that it is meaningless to call this vase fragile or this cube of sugar soluble because they have never been tested? Just when and how many times does the testing for the disposition need to be conducted for the reduction sentence to be confirmed? Carnap is not wholly clear on this. Consider again the quantified version of the bilateral reduction sentence R. The disposition predicate 'Q3' is non-relative to a time *t*, hence one test of the reduction sentence at time t_1 will, if Q2 is also realised at time t_1, confirm the truth of Q3 for all times. We must say therefore, that a confirming instance is insufficient to confirm the truth of 'Q3(x)', rather it suffices only for the confirmation of 'Q3(x,t)'. This apparently adds further to the area of indeterminacy of Q3, for we must say that the reduction sentence is not only indeterminate when a test is never made, but now it is also indeterminate whenever the disposition is not currently being tested because we have no verification of its behaviour in between tests. Carnap realised there was this problem and made concessions in an attempt to answer it (e.g. Carnap 1936: 445). We will not follow the point further, however, except to say that we do not think he made the problem go away.

Carnap's reduction sentences are ultimately inadequate to fully grasp the meaning of a disposition term. A simple material conditional ' $P \longrightarrow Q$ ' will not do the job and Carnap's reduction sentence does little better, we have claimed.

The inadequacies of the material conditional seem to be the cause. If we restrict our consideration again to propositional logic, we can see that there are many other counterintuitive results. Based mainly on a list of theorems assembled by C. I. Lewis (1918), we offer some natural readings that illustrate the problem:

1   $\neg P \rightarrow (P \rightarrow Q)$

If x is not put in water, it follows that if x is put in water, it dissolves.

2   $Q \rightarrow (P \rightarrow Q)$

If x breaks, it follows that if x is exposed to light, it breaks.

3   $\neg(P \rightarrow Q) \rightarrow P$

If it is not the case that if the match is in water it dissolves, it follows that the match is in water.

4   $\neg(P \rightarrow Q) \rightarrow \neg Q$

If it is not the case that if x is exposed to light then it breaks, it follows that it is not the case that x breaks.

5   $\neg(P \rightarrow Q) \rightarrow (P \rightarrow \neg Q)$

If it is not the case that if x is exposed to light it breaks, it follows that if x is exposed to light, it does not break.

6   $\neg(P \rightarrow Q) \rightarrow (\neg P \rightarrow Q)$

If it is not the case that if x is exposed to light it breaks, it follows that if x is not exposed to light then it breaks.

7   $(P \& Q) \rightarrow ((P \rightarrow Q) \& (Q \rightarrow P))$

If x weighs ten kilos and dissolves, it follows that if x weighs ten kilos it dissolves, and if x dissolves it weighs ten kilos.

8   $(\neg P \& \neg Q) \rightarrow ((P \rightarrow Q) \& (Q \rightarrow P))$

If it is not the case that x weighs ten kilos and not the case that x dissolves, it follows that if x weighs ten kilos it dissolves, and if x dissolves it weighs ten kilos.

9   $(P \rightarrow Q) \lor (Q \rightarrow P)$

It is either the case that if x is immersed in water it breaks, or that if x breaks it is immersed in water.

10   $(P \rightarrow Q) \rightarrow ((P \& R) \rightarrow Q)$

If it is the case that if a match is struck it lights, it follows that if a match is struck and there is a gale blowing, it lights.

While conditionals with false antecedents have received much attention since Lewis's (1973b) work on counterfactuals, the Humean assumption is best revealed, we suggest, in (7) above: where two true propositions make a true material conditional going from either one to the other. This means that a conjunction suffices to derive a material conditional in either direction between any two truths. We take this to be a trivialisation of conditionals, suggesting that we cannot really have the material conditional in mind when we assert a conditional 'if P then Q'. The mere fact that from any pair of truths, we can infer a material conditional in each direction, tells us that this is a Humean way of understanding a conditional.

One might object against this putative trivialisation that in a Humean metaphysic there really is nothing more a conditional could assert than that it is not the case that the antecedent is true and the consequent false: 'not (P and not-Q)'. Similarly, causation can mean nothing more than what we know of it, according to Hume's analysis, which is constant conjunction, temporal priority and contiguity. We have no knowledge of any necessary or other modal connection between cause and effect. Constant conjunction just means that whenever C occurs, E occurs (where each C is before and spatially next to an E). Given the lack of connection in the Hume-world, then there is nothing more that causation could mean than that when C is the case, E is the case (plus the other two conditions, henceforth assumed). To be explicit, there is no necessary or other modal connection to be taken into account between C and E. Hence, there is no distinction to be drawn between 'accidental' and 'genuinely causal' constant conjunctions, for example, a distinction that many critics of Hume have tried to assume (e.g. Armstrong 1983: ch. 2). Furthermore, no conclusion is to be rationally drawn about those cases in which C is not the case. If one accepts the Humean framework, therefore, the logic will do just fine. But this is precisely the point we are making.

6 Logical strengthening and weakening

It might yet be argued that we shouldn't blame logic for any of this. Logic is what we make it. If we have concerns, shouldn't we simply add some further strength to classical logic so that it allows us to express truths about a richer world such as ours: one richer than a Hume world? We are certainly at liberty to develop a logic that allows us to express what we think should be expressed. The problem is, however, that for anyone serious about the ontology of real causal powers, anything that includes the classical base will also contain its flaws. One cannot

simply bolt on to Frege's logic additional components that would satisfy powers metaphysics. The two would be fundamentally at odds. Thus, any extended logic that retains the classical base will see the same counterintuitive results resurface that the dispositionalist rejects. We show this for the sample cases of first-order predicate logic and modal logic.

Predicate logic is the most familiar extension of propositional logic. For more complex arguments, such as Aristotle's syllogisms, we need this first-order logic to uncover the argument's structure. Have we only made it seem as if classical logic could not express dispositionalist claims because we restricted it to its simplest form? Would the possibility of quantification give us a stronger link between antecedent and consequent? It seems not. From any universally quantified conjunction we can derive a universally quantified conditional in any direction (11); if everything is G, then if something were F it would be G (12) and if nothing were F, then if anything were F it would be G (13). Because predicate logic retains the truth-functional connectives, we get correspondingly counterintuitive results, as far as anti-Humeans are concerned: just quantified versions of them. Hence:

11 $\quad (\forall x)\big(Fx \ \& \ Gx\big) \Rightarrow ((\forall x)(Fx \rightarrow Gx) \ \& \ (\forall x)(Gx \rightarrow Fx))$

12 $\quad (\forall x)\big(Gx\big) \Rightarrow (\forall x)(Fx \rightarrow Gx)$

13 $\quad (\neg \exists)\big(Fx\big) \Rightarrow (\forall x)(Fx \rightarrow Gx)$

Perhaps it might be said, then, that modality is the real issue and this is what needs to be added to classical logic. Once one does that, one might say it shows that there was nothing inherently Humean about the classical base. It is simply that one needs to find the right form for anti-Humeans. We can give the realist about powers a modally strengthened logic and then let them get on and express their claims about dispositions using it. Unfortunately, this does not work out with any of the best developed modal logics, given that they have all retained the classical base of the usual truth-functional connectives (such as the systems described in Hughes and Cresswell 1996).

Introducing modal strengthening does not secure the conditional connection between antecedent and consequent that the neo-Aristotelian wants. Instead we get consequences that look very much like the material conditional, but with necessity replacing truth. A necessary conjunction, for instance, will give a necessary conditional in any direction (16). Other results also follow that the dispositionalist would see no reason to accept, hence:

14 $\quad \Box Q \Rightarrow \Box(P \rightarrow Q)$

15 $\quad \neg \Diamond P \Rightarrow \Box(P \rightarrow Q)$

16 $\square(P \,\&\, Q) \Rightarrow \square(P \rightarrow Q) \,\&\, \square(Q \rightarrow P)$

17 $\square(\neg P \,\&\, \neg Q) \Rightarrow \square(P \rightarrow Q) \,\&\, \square(Q \rightarrow P)$

Now why would such a modal logic be developed in the first place? An answer seems to be that if one adds modal operators to standard truth-functional logic, it still remains possible to have an entirely extensional interpretation of modality, as the work of Lewis (1986a) ably demonstrates. $\square Q$ need not, as a dispositionalist might at first have expected, mean that there is some worldly necessity to Q, in addition to its truth. Rather, Lewis shows that this can be accounted for entirely in terms of truth alone – but truth in all worlds, which can be thought of as a kind of hyper-extensionalism.

7 Conditionals and deviant causal chains

The Humean assumptions within the logical treatment of dispositions run deep. But perhaps they are deeper than even many dispositionalists realise. We wish now to push this point further. It is not just the interpreting of 'if P then Q' as a material conditional that shows a broadly Humean metaphysics at play, but explicating dispositions in conditional terms at all is arguably an ill-advised move for a dispositionalist.

While those developing a realist theory of dispositions are likely immediately to see that the material conditional is not up to the job, they could think that some suitably realist, alternative theory of conditionals would be all that's needed. Perhaps one could keep the conditionals and merely take real dispositions, rather than the Lewisian plurality of worlds, to be their truthmakers (e.g. Bird 2007: ch. 3). Or perhaps one could have a robustly anti-Humean account of the conditionals. One could then say that a realist view requires a real causal modal connection between antecedent and consequent. The antecedent names the stimulus and the consequent names the response, in the usual way.

Such a permissive view in respect of a conditional account of dispositions, we suggest, plays into the hands of the Humeans. It still accepts the Humean framing of the approach to dispositions. What, for instance, if the consequent is true because there is a deviant causal chain leading to it from the antecedent condition?

A basic conditional account tells us that x is fragile, where if it is dropped, it breaks. We have now granted, for purposes of argument, that this conditional can be as strong as one likes modally and concern a real causal connection between antecedent and consequent. We say that this still is not adequate because the antecedent conditions could cause the consequent through a deviant causal route and, where it does so, it is not necessarily the case that x is fragile. An object being dropped, for instance, might cause someone to smash it with a heavy sledgehammer. The object broke after being dropped, and being dropped was causally connected to it breaking, according to the case we have constructed.

But such an object may or may not be fragile. The truth of the conditional is alone unable to determine which.

One might then try to produce a conditional that rules out this kind of possibility. Indeed, the debate around the conditional analysis of disposition ascriptions has brought ever more elaborate analyses. Lewis's revised conditional analysis is one but see also Choi (2008).

What the possibility of deviant causal chains within true conditionals shows is that it is not enough to count as a manifestation of a disposition merely that the typical consequent manifestation occurs, and its occurrence was caused by the typical antecedent stimulus. The true dispositionalist can explain why. A disposition is for a certain natural causal process towards an outcome or manifestation that can, unless interrupted, result in the consequent response, which is the end point of that process. The stimulus and response, captured by the antecedent and consequent of a conditional, are only the start and end of a process. But the disposition has to be for the whole process. It matters, for it to be a real disposition, how the causation gets from one to the other. It has to be via this natural route. In the case of fragility, it has to be via a process in which small cracks appear on impact, leading gradually to bigger cracks and eventually breaks. Being smashed by a sledgehammer, even if this were to be a causal result of being dropped, still does not count as a manifestation of fragility because it is not the disposition that is doing the work: taking its natural course. What is being invoked is a distinct natural kind of process from A to B (see for instance Ellis 2001: 162–4), not simply that A is causally responsible for B.

The metaphysical view that accompanies the conditional analysis is one of discrete (cause and effect) events standing in a certain relation. It is a metaphysics of discrete stages. Instead, the dispositionalist should understand the world in terms of continuous processes, running their course unless interrupted. It is possible to get causally from the same stimulus to the same response via more than one process. But on a conditional analysis of dispositions, these two or more processes would come out as the same disposition. For a realist, they would be different dispositions and thus such a realist should never be satisfied with a conditional analysis, even a strengthened one. It plays into the clutching hands of Humean metaphysics.

8 The irreducibly intensional connection

At the risk of overdetermining the case against reductive accounts of dispositions, there is one further important argument that shows how the dispositionalist needs to express something that cannot be expressed in standard logic, with its extensionalist commitments.

It is a mark of dispositions that they can fail to manifest, even when stimulated in the usual way. This is because all natural causal processes are susceptible to prevention and interference. No matter how much content one builds into the antecedent of a supposed causal conditional, it is always possible to add something more that prevents the manifestation.

Hence, where F is the typical stimulus for the Disposition D, and G is the typical manifestation, the simple conditional analysis, SCA:

$$(\text{SCA}): \quad \forall x \left(Dx \leftrightarrow (Fx \rightarrow Gx) \right)$$

is false because there could be a further factor φ which prevented the manifestation G even under stimulus F. There are exceptions to the conditional analysis, of the kind shown in ECA:

$$(\text{ECA}): \forall x \left(Dx \rightarrow \lozenge \exists \varphi \left((Fx \ \& \ \varphi x) \rightarrow \neg Gx \right) \right)$$

A way of avoiding this problem intuitively is to say that conditionals such as those in (SCA) are to be *ceteris paribus* qualified, that is, only true under some ideal or normal conditions. But what sense can the *ceteris paribus* qualification have that is neither circular nor still subject to counterexample? If the *ceteris paribus* clause points to some set of conditions under which the manifestation occurs, there might still be further factors added to those conditions that prevent the manifestation, for instance (Anjum and Mumford forthcoming: ch. 6).

We have argued (Chapter 1) that there is an irreducible dispositional modality. Dispositions do not necessitate their manifestations but their connection to them is nevertheless more than purely contingent. It is more than the mere conjunction that Hume claims. When the conditions are right – when they meet their mutual manifestation partners – dispositions will tend, but no more than tend, to produce their effects.

No extensional connective can express this irreducible dispositional modality that ought to be the central commitment of a causal powers metaphysic: a commitment inexpressible in standard logic. Now perhaps one could say that a conditional analysis of dispositions is still possible as long as a connective is used that does indeed carry this dispositional force. The conditional could use a connective, indicated by an arbitrary symbol ' $_D\rightarrow$ ', that involves the dispositional modality, for instance, that Fx disposes towards Gx. This would be to concede, however, that the extensional definition of Dx does not work because the truth-value of ' Fx $_D\rightarrow$ Gx ' is not simply a function of the truth-values of Fx and Gx.

If one were to say that this explained the meaning of a *ceteris paribus* clause, for instance, then clearly it would be no use in a conditional analysis. Such an analysis would have to deploy the very notion – dispositionality – that the analysis was intended to analyse. Instead, then, we could offer a dispositional analysis of conditionals (Mumford and Anjum 2011a: ch. 8.10). The fragility of a glass makes it true that if it is thrown at a wall, dropped on a tiled floor, struck with force, etc. it will tend to break. The truth or falsity of these various antecedents is itself irrelevant for the truth of the conditional as a whole, which means that there is also no need to distinguish indicative from subjunctive or counterfactual conditionals. The grammatical form of the stimulus conditions does not affect the causal relationship between the antecedent and the consequent. What is crucial for these conditionals, however, is that the modality has to be of tendency

only, since in all cases there will be possible conditions under which the glass would not break.

We are now in a position to draw our conclusions, which are as follows. The classical logic that employs only extensional connectives is not a neutral or innocent tool of reasoning. It is an apparatus that coheres perfectly with a Humean theory of reality in which all is loose and separate, conjoined but never connected. Those who follow a neo-Aristotelian, causal realist and dispositionalist line, ought not to think it harmless to their metaphysic to use such a logic. It almost certainly would undermine their claims to express them in this way.

We saw that there are some extensionalists, such as Carnap, who see that the dispositional idiom cannot be ignored by anyone claiming to have a naturalistic approach. Some account of disposition terms was owed to us. Carnap and others have failed to fulfil this obligation, which itself is indicative of the point we have argued. The realist about dispositions cannot express their claims within the standard logical framework. They should, therefore, be prepared to overthrow it. Our conjecture is that part of the continuing appeal of an otherwise counterintuitive Humean philosophy of nature is that it coheres so well with the logic on which we have now all been brought up. Logic should be our slave. In at least some instances, however, it may have made a slave of us.

6 Conditional probability

Conditional probability from an ontological point of view

With Johan Arnt Myrstad

1 Logic and metaphysics

There is quite a low probability that you will die shortly after reading this paper: within 20 minutes, for instance. Nevertheless, one might still grant that there is a high conditional probability that you will die soon if you jump out of a fifth-floor window or if a tiger is released into the room. How do we know this, and what does it mean? Our answers depend on what we take to be the correct understanding of conditional probability. However, they also depend on our philosophical understanding of probability, the logic of conditionals and on our wider metaphysical commitments.

Leibniz (1765) made the first attempt to find a way of calculating the probability of conditional statements. His original interest was in law statements such as rights and liabilities, which he found to be conditional more often than absolute (Ishiguro 1990: 155). Someone is liable to a fine, for instance, *if* speeding. And someone has a right to inherit from their parents *if* the parents die first. Leibniz understood such hypothetical statements as the conditional assertion of the consequent upon the truth of the antecedent. It is this and similar non-technical, pre-theoretical notions of conditional probability (or probability of conditionals) with which we are here concerned.

In this chapter we consider conditional probability from an ontological perspective, as opposed, for instance, to a logical or epistemic one. Our approach is controversial for a number of reasons. First of all, not everyone thinks there is a link between metaphysics and logic. We try to show that there is. Moreover, one might think that conditionality and conditional probability are two entirely separate matters. We argue that they are not. Finally, the standard technical definition of conditional probability is often used as synonymous with conditional probability. We hope to show that this practice creates unnecessary confusion.

Contrary to the orthodox view, it is a premise of this chapter that the notion of conditional probability has a wider meaning than the technical one. This wider meaning is what Leibniz was after, and it is what makes conditional probability so important for our scientific and everyday reasoning. Arguably, our technical tools for probabilistic reasoning ought to match our non-technical and pre-theoretical notion of conditional probability. At least these two should not clash considerably.

There are two immediate obstacles. One concerns the logic of probability; the other concerns the logic of conditionals. While logic is often thought to be metaphysics-free, we will argue that both the ratio analysis of conditional probability and the material conditional are particularly suited for a Humean metaphysics of discrete, distinct existences, where all events, facts or states of affairs are entirely without connections. This metaphysics has its roots in the philosophy of Hume (1739), who believed there were no powers or necessary connections in nature, and later in neo-Humean accounts such as that of Lewis (1976 and 1986c). For Hume, the only connectedness resides in logic; that is, relations of ideas.

One essential feature of extensional logic is compositionality: where all molecular statements are composed from atomic ones. This means that if we know all the occurrent and non-occurrent events, facts or states of the world, this alone should suffice to derive all relations that hold between them: conditional and even causal ones included (Frege 1879: 134). We here argue that the ratio analysis of conditional probability, applied within extensional logic, implies a Humean ontology, and that the use of the corresponding ratio scheme to calculate individual cases of conditional probability sometimes fails to produce plausible results.

From an anti-Humean perspective, this feature of extensional logic is unattractive, both ontologically and logically. If we are realists about powers, this should commit us to an irreducible and dispositional form of conditionality. The attempt to analyse dispositions into something non-dispositional, through conditional analyses, therefore gets it the wrong way round. Dispositions cannot be given a conditional analysis (see also Mellor 1993). Instead, we have proposed that conditionals should be given a dispositional analysis (see Chapter 5 and Mumford and Anjum 2011a: ch. 8.10). On this view, dispositions are the worldly truthmakers of causal conditionals, as we will explain below.

Armed with an ontology of real dispositions or powers, the path will be open for an alternative account of probability. This should not be based on frequentist interpretations, as fits best with Humean supervenience, where the probability of an event supervenes on the frequency with which events of its type occur within the Humean mosaic. Rather, our preferred version will be one where probabilities are determined by singular propensities fixed by the intrinsic dispositions of things (different versions of propensity theory have been proposed, for instance by Mellor 1971, Popper 1990, Gillies 2000, Drouet 2011, Suárez (ed.) 2011, Suárez 2013, 2014). It would be such a propensity of a flammable match to light, for instance, conditional upon it being struck, that grounded the relevant conditional probability. This may require amendment to some of the standard ways in which we understand conditional probability.

More needs to be said. A fully developed theory of dispositions, conditionals or propensity will not be offered in this chapter, though some lines for further development will be indicated. What will be shown, however, is that for a deeper understanding of these matters we will need what Heil (2003), in response to Quine (1953), calls an ontological point of view.

The structure of the chapter is as follows. We start by looking at conditionals and their purported logical properties, including the material conditional,

Lewisian counterfactuals and Adams's Thesis. Next, we present the ratio analysis of conditional probability, followed by three results that we take to be counterintuitive if we understand conditional probabilities dispositionally. This is the only technical part of the chapter. We then present an ontological reading of conditionals where we single out some natural uses of 'if', designed to express a causal connection between the antecedent and consequent conditions. Such conditionals, we argue, have dispositions as their truthmakers and are better suited for a propensity based notion of conditional probability than the logical alternatives. Understood dispositionally, conditional probability is incompatible with the ontological commitments of Humeanism, and its logic is insufficiently represented by the ratio definition.

2 The logic of conditionals

Consider first the logic of conditionals. Understood as a material conditional, 'if p then q' is a (truth) function of the statements 'p' and 'q'. This means that we can calculate the truth-value of the conditional from the truth-values of its antecedent and consequent. The material conditional is defined as true whenever we have one of the following combinations of truth-values for the antecedent and the consequent: (TT), (FT) or (FF).

The truth-functional account of conditionals involves well-known problems. Below are some of the results that might seem counterintuitive if we take the material conditional to account for the truth conditions of 'if p then q':

1   $q \Rightarrow ((p \supset q) \& (\neg p \supset q))$

2   $\neg p \Rightarrow ((p \supset q) \& (p \supset \neg q))$

3   $(p \& q) \Rightarrow ((p \supset q) \& (q \supset p))$

The second inference has received most attention, often referred to as the problem of counterfactuals: that the conditional is truth-functionally defined as true whenever its antecedent is false. A common response is that although the material conditional might work as a logical representation of indicative conditionals, some further account is needed for conditionals with false antecedents (e.g. Stalnaker 1968 and Lewis 1973b) or subjunctives (e.g. Adams 1975). This challenge has led to an extensive literature on counterfactuals (see for instance Harper, Stalnaker and Pearce (eds) 1981). We will not enter the debate on counterfactuals here, since the problem we seek to address is a more general one concerning the attempt to treat conditional statements as functions of their antecedents and consequents.

What is more relevant for our purpose, however, is that Lewis's theory of counterfactuals has a metaphysical grounding in Humeanism. Humean supervenience is the thesis that there is nothing but spatiotemporal arrangements of point-like

intrinsic qualities and what supervenes on these (Lewis 1986b: ix–x). This fits well with the principle of compositionality in extensional logic, according to which the truth, necessity, probability, etc. of molecular propositions are inferred from the truth, necessity, probability, etc. of atomic propositions (see Chapter 5).

Unless we share Lewis's metaphysical commitments, we should resist his treatment of counterfactual conditionals. On this theory, a counterfactual '$p \,\square\!\!\rightarrow q$' is true in the actual world if in one or all (depending on the interpretation) of the closest possible worlds where 'p' is true, 'q' is also true (where $\square\!\!\rightarrow$ marks the counterfactual connective). This could commit us to the metaphysically rich theory of multiple worlds and inter-worldly modality in addition to the material conditional, which still holds within all possible worlds. As we can see in the following inferences (which would still hold even on the metaphysically weaker ersatz interpretation of possible worlds), there are some clear similarities between the material conditional and Lewis's counterfactuals.

1   If 'q' is true in all worlds, then '$p \,\square\!\!\rightarrow q$' is true and also '$\neg p \,\square\!\!\rightarrow q$'
2   If 'p' is true in no worlds, then '$p \,\square\!\!\rightarrow q$' is true and also '$p \,\square\!\!\rightarrow \neg q$'
3   If both 'p' and 'q' are true in all worlds, then both '$p \,\square\!\!\rightarrow q$' and '$q \,\square\!\!\rightarrow p$' are true

While much of the debate concerning conditionals is centred on counterfactuals and subjunctives, there is another one that concerns assertability rather than truth conditions. This debate started when Adams (1975) offered a different solution to the apparent divergence between indicative and material conditionals, saying that although the material conditional might work as a logical representation of a conditional's truth conditions, some further account is needed for its more pragmatic assertion conditions (see also Jackson 1987 and Grice 1989). The assertability of an indicative conditional 'if B then A' is, according to Adams (1975: 3), given by our conditional credence, or subjective belief, identified with the conditional probability of A given B, as determined by the Kolmogorov axiomatics for conditional probability. This is known as Adams's Thesis (AT).

AT   *Assert* (if B then A) = P(if B then A) = P(A given B)

$$= P(A \,|\, B) =_{\text{def}} P(A \,\&\, B)/P(B) \;\left(\text{when } P(B) > 0\right)$$

AT plays a central role in the debate on conditionals (see for instance Edgington 1986, 1995, Jackson 1987, 1991, Lewis 1976, 1986c). For our purpose, the thesis is interesting because it assumes that conditional probability is somehow linked to conditionality as such.

As presented here, AT contains three equations: (i) between the assertability and the probability of a conditional, (ii) between the probability of a conditional and conditional probability in the non-technical sense and (iii) between the non-technical and the technical notions of conditional probability. While we take (ii) to be intuitively plausible for ordinary conditionals and (iii) to be counterintuitive, logicians now usually accept (i) and (iii) and reject (ii).

The question remains whether AT is well suited to our conditional credence in the intuitive, non-technical sense. Consider next the logic of conditional probability.

3 The logic of conditional probability

AT links the assertability and probability of conditionals to conditional probability in the technical sense, $P(A|B)$. Hájek (2003), however, argues that the plausibility of AT rests solely on the intuitive notion of conditional probability: $P(A$ given $B)$. This suggests that any counterintuitive result we get will be a result of the technical notion of conditional probability, and not of the assumption that the assertability of a conditional is tightly linked to its probability:

> Adams' Thesis is thought to sound right, and to accord with our intuitions about a wide range of cases. What sounds right and so accords, I suggest, is equating the assertability of the conditional to the corresponding conditional credence; it is the further equation of this conditional with a ratio of credences, then, that is the culprit.
>
> (Hájek 2003: 309)

We will now explain why we agree with Hájek on this point. According to the standard conception, conditional probability is given by RATIO. This analysis makes the conditional probability of A given B calculable from the unconditional probabilities of A and B.

RATIO $P(A$ given $B) = P(A\,|\,B) =_{\text{def}} P(A \,\&\, B)/P(B)$ $\big($when $P(B) > 0\big)$

Note that a distinction should be made between the ratio analysis and the ratio definition. We argue that the ratio *analysis* cannot be universally applied. The ratio *definition*, on the other hand, is a technical definition that obeys the Kolmogorov axiomatic and determines $P(A|B)$ on the condition that $P(A)$ and $P(B)$ can be defined. One can apply this ratio definition to some intuitively plausible cases of conditional probability, but we would take the plausibility of these typically to depend on some underlying dispositional property or propensity that conditionally connects A to B.

Some are sceptical of propensity based conditional probabilities because they are not easily subsumed under the ratio definition. According to Humphreys (1985), all attempts to apply the ratio definition to propensities have so far failed. Propensities give rise to conditional probabilities that are essentially asymmetric and quite specific; that is, they do not apply universally to all events, propositions, states of affairs, and so on. The ratio definition, in contrast, demands essential symmetry, as does the Kolmogorov axiomatic, and the standard understanding of the ratio analysis is that the ratio definition applies universally (see for instance Lewis 1976). Humphreys therefore denies that the ratio definition applies to propensity based conditional probabilities (for details, see Humphreys 1985, 2004 and Drouet 2011).

Hájek (2003) demonstrates some further problems with taking RATIO as expressing the necessary characteristics of our non-technical notion of conditional probability. Often, we have an immediate and clear intuition of the probability of A given B while no value can be given for $P(A \mid B)$. This problem occurs when the probabilities of $(A \& B)$ and (B) are zero, infinitesimal, vague, or undefined, in which cases no calculation of $P(A \mid B)$ is offered by RATIO. From this, he concludes that RATIO is not an adequate analysis of conditional probability (Hájek 2003: 273) and argues that conditional probability must instead be taken as basic and primitive, hence: 'I suggest that we reverse the traditional direction of analysis: regard conditional probability to be the primitive notion, and unconditional probability as the derivative notion' (Hájek 2003: 315).

We agree with Hájek on both points and some more detailed reasons for this will be offered in the next section. But first the question remains, as Hájek seems to suggest, whether RATIO could be used as a constraint over rational probability assignments to A given B, so that whenever $P(A \& B)$ and $P(B)$ are well-defined, the probability of A given B is precisely calculated by RATIO. It would then work as an analysis for a sub-class of cases where the conditions are met (Hájek 2003: 314). We will argue that this is not the case. Next, we present three cases where RATIO can be calculated but where the results seem counterintuitive from an anti-Humean and propensity based understanding of conditional probability.

First result

The first result of RATIO follows whenever the probability of A is one. For such cases the probability of $(A \mid B)$ will also be one:

R1　$P(A) = 1 \Rightarrow P(A \mid B) = 1$

We can calculate this result from RATIO as follows: since $P(A \& B) = P(B)$, $P(A \mid B) = P(A \& B)/P(B) = P(B)/P(B)$, namely one. Note that this is similar to the first result of the material conditional where a true consequent gives a true conditional, irrespective of the antecedent.

Now consider an example where the conditional probability seems to be ontologically grounded in real propensities or dispositions. Say we strike a match and it lights. The match is lit and thus the (unconditional) probability of it being lit is one. Still, this does not entail that the match lit given that there was a strong wind. A number of conditions could counteract the match lighting, thus lowering the probability of this outcome. The match might be struck in water, the flammable tip could have been knocked off, the match could have been sucked into a black hole, and so on. The probability of the match being lit given any of these conditions should intuitively be less than one (see Chapter 3).

As Hájek suggests, we should not conclude from this that Adams was wrong in assuming a link between the assertability of conditionals and our subjective belief in the consequent given the antecedent. What we should conclude is that

the determinations of $P(A \& B)$ and $P(B)$ are not in themselves sufficient to calculate our credence in A given B. This means that we might take this result as an indication that the probability of A given B is not fully specified by $P(A|B)$, that is, by $P(A \& B)/P(B)$. If $P(A) = 1$, this is not in itself a reason for concluding that $P(A$ given $B) = 1$, or $P(A$ given $C)$, for that matter.

Someone might object that if A is certain, it is certain given B, C or whatever else. Lewis (1976: 307) offers an example in support of this: 'I'll probably flunk, and it doesn't matter whether I study; I'll flunk if I do and I'll flunk if I don't.' This example would not, however, be an instance of what we might normally think of as an indicative conditional, or what Lowe (1995:50) calls proper conditionals and Austin (1956: 209–10) calls ordinary causal conditionals. Indicative conditionals, at least, typically allow modus ponens, modus tollens and contraposition, which Lewis's example does not. On the contrary, the consequent seems to be asserted *unconditionally*: irrespectively of whether the antecedent is true.

In Lewis's example there is an implicit claim that there is no conditional or causal link between studying and flunking. Hence the studying and flunking are stated to be probabilistically independent. Such constructions are best understood as denials of a conditional relation between antecedent and consequent. A better formulation would be 'Even if I study, I'll still flunk' or 'It is not the case that if I study, I'll pass'. We should think of such statements as 'contra-conditionals', as they are characteristically used to deny that the antecedent is a sufficient or even relevant condition for an expected consequent. Contra-conditionals do not allow contraposition, modus ponens or modus tollens, and would therefore not be suitable candidates for indicative or causal conditionals. If AT fits conditional constructions that are typically used to deny a conditional relationship, we should take this as a clear indication of the logical discrepancy between the ratio analysis and conditional credence.

Notice that R1 might seem plausible when applied to epistemic conditionals such as Lewis's example above. But a few such examples are not enough to conclude that RATIO is universally applicable; that is, that the ratio definition can be plausibly applied to all types of conditionals (cf. Humphreys 1985: 563–4).

Second result

A second result of RATIO follows when A and B are probabilistically independent, here understood according to the criterion $P(A \& B) = P(A) \cdot P(B)$. In this case, $P(A|B)$ will be equal to the probability of A:

$$\textbf{R2} \quad \big(P(A \& B) = P(A) \cdot P(B)\big) \Rightarrow \big(P(A|B) = P(A)\big)$$

This result can be calculated as follows: since A and B are probabilistically independent, $P(A \& B) = P(A) \cdot P(B)$. Hence $P(A \& B)/P(B) = P(B) \cdot P(A)/P(B) = P(A)$.

An example can illustrate this point. The dispositional properties of solubility and sweetness are not generally thought to be probabilistically dependent.

Sugar has both dispositions, but we do not think them related in any further way, since some things are soluble without also being sweet. Following RATIO, however, if we assign high probability to 'sugar is sweet', we should assign equally high probability to 'sugar is sweet' given that 'sugar is soluble'. By AT, our credence in the conditional 'If sugar is soluble, then it is sweet' should therefore also be high. But this seems to imply that the sweetness of sugar is somehow conditional upon its solubility. If so, solubility and sweetness are not probabilistically independent after all, which means that a different calculation of conditional probability should have been used.

An obvious objection to this would be to say that the conditional link itself is nothing more than what is indicated by RATIO. As already argued, such a view may be attractive to Humeans, but not to anti-Humeans. The ratio analysis thus seems particularly well-suited for a Humean metaphysics, according to which there are no dispositions or other ontological connections between events. Much of our conditional reasoning, on the other hand, is premised on there being at least some type of connection that can ground our hypothetical reasoning. An anti-Humean might ground such connections in real dispositions, necessary laws or causation, none of which are part of the Humean ontology. It is thus the ontological relations that enable us to judge the solubility of sugar and its sweetness to be probabilistically independent, even though they come together.

If we read conditional probabilities from the Humean mosaic, we have no ontological grounds to make such a distinction. Lewis (1976) demonstrated that if the conditional (as characterised in AT) is taken as a dual connective that is universally applicable, it follows that the probability of A given B is equal to the probability of A for any A and B. Lewis used this triviality result to argue against Adams's equation of $P(\text{if } B \text{ then } A)$ and $P(A|B)$, while keeping the equation of $Assert(\text{if } B \text{ then } A)$ and $P(A|B)$, as calculated by RATIO. By doing this, the demonstration can be used to show that RATIO has the consequence that all sentences, and hence all facts, are probabilistically independent. And if all facts are probabilistically independent, this means that $P(A \text{ given } B)$ is not affected by B having high or low probability.

According to RATIO, taken on its own, however, $P(A|B)$ does not depend only on whether $P(A)$ and $P(B)$ are high or low, but on whether or not A and B are probabilistically dependent. AT estimates that the probability of A given B is given by RATIO also when A and B have low probability (close to zero). But there are different scenarios for this, and RATIO offers different answers for these scenarios. If A and B both have low probability but are probabilistically *independent*, it follows that $P(A|B) = P(A)$, that is, close to zero. But if A and B both have low probability but are probabilistically *dependent*, then $P(A \& B)$ is close to $P(B)$ (as well as close to $P(A)$, since these probabilities concur), and $P(A|B)$ is close to one.

Consider a case where we know that Peter and Jane are spending the day together. It might be highly improbable that Peter is on the top of Mount Everest and also highly improbable that Jane is on the top of Mount Everest. But given that we know they are together, the conditional probability of Peter being on Everest is high given that Jane is on Everest. This means that $P(A|B)$ being high

might indicate a dependence between A and B, independently of the probabilities for (A) and (B). But it does not mean that $P(A)$ and $P(B)$ being high is *sufficient* for $P(A$ given $B)$ being high.

Third result

Regardless of the probabilistic relation between A and B, a third result of RATIO follows whenever the probability of A and B is high. In these cases, $P(A|B)$ is high, but so is $P(B|A)$:

$$\textbf{R3} \quad \left(P(A \& B) \sim 1\right) \Rightarrow \left(\left(P(A|B) \sim 1\right) \& \left(P(B|A) \sim 1\right)\right)$$

An example might illustrate why this is counterintuitive as a result for $P(A$ given $B)$. The probability of the conjunction of 'the sun will rise tomorrow' and 'snow is white' is high. But this doesn't necessarily imply that the sun rising tomorrow is conditional upon snow being white, or vice versa. Even if we could find no connection between the rising of the sun and the colour of snow, RATIO calculates a high probability to the sun rising tomorrow given that snow is white and snow being white given that the sun rises tomorrow.

Assuming AT, we then end up trivialising conditionals. For any pair of highly probable statements A and B we can form highly probable conditionals (If A then B) and (If B then A) (see the triviality proofs in Lewis 1976: 300ff). No assumption about a logical, conditional or any modal link between A and B is needed for this inference beyond the criterion of high probability for both. Ultimately, this also trivialises conditional probability and blocks an ontological interpretation involving real propensities. If we can derive high conditional probability from high conjunctive probability, we have already assumed that conditional relations are derived from unconditional relations. As already mentioned, this is a basic assumption in extensional logic and one that fits well with a Humean metaphysics of discrete objects or events.

Summing up

There could of course be creative ways to interpret these results as plausible readings of a non-technical notion of probability of A given B. This is because the phrase 'A given B' is notoriously ambiguous, something that gives rise to various interpretations of conditional probability (cf. Drouet 2011). In this section, we have tried to demonstrate that the ratio analysis of conditional probability gives some results that cannot easily be matched with an ontological, propensity based understanding of conditional probability.

R1, R2 and R3, as presented above, are related to our metaphysical concerns about treating the conditional extensionally, that is, as material or any other function of the antecedent and the consequent. As already mentioned, Lewis's triviality proof demonstrates that if we make the conditional a universally applicable dual connective, as implied by AT, all pairs of sentences A, B must be probabilistically independent. This result might seem harmless to some

Humeans – although not to Lewis (cf. Lewis 1976: 300) – or as justified for atomic sentences *A*, *B* expressing atomic events. For most anti-Humeans, however, this is an unexpected and unattractive consequence of accepting the ratio analysis of conditional probability.

Some philosophers have assumed that we can keep the material conditional as explicating a conditional's truth conditions and add AT to account for a conditional's assertion conditions (e.g. Jackson 1987 and Grice 1989). This move does not allow them to escape the first and third result of the material conditional, since these are then reproduced in the first and third results for conditional probability, as demonstrated above. The more serious consequence is however related to the second result of the material conditional, concerning counterfactuals. While it shows that the material conditional can give counterfactuals and subjunctives no meaningful exposition, the second result for conditional probability, combined with Lewis's demonstration of the converse result, implies that there are no conditional probabilities. This is because there is no conditionality in the ontological, anti-Humean sense.

If we instead assume a dispositional ontology, we have reasons to take conditionals and conditionality as basic notions. Here we find some support in Hájek (2003). Rather than treating conditional probability as a function or ratio of unconditional probabilities, he suggests that conditional probability must be taken as a basic notion. Contrary to what is assumed in AT and RATIO, he argues that all unconditional probabilities are derived from conditional probabilities.

> The problem lies in the very attempt to analyze conditional probabilities in terms of unconditional probabilities at all. It seems that any other putative analysis that treated unconditional probability as more basic than conditional probability would meet a similar fate … On the other hand, given an unconditional probability, there is always a corresponding conditional probability lurking in the background. Your assignment of 1/2 to the coin landing heads superficially seems unconditional; but really it is conditional on tacit assumptions about the coin, the toss, the immediate environment, and so on. In fact, it is conditional on your total evidence.
>
> (Hájek 2003: 315)

We agree with Hájek that conditional probability is not reducible to absolute probabilities. But this is mainly because we take conditionals to be irreducible, meaning that any attempt to treat them as functions of their components will necessarily fail. We now move on to an alternative account of conditionals that should be more appealing to the anti-Humean than the existing logical framework of conditional probability.

4 The ontological point of view

R1, R2 and R3, as presented above, are symptoms of a failure within the theory to understand conditionals ontologically. Conditionals are capable of an

ontological use primarily marked in the expression of a more than purely logical connection between the referents of the antecedent and consequent. What Lowe (1995) and Austin (1956) were concerned with were conditionals in which the consequent in some way depends on the antecedent. These conditionals should therefore not be treated as logically compositional; rather, they should be taken as indivisible wholes. So instead of treating the 'if … then …' as a two-place connective between distinct propositions, these conditionals should be treated as single, indivisible propositions. Admittedly, the neat logical properties we get from treating a conditional sentence as logically compositional are lost. But those are the very properties that, in the case of proper conditionals, clash so obviously with the work that we want the conditional sentences to do.

Not all conditional sentences or statements have to be read in the ontological way we are advocating. A number of conditional sentence constructions do not express the kind of dispositional dependency between antecedent and consequent. We will call these, collectively, *non-causal uses of 'if'*. Among these are:

Classificatory conditionals: if *a* is a man, then *a* is mortal (or: all men are mortal)
Identity conditionals: if this is water, it is H_2O (or: water is H_2O)
Rhetorical conditionals: if that is Madonna, then I'm Bart Simpson (or: that's not Madonna)
Logico-analytic conditionals: if today is Sunday, tomorrow is Monday (or: Sunday comes before Monday)
Contra-conditionals: if I win the lottery, I cannot afford this car (or: I cannot afford this car)

In contrast with these cases, many other natural uses of 'if' clearly are designed to claim an ontological connection between the antecedent and consequent conditions, usually where this connection would be filled out in broadly causal or dispositional terms, directly or indirectly. To give some standard examples: 'if you get hit by a train, you'll die', 'if ice is salted, it melts', 'if an iron bar is heated, it expands' are all cases where we want to draw a direct causal connection between antecedent and consequent. The connection could perfectly well be indirect, however. It may be that 'if the barometer falls, it will rain' not because the falling barometer causes rain but because the antecedent and consequent conditions are connected by a common cause: a drop in air pressure. Conditionals should be understood ontologically, then, when there is some causal dispositional connection that makes them true.

Common for causal conditionals is that they should be given an irreducibly dispositional or tendential reading. Getting hit by a train tends towards one's death and salting ice tends towards its melting. Characteristic of dispositional statements is that they invoke the dispositional modality. There is a disposition towards a particular outcome, which is irreducibly tendential and could be counteracted. This allows us to draw a clear line between the ontological, causal conditionals and the more logical, non-causal ones, in the following way.

Causal conditionals have to be asserted only *ceteris paribus* because they admit exceptions in a sense that non-causal conditionals do not. There are no exceptions to statements such as 'If *a* is a man, then *a* is mortal' or 'If today is Sunday, then tomorrow is Monday', for which additional *ceteris paribus* clauses would be inappropriate. There will be an inviolable constant conjunction between antecedent and consequent here. But contrary to Hume's account, which links causation to constant conjunction, we would take constant conjunction as an indication of a non-causal relationship. If there is nothing one can do to influence or alter the effect, even in principle, then we side with the manipulability theorists (Woodward 2003) and ask on what ground we might plausibly call it a case of causation. The dispositional modality thus offers a way to distinguish causal from non-causal uses of 'if': causal ones are tendential and require non-monotonic reasoning while non-causal ones are non-tendential and require monotonic reasoning.

It is thus paramount that we draw this distinction between the causal and non-causal uses of 'if'. It seems unlikely that there will be a single theory of conditionals that accounts for them both. Lowe (2012), for instance, argues that one cannot use antecedent strengthening as a test of the necessity of a conditional. Antecedent strengthening would be a way of testing whether a conditional is subject to falsity under additive interference, and thus whether it is a causal conditional (or not, and therefore non-causal). But Lowe identifies a possibility of the additive interferer being something inconsistent with the prior antecedent conditions as they stand. The conditional then comes out true trivially on account of having an impossible antecedent. However, if we consider conditionals ontologically, as pointing to natural causal processes, then of course no such conditional could come out true for this reason alone. In other words, it would be impossible to rescue a causal conditional from falsity, in the face of antecedent strengthening, by giving it an inconsistent antecedent. Inconsistent circumstances are not things that can be brought about in reality. It is thus no accident that it is particularly counterintuitive to apply RATIO to calculate conditional probabilities for propensities.

5 Dispositions as truthmakers of causal conditionals

We have now offered a brief account of how we think conditionals can be understood ontologically, and we have narrowed down the particular type of ontological conditional that we think is needed for a propensity based notion of conditional probability. We can assign a higher or lower probability to such causal conditionals. These conditionals, when read dispositionally, are linked to a particular type of conditional probability. We have already suggested that this particular form of conditional probability carries with it ontological commitments that are incompatible with Humeanism and not suitably represented by the ratio analysis. This is, however, not to say that no types of conditionals could be accurately represented by RATIO.

Many details remain to be outlined if this were to become a full theory of conditionals. While this is not the place to develop those details, it should be clear

that we take a dispositional account of causal conditionals to have credibility. This has an important consequence. There is a long history of attempts at a conditional analysis of dispositions, the motivations for which are to be found in the preservation of a Humean metaphysic and philosophy of science (see Carnap 1936 for the instigation of this trend, and Chapter 5 for a discussion of it). Rather than offer a conditional analysis of dispositions, however, we have effectively offered a dispositional account of conditionality, at least as regards those conditionals we identify as ontological in import. This indivisible causal dispositional connection, we have argued, is what best explains the connection to which we draw attention in making many of our conditional claims, and it is what we need for a propensity based notion of conditional probability.

There is still some tidying to do. We have been keen to emphasise the diverse uses of conditionality, which we can now make explicit. There are different sorts of conditional *sentences* (i.e. linguistic expressions that can be used to express conditional statements), different sorts of conditional *statements* (that is, statements one uses conditional sentences to express), some of which are contra-conditionals (that is, elliptically expressed denials of a conditional relation between antecedent and consequent), some of which are rhetorical (i.e. only feigning a conditional relation) and then *proper conditional statements* that actually state a conditional connection. Among the proper conditionals there are those that are used to express a logical or classificatory relation between antecedent and consequent (e.g. 'if *x* is a man, *x* is mortal'), or an ontological principle (e.g. 'if *x* is influenced by a net zero moving force, *x* will continue in constant rectilinear motion or remain at rest'), or a mathematical relation (e.g. 'if *x* is a triangle, the sum of the interior angle will be equal to two right angles') and finally, ordinary causal conditionals, which will always be stated with a tacit *ceteris paribus* clause.

The conditional probabilities associated with propensities are essentially conditional. This means that there are no plausible ways to define absolute probabilities and from which we can derive conditional probabilities. An upside of our dispositional account is that there is no need to distinguish between indicative and subjunctive conditionals in the case of propensities, since they nevertheless have the same disposition as truthmaker. Similarly, Hájek (2003) demonstrates that we have perfectly determinate and plausible intuitions about conditional probabilities also in cases where we ignore whether the conditions take place and with what (absolute) probabilities. Denying that the ratio definition applies to propensity based conditional probabilities also allows us to re-establish the connection between conditionals and conditional probabilities, separated in the standard attempt to save us from Lewis's triviality result.

We pointed to a number of cases in which the ratio analysis fails to account for a propensity based notion of conditional probability, even where the probability of antecedent and consequent are well defined. A general diagnosis of these failures was that the probability of *A* given *B* was dependent on an ontological connection between *A* and *B* that the ratio analysis cannot capture. In many cases where the unconditional probabilities are derived from underlying conditional ones, application of the RATIO method of calculation does not produce

unintuitive results. But, we argued, it does in cases where the probability of *A* is one, where *A* and *B* are probabilistically independent and where the probability of *A* and *B* is high.

A crucial move is that we understand causal connections within a dispositional framework. This allows us to see the true difference between the purely logical and ontological uses of conditionals. If we understand the ontological connection to be a causal dispositional one, then there is a very real difference between the way we understand causal uses of 'if' and non-causal uses. Causal uses will be defeasible under antecedent strengthening, showing that causation involves the dispositional modality, which permits exceptions under additive interference. Other uses of 'if' – the non-causal ones – do not have this feature.

If we recognise that there are cases where *A* and *B* are connected in some significant, ontological sense, then the use of RATIO often fails to give plausible results. Indeed, it is usually because of this ontological connection that we take the probability of *A* to be conditional on that of *B*. When we look at conditional probability from an ontological point of view, it seems essential that we assume a non-Humean causal connection between antecedent and consequent and not merely the causation that is gained within the theory of Humean Supervenience. At the very least, and no less significant, it is such a real connection that we wish to assert in many of our conditional statements.

Part IV

Epistemology

7   Perception
What we tend to see

1 Anna and Bill

Anna sees a distinctive Paul Klee painting displayed on the wall at the art gallery. Klee's paintings are instantly recognisable and Anna likes them, quickly immersing herself in an aesthetic experience while viewing the work. Outside, Bill is walking down the street and glances upon some neglected shabby section of wall on which colours have been haphazardly overlaid. Bill regrets the building is not in better shape and moves on, hoping one day it will get a complete repaint. Neither Bill nor Anna realise that the Klee painting and the area of outside coloured wall coincide almost exactly. The shapes, sizes and colours correspond. In the gallery, Anna enjoyed her aesthetic immersion. In the street, Bill had none. But didn't they see the same thing?

Aesthetic experience is neither an entirely objective matter nor an entirely subjective one. It is not as if we all take aesthetic pleasure from the same things in the same ways, that we concur on what is beautiful, that we agree on the proper objects of aesthetic experience, nor what are the opposite. Tastes differ. We do not think that there is anything that must be seen aesthetically, nor that there are things that mustn't. Yet we also do not want to say that aesthetics is an entirely subjective matter, otherwise no meaningful disagreement would be possible. And there is, after all, some broad, even if not universal, agreement on the aesthetic values of certain art works or naturally occurring phenomena. In many instances, we tend to agree. Who would deny that a sunset bursting through broken cloud was aesthetically valuable? Only a few.

To explain at least some part of the nature of aesthetic experience we will apply a dispositional theory in which aesthetic experience is understood in terms of a mutual manifestation between perceiver and object perceived. This gives us an account that is a mitigated form of aesthetic voluntarism. Within limits, one chooses to take aesthetic pleasure from certain experiences.

Are there lessons that can be taken from this and applied to perceptual experience generally? We say so and thus develop a mutual manifestation account of perception – not merely aesthetic perception. We argue that the account respects many of our core beliefs about the objective and subjective mix within perception.

2 Aesthetic experience

There are differing views on what are the appropriate experiences from which to take aesthetic pleasure. Hume (1757) argued that agreement on aesthetic value is not universal. But it doesn't seem a completely random matter either. Not everyone has heard Mozart. But those who have very often agree that Mozart has created something valuable. There is a degree of convergence on the view that this is beautiful music. Similarly, those who have seen works by van Gogh or Frida Kahlo, or have studied Jane Austen's books, see it as entirely appropriate that they are used as sources of aesthetic enjoyment. While there is of course no unanimity, this degree of convergence suggests, though by no means conclusively, that aesthetic value is not an entirely subjective matter. Of course, agreement could all be down to peer pressure. Some of it probably is, but we rather doubt that it all is. There seem to be some real properties of certain things in respect of which we human perceivers tend to have positive aesthetic experiences. Still, it seems implausible that such properties alone could guarantee a positive aesthetic experience.

We will offer a dispositional theory of aesthetic perception, starting from the Kantian view that aesthetic experiences are more than merely subjective, but also less than strictly objective (Kant 1790, Second Moment: §6–9). Hence, our concern is with what we *tend* to see as beautiful, where the tendency comes not only from the perceived object nor only from the perceiving subject. But we do not want to restrict ourselves to aesthetic perception, since we think our theory has something more general to offer about all forms of perception.

We have not yet said what it is about an experience that makes it a distinctly aesthetic one. And we have certainly not said that a tendency towards convergent agreement of aesthetic value is constitutive of that value: not even that it entails it. We are, rather, concerned to motivate the idea that there is a degree of objectivity in aesthetics, though not complete objectivity. This latter qualification is important. It is hard to rule that someone is plain wrong if they claim that something atypical – compared to the rest of us – gives them aesthetic pleasure. Some paintings, music or film might be 'special interest' but how can we say someone is plain wrong if they think those things good? Another consideration against absolute objectivity in aesthetics is that we can apparently choose to take aesthetic experience from virtually anything we want. If someone is found staring intently at a radiator hanging on her wall, for instance, entranced in contemplation, who is to say that she is wrong in viewing that object aesthetically, taking pleasure from the visual experience? In such a case, it looks as if we can choose when to take an aesthetic experience and from what.

This latter point suggests we should accept some form of aesthetic voluntarism in which an aesthetic experience is something we choose to have (Mumford 2011b: ch. 7, 2013). Anna in the art gallery has chosen to have such an experience while Bill, outside, has not, even though the sight before the two of them is virtually the same. Doubtless, there are clues that perhaps prompt Anna to take a positive aesthetic experience. The Klee painting is hanging in an art gallery, which is a clear signifier that it is meant to be viewed a certain way. Bill's piece

of wall lacks any such signifier, though he might nevertheless have paused and enjoyed the colours had he been in contemplative mood. He might even have considered how much it looks like a Klee painting. A picture frame indicates in a very clear way that the image is meant to be viewed aesthetically. But we maintain that there will always be a voluntary element from the observer when the image is so viewed. Anna went to the art gallery voluntarily, for instance, presumably with every intention of taking aesthetic experiences. And she passed quickly by works of Yayoi Kusama, Georgia O'Keeffe and Andy Warhol, actively seeking out something she would enjoy more and pausing only once she had reached this Klee. It was at that point that she looked intently, stroked her chin and smiled.

We explain the puzzles raised by the differing experiences of Bill and Anna by understanding aesthetic perception in terms of a mutual manifestation between perceiver and thing perceived. Certain properties of things – visual, audible and sometimes even tactual – are apt to produce positive aesthetic experiences but only when meeting a suitably receptive perceiver who is disposed to perceive those properties aesthetically. Cases of negative aesthetic value involve more complications, as they are not experiences we tend to seek voluntary. The extreme case of disgust is almost always involuntary, so we will set the negative cases aside and concentrate on the enjoyment of aesthetic pleasure. Again, we use the conceptual apparatus introduced by Martin (2008) of mutual manifestation partnerships, which receives an exemplary illustration in the case of aesthetic experience. It is not simply that the properties of the object of perception stimulate the aesthetic experience of the perceiver. That is altogether too suggestive of passivity on the part of the perceivers and does not explain enough how, from the same objects, some perceivers gain aesthetic pleasure and others don't. The mutual manifestation model tells us that the perceiver is also an active contributor to the aesthetic experience, which sounds entirely right. The aesthetic experience would not occur unless the perceiver exercised her own powers on what she is able to see. Effectively, this makes the experience an action – something done by the agent – rather than a passion in the old sense of the term: something with respect to which we are passive.

As well as explaining how we can actively take an aesthetic experience from some things and not others – different people doing so from different things, as is their want – the account also offers hope of explaining our quandary regarding objectivism and subjectivism in aesthetics. Some properties, such as certain shapes, figures or arrangements, might be disposed to be seen in a certain way by a reasonable, regular perceiver: tending to be perceived beautifully, for instance, as has been suggested by the formalists (see for instance Kant 1790, Bell 1913, Zangwill 2001 and 2005). But for them to actually be so seen, they must be received by a suitably empowered perceiver; that is, someone suitably disposed to perceive those properties as beautiful. In such an account, there is nothing wrong in principle with a rational agent admitting that something bears a property that for the most part tends to cause aesthetic enjoyment – in mutual manifestation with suitably empowered agents – but conceding that she personally is not such

an agent because she has different tastes. Such a perceiver could say that while Mozart is not for her, she accepts that people of more standard tastes tend to like his music and gain a lot of pleasure from listening to it. The account thus allows for the possibility of meaningful disagreement. Even someone with eccentric tastes could discuss whether the music of Mozart is the sort of thing that tends to give aesthetic pleasure to 'regular' perceivers. One might even, when engaged in argument, put it in terms of whether you ought to take pleasure from Mozart. We see that aesthetic standards of taste then come out as partly objective but also partly subjective, in agreement with our interpretation of the Anna and Bill case.

3 Perception generally

Much more can be said regarding what is happening when such perceptions are made. But rather than pursue these issues in specific relation to aesthetics, we wish to consider whether this account of aesthetic experience can be generalised to all sorts of experience, not just aesthetic ones. As we think it can, we will add the requisite details as part of the general theory rather than the specific one. When generalised, the account supports a qualified form of epistemic voluntarism, as we will explain.

Our account applied to perception generally gives us a view that objects and their properties have a tendency to appear a certain way in mutual manifestation with a perceiver. This accords with the idea, which we support, that perception is an essentially causal notion (Grice 1961, Strawson 1974, Pears 1976). It might not be an exclusively causal matter, of course, but for *a* to perceive O is, at the very least, for *a* to have entered into a causal interaction with O. Such a view is a near orthodoxy. Even a dissenting voice such as Snowden's, with a number of reservations about the sufficiency of causal theories of perception, offers no serious challenge to such a claim – what he calls the 'causal thesis' (Snowden 1980: 176) – as a necessary condition upon perception.

We might ask for more detail on the causal component of perception. What exactly is the causal interaction that is involved? And is it right to characterise it as an interaction, which suggests that both parties to the causal transaction undergo change during the perception? Perhaps a more standard way of thinking is that the perceiver undergoes the change – to her mental states – when she perceives, but the object of perception need not undergo a change merely in virtue of being perceived. The issue could be brought into focus by considering our attitudes to two extreme positions, both of which would now probably be considered strawmen. On one side, an objectivist about perception – perhaps a naïve realist – would say that we passively receive a copy of the perceptual stimulus, being causally affected by it but not affecting it in return; hence, not affecting its appearance. Neisser (1967: 16) outlines such a view, about which he is rightly sceptical. The polar opposite view is subjectivism, which suggests that we project our thought onto the world and thereby determine what we see. Some of the examples illustrated by Gregory (1977) might tempt one towards such a view. To take the simplest example, in the Müller-Lyer illusion, where the different

arrow-like lines are the same length and yet we see them as different depending on the pointed direction of the fins. It must, then, be us perceivers who determine the appearance of different length, rather than the lines themselves. We could consider Berkeley's (1710) idealism as the ultimate form of subjectivism, with individual perceivers and God bringing the physical objects of perception into being through the very act of perception. A more credible subjectivist and constructivist position would be that what we perceive is entirely determined by us: by our background beliefs and theories, for example.

Such objectivist and subjectivist views both make a mistake of assuming asymmetry in the causation that is involved in perception. They both tell a story of the causation going one way: either from object to perceiver or from perceiver to object. The disagreement is over which way. But what both sides fail to accept is the idea of perception being mutually produced by object and perceiver acting together. We can see that a theory of perception ought to make some room for the real nature of the world. After all, perception is useful to us precisely because it gives us some knowledge of a world outside of our own minds. But if our theory of perception is solely objectivist, then it cannot account for the apparent datum that different perceivers who look at the very same thing can nevertheless see it differently. We can see also, therefore, that a theory of perception ought to make room for the subjective nature of experience, allowing that perceivers with different beliefs, or indeed different perceptual faculties (Nagel 1974), can see the world differently. Hence, the reason it is so unattractive to adopt either extreme view – a total objectivism or a total subjectivism – is that the right account of perception must have elements of both. But what is the right account that delivers them, or in some way finds a compromise between the two extremes? One famous answer is offered by Kant's (1781) distinction between the noumenal world (*Ding an sich*) and the phenomenal world (*Ding für mich*), where only the latter is experienced, but we think a dispositionalist can give a plausible alternative also without that distinction. We do not offer a full theory here, but we do think it helps to get the causal elements right and thus understand the causal thesis better.

4 Replacing the stimulus–response model

There had been a standard view, tacitly present in much of the philosophical treatment of dispositions and powers, in which the powers of a particular await stimuli (for example, Bird 2007: 19–29). A stimulus is understood to be what triggers the power to manifest itself. It is easy, for instance, to think of solubility as a disposition that does nothing until it encounters the appropriate stimulus, and it is at that point only that it will manifest itself in dissolving. This view accords with a number of related claims that are especially conducive to an empiricist framework. One is a conditional analysis of disposition ascription. The stimulus condition can form the antecedent condition of such a conditional, and the possible manifestation can take the place of the consequent condition. Allied to this, a stimulus–manifestation model of how to trigger a power seems to fit also

with an event ontology: one that sees events as the relata of causal relations. Hence, what triggers solubility can easily be identified as the *event* of it being put in liquid. Given that Modern philosophy on the whole attempted to understand causation exclusively in terms of efficient causation (see Schmaltz (ed.) 2014 and Mumford 2014), then it was important for its understanding of dispositions that it be in terms of events or changes.

   Those who take powers seriously ought to object to such an account at every stage, though in practice they don't always. A conditional analysis should be spurned because, among other reasons, if successful then it brings the reduction of disposition ascriptions to occurrences (see Chapter 5). Nor should we accept so easily the empiricist understanding of causation in terms of relations of events. Martin (2008) challenged the idea of powers standing in need of stimuli. His contribution is vital for showing why we should not accept a stimulus–response model for the activation of powers. That model indicates something that an empiricist might accept, while a realist about powers should not, namely that powers are inherently passive; that is, powers alone are incapable of doing anything and act only when stimulated to do so. Perversely, the account makes it look as if the powers are inert while the stimuli are depicted as active (see Groff 2016 for a criticism of such passivism). The application of a stimulus–response model to the case of perception then naturally tempts one to the view that objects stimulate the senses and that we are passive with respect to the perceptions we receive. Statements by Russell and Quine, for instance, seem to confirm this sort of view:

> my stance is naturalistic. By sensory evidence I mean stimulation of sensory receptors. I accept our prevailing physical theory and therewith the physiology of my receptors.
>
> (Quine 1981: 24)

> We have a number of experiences which we call 'seeing the sun'; there is also, according to astronomy, a large lump of hot matter which *is* the sun. What is the relation of this lump to one of the occurrences called 'seeing the sun'? The causal relation is as follows: at every moment a large number of atoms in the sun are emitting radiant energy in the form of light waves of light quanta, which travel across the space between the sun and my eye in the course of about eight minutes. When they reach my eye, their energy is transformed into new kinds: things happen in the rods and cones, then a disturbance travels along the optic nerve, and then something (no one knows what) happens in the appropriate part of the brain, and then I 'see the sun'. This is an account of the causal relation between the sun and 'seeing the sun'.
>
> (Russell 1940: 117–18)

In Martin's model, powers become active when they meet their mutual manifestation partners. This is far more than a terminological change. Mutual manifestation indicates the idea that all components are active, that they come together

for an effect and that they produce something jointly that they would not have produced alone. Significantly, there is no longer an asymmetry between the power and its stimulus, where the stimulus is active and the power a mere passive recipient of change. In Martin's model, effects occur when a number of powers come together, each making an active contribution to the effect, in a more or less equal partnership. We would not deny that a coal fire makes a bigger contribution to the warming of a room than does the body heat of a man sitting within. But while there can be different degrees of contribution, this model grants that those contributions do not differ in kind: in respect of having active, powerful natures or not.

We have elsewhere offered a number of amendments to Martin's account (Anjum and Mumford 2017b). One significant difference between our version of the view and Martin's is that we think of mutual manifestation as giving an account of causation, while he insists in at least one place that he does not. Martin seems to be offering mutual manifestation as an alternative to causation. Instead, we think that, once nonlinear and emergent processes are allowed, it becomes clearer that we are dealing with causal production. Martin speaks as if the mutual manifestation partners become the effect, for instance when two triangles come together to form a square (Martin 2008: 51), and the way he sets it up makes it look too much like mereological composition. We substitute this with an account in which the mutual manifestation partnerships produce their effect rather than constitute it, which we think is crucial for accommodating cases of real emergence (Anjum and Mumford 2017a).

We said that the stimulus–response model lent itself to a certain view of causality in perception, one in which external objects had a one-way causative effect on our perceptions. This account might lead one towards an objectivist account. Does a mutual manifestation model likewise suggest anything about the kind of theory of perception we should prefer? It does, and it is an account that steers a middle path between objectivist and subjectivist views. It is not merely that the object has an effect upon us as perceivers. Rather, our own predispositions as perceivers and the properties and objects perceived are the mutual manifestation partners for the production of the perception. There is a causal interaction: an act of perception performed by the agent, which garners information about some object of perception. No inanimate object has the capability of producing a perception alone, as far as we know. But nor can a conscious subject produce a perception of the world without the presence of that world causing it.

This looks like a paradigm case of a mutual manifestation partnership; therefore, the perception being produced by the object and subject together, while it could not be produced by either alone. There may, of course, be some experiences – such as illusions or hallucinations – which arguably might be produced by the agent alone. Perhaps someone who is sleep-deprived could imagine that he sees a bicycle in front of him when one is not there. But the point is that because this experience was not caused by an actual bicycle in front of him, then it is not a case of perception of that bicycle. It seems that we would even be prepared to say this if someone experienced a hallucination of a bicycle and there was,

coincidentally, a bicycle exactly like that in front of him. If the bicycle did not produce the experience – for instance, if he would have had that same experience anyway, given that he was hallucinating – then it does not count as perception of that bicycle.

Using this mutual manifestation model, we have tried to moderate the claims of the objectivist. It is not simply that the objects of perception affect us and that we are passive recipients of sense data, for instance. We have a more active role in the production of perceptual experience, as we will go on to outline shortly. But it is also worth saying that the mutual manifestation model moderates the pure subjectivist view as well. This has to be noted because we also can speak of the object being perceived and the subject being the perceiver, which in this case suggests that the thing is entirely passive and the perceiver is exclusively the agent. Again, the problem here is a suggestion of a one-way causative relation that, insofar as it is coherent, says that the perception is only about what the perceiving subject does. Such an idea is too subjectivist, we think. The perception is not merely something done to the object. Clearly a defensible account allows also that the object does something to the perceiver, and this is what a mutual manifestation model can give us.

5 The old bucket and the searchlight

That is the account of causation, which we say fits a theory in which perception is a mutual manifestation produced by the object and subject of perception working in partnership, through genuine causal interaction. But how plausible would it be as a theory of perception? Would it fit with our broader theory of knowledge? We will now argue that there are good independent reasons to accept this sort of account.

As a starting point, we revive an old distinction employed by Popper (1972) between bucket theories and searchlight theories, even though Popper was not thinking explicitly, nor exclusively, about perception. His concern was with theoretical knowledge broadly and an argument against induction. However, we find it useful to think of some of the empiricist theories, modern and contemporary, as bucket theories of perception. Such a bucket theory suggests that we accumulate experiences – as if piling them into a bucket – and from them we somehow produce concepts, and from them thoughts and then theories (e.g. Locke 1689). The crucial stage for our purposes is the first one. The experiences drop into our own personal buckets. We are passive recipients of them. We get what we are given and nothing more.

Among many others, Hanson (1958: ch. 1) provided a critique of this. According to a now widely accepted view, our beliefs and expectations can influence what we see. If one accepts that they must always do so, then to that extent it means that there is no such thing as presuppositionless observation, or 'raw' data (Anjum and Mumford forthcoming: ch. 11). Our background theories and beliefs cast a light on the world – using Popper's metaphor – acting as a searchlight that directs our observation and to an extent what we see. Hence, a belief that the sun

revolves around the earth might lead one to 'see' as if it does; likewise, those who believe the earth revolves around the sun find it is also empirically confirmed. Clicks on a Geiger counter count as data only if one accepts a certain theory about what those clicks mean. Observation in such a case is theory dependent. An image in a painting may be there to symbolise or signify something and is thus seen as such only by someone who understands how to decode the signifier. People who believe in ghosts might report having seen them, when another perceiver in the same situation would not do so. The latter example could be thought of as a special case of a more general kind of phenomenon. The sortal concepts of a perceiver enable her to see what someone would not see if they lacked those concepts. Consider, for example, two perceivers, one who has a single concept for all four-legged animals and the other who has separate sortal concepts of horse, cow, dog, and so on. In that case, the latter is able to see a horse whereas the first person, although looking at the very same thing, in a sense sees only a four-legged animal. There is ample discussion of the full variety of cases in Hanson (1958) and since (see e.g. Campbell 2002: ch. 4 and Fish 2009: ch. 2). A further kind of example is where we make sense of 'blurry' or 'incomplete' perceptual experiences and fill in the missing information (see Gregory 1997, Dennett 1991: 344–56 and Tye 2002: ch. 4). We might see just a loose collection of lines, for instance, but nevertheless be able to read them as words in a language, or one might see a shape even though parts of the lines forming it are absent.

   At this point, one can see some of the attraction of epistemic voluntarism. In the aesthetic case, Anna, our patron of the arts, entered a context where she was seeking aesthetic experiences. Her expectations in some way shaped her experience. When encountered by sight of certain worldly properties, she saw them in a particular way (see Berger 1972 for the notion of ways of seeing), whereas Bill, outside, saw the same kind of worldly properties in a different way. There is much more that can be said about such examples (see Mumford 2011b: ch. 7) but the main point now is that the perceivers' own mental states played a role in his and her experiences. This is the same principle that we wish to apply to perception generally. Different beliefs, experiences, desires and conceptual vocabularies can play a role in what one sees, even if two viewers are looking at essentially the same thing. We doubt that many would now understand such claims as controversial although it might be debatable that we should class it as epistemic voluntarism. The point of the latter, however, is simply the claim that the perceiver plays a role in, or contributes towards, what they see. Seeing is certainly an act on this view, therefore. The perceiver is an agent *qua* perceiver.

   The metaphor of the searchlight is useful here. Perception requires attention. We actively seek out experiences insofar as we look for or attend to certain things in our visual field, while ignoring others. We 'cast a light' on some things but not all. Among the various things that would be available to see, we attend only to some (see Simons 2000 and Mack 2003). This phenomenon relates to the frustrating differences we often find between perception and photography, for example. The photographer has a difficult task getting the viewer to see what she saw and wanted to be captured in the photo. One attends to a distant mountain,

for instance, and attempts to snap a picture to capture its glory, only to find that it occupies a tiny portion of the photograph and the eye of the viewer is not drawn to it at all (on perception of the photograph, see Mack and Rock 1998: 165–71). This is not to deny that a skilful photographer might be able to lead the perceiver into seeing what she wants him to see.

However, while this broad outlook is to an extent an orthodox matter, it is important that it accords with the account of causation that we developed above. And it does. The agent plays a role in what is seen but doesn't determine it completely. That would have been the danger of subjectivism. We might be able to see the sun revolving around the earth or the earth revolving around the sun, but we cannot see the sun as a pair of oven gloves, for example. At least, it is hard to believe it would be so seen.

The world offers some resistance to being perceived, and perhaps classified, in certain ways. We think it absolutely vital that this be understood in a dispositional or tendential way. A square tends to be seen as a square and resists being seen as a circle, for instance. The square might not always be seen as such. One could view the square from a slight angle and think that one is actually seeing a diamond. Of course, we accept that 'see' and 'perceive' are often understood as success verbs, and in that case one sees a diamond only if one is there. In that instance, we are happy to say that one misperceives the square as a diamond, in some cases. The point is that we tend to see squares as squares, rather than other shapes. Indeed, we have a tendency to perceive them this way even when we view them at an angle, as we almost always do. Hence, the retinal image may be more diamond-like, but still we are able to see it as a square because it fits our gestalt, expectation, background knowledge of angles or whatever. There is, in contrast, little tendency for a square to be seen as a circle, although this is not to deny that it could happen. There might well be some circumstances in which it is possible for a square to look like a circle to a standard perceiver, but the point is that it has no tendency to be so seen.

The modality of perception is the dispositional modality. A square tends to be seen as such but it is not necessary that it be so seen. Clearly, it is a more than purely contingent matter that it be so seen. The square has no significant tendency to be seen as a shoe, as the colour red, as Nicole Kidman or many other things. Again, we must think of perception as a mutual manifestation and what goes tendentially for the objects must go also for the perceivers. We viewers tend to see squares as squares, so it is not just a disposition of the object to appear a certain way that is at issue but also the disposition of the perceiver. And there is certainly a good prima facie reason to think that we ought to be disposed to see squares as squares, fires as fire and tigers as tigers. If we didn't at least tend to see the world as it is disposed to be seen, then perception would be useless to us.

There are many complexities. Tendencies can come in degrees, for example. Something could tend quite strongly towards being perceived in a certain way or it might tend only slightly. And an object of perception might be ambiguous, which in our theory means it could have multiple contrary tendencies, which different perceivers can perceive in different ways. Consider the Necker cube or

the two faces together that can also be seen as a candlestick. There is nothing wrong in principle with the idea of something holding contrary tendencies, even though they might not be able to manifest them all at the same time. In the case of perception, then, one could see the shapes either as a candlestick or as two faces looking towards each other, but it's very difficult to see them in both ways at the same time. And more complex objects of perception could be capable of contributing to many different sorts of perception. We have been using the simple example of squares but think of the different ways in which a person's behaviour could be perceived, not to mention a society or history. Clearly these more intricate objects of perception are disposed towards being perceived in a variety of ways, depending on the perceiver's focus, background knowledge, expectations or interests.

   In all cases we are assuming a tendency or tendencies towards a perception. Suppose our own perceptual powers did not involve the dispositional modality, for example. What if it was completely random what we experienced when we looked at something? Any such 'perception', if it even deserved the name, would be useless to us. But it would be far too strong a constraint on perception to say that it must always result in a definite type of experience in a set of particular circumstances. Misperception would then be impossible. Examples we have already considered show that clearly to be false. Rather, perceiving the world and the things in it in a certain way is more natural than perceiving it in another way, with different degrees of tendency for different things. Our account is that this is because perception is a mutual manifestation between perceiver and object, and like all natural causal processes, it involves the dispositional modality.

6 Rational animals

A possible line of criticism against our account is that it assumes too high a level of rationality as a precondition of perception. Hanson (1958) tells us that seeing is always 'seeing that', which suggests that the holding of a propositional attitude, background theory and conceptual framework is integral to perception. But then it might be objected that animals, even some quite simple ones, seem able to perceive even though they have almost nothing by way of background theory in order to see that something is the case. Another way to express the concern would be to say that it conflicts with Aristotle's division of vegetative, sensitive and rational souls (Aristotle 1986, *De Anima*: Bk II). Plants have a vegetative soul but cannot perceive or reason. Animals can vegetate and perceive but do not reason. Humans have all three abilities. There could be an uneasy alliance here between the Aristotelian view and empiricist treatments of perception. If one considers Locke (1689: Bk II) or Hobbes (1651: ch. 1), for instance, then perceptions seem to occur to us, prior to the exercise of our cognitive abilities. We are depicted as organic machines, receiving inputs from which we form concepts and, from those, language. Indeed Locke (1689: Bks II and III) and Hume (1739: Bk I) both construct accounts that show how it is from perceptual experience that we build concepts, reason and language: resources which cannot then be a precondition

of the original experience. The idea that there can be conceptless experience retains adherents (see Dretske 1969: ch. 3 on primary epistemic seeing, Crane 1992 on nonconeptual content and Lyons 2005 on nondoxastic experiential states). But if one claims that rationality is required for perception, it challenges the Aristotelian account. How could one have a sensitive soul without a rational one if perception requires a theory of the world and expectations concerning it, which sound like relatively sophisticated cognitive abilities? Perception would seem to demand a capacity for abstract thought and possibly language, reversing the kind of psychic hierarchy that Aristotle suggested.

One can see how the Aristotelian account might fit well with an objectivist view of perception, or one in which objects merely acted upon our sense organs in a one-way causative relation (we are not claiming that this was Aristotle's actual theory of perception, for which see Marmodoro 2014). But once one allows rational elements into the mutual manifestation for perception, the matter becomes more complex. Suppose one sticks to this latter view, insisting that perception requires rationality, concepts and cognition (for instance Evans 1982: 157–61, McDowell 1994: lecture 1, Seigel 2006 and, for a nuanced view, Bayne 2009), then does that mean that non-human animals are incapable of perceiving? That sounds unintuitive. They seem quite obviously able to sense their environment and negotiate their way around the world, with varying degrees of success. But then the other alternative would be to say that animals are rational. Might then the sensitive soul collapse into the rational one?

The best response is to say that the boundary between sensitive and rational souls is not as clear cut as Aristotle suggests. But then the boundary between the vegetative and sensitive soul might also be questioned, depending on one's theory of perception. If one says that to perceive is to be sensitive to changes within one's environment, for instance, then clearly many plants are able to do this, in respect of many environmental changes. A plant turns to face the sunlight, for example, and shrivels without water. Should the exercise of these abilities count as perceptions of their environments? The problem with saying so is that even a barometer and thermostat are sensitive to environmental changes in this way and we almost certainly would never want to say that they are perceivers. Again, this might favour the consideration of rational elements in perception, which plants and artefacts clearly lack and might then be the basis for saying that they are non-perceivers.

We have stated that we side more with rational theories of perception. At least, it seems that perceptual capacities have a point only if they are integrated within a package of abilities, including capacities to believe, to intend and to behave (Armstrong 1968: II). It is hard to conceive of perceptual abilities evolving that did not feed into the behaviour of their owners, for example. And we ought then to say, when considering humans, animals, plants and inorganic machines, that the gaps between humans and animals, and between plants and artefactual machines, are smaller than the gap between animals and plants. To perceive requires a degree of rationality, which neither the thermometer nor photo-responsive plant have.

A key word here is *degree*. Rationality is not to be taken as an all-or-nothing matter but something of which you can have more or less. It could then be a basis of perception even for non-human animals, which might have less rationality than humans on the whole, but still enough to be perceivers. This ought not to be a controversial view. Indeed, in theory, it seems possible that the gap in degree of rationality is wider, in some case, between one human and a second, than it is between that second human and an intelligent animal. Furthermore, the account allows that one can come to perceive more proportionally with an increase in reason: as one acquires more concepts with which to understand the world, for instance. One can learn to see (Gregory 1977: ch. 11), as does the wine connoisseur who can distinguish many more flavours than the rest of us tasting the same set of wines. The connoisseur might not simply have a more sensitive palate. It seems more credible that the very same powers of the wines act upon her but she is able to taste more simply because she has a more sophisticated theory and conceptual divisions for her experience. It is not merely that she has more sense receptors on her tongue.

We have argued for an understanding of perception as a mutual manifestation between perceiver and object perceived. This provides the right middle path between the extremes of pure objectivism and pure subjectivism. It leaves us with the view that we tend to see worldly features in certain ways, where such a tendency means that it can be seen in many other ways but tends not to be; nor must a worldly feature be seen only in one way. The more rational something is, then the more possibilities of perception (seeing that) are available from the same sensory effects. Many animals have better senses than us. But their ability to perceive may by limited if they are less capable of abstract thought. It is vital to understand, however, that we are not saying that two subjects of experience looking at the same thing see the same – and then one person has more sophisticated thoughts than the other about what she sees. To be serious about the mutual manifestation model is to say that the perception is something produced in causal interaction between the powers of the objects and those of the perceiving subject. The perceiver acts in producing her perception, which is then already a rational product at the moment it is experienced.

Such a view will be controversial to some and less so to others. What we have done that is original is to situate the theory of perception within a framework of mutual manifestation of powers and the dispositional modality to justify a mitigated form of epistemic voluntarism. At the same time, we hope for a better understanding of causal theories of perception by rejecting one-way causative models.

8 Metascience
What we tend to know

1 Insecurity of inference

As well as immediately experiential knowledge, much of what we know, or want to know, involves an attempted ampliative inference. Deductive inference is one thing but, to follow the standard line, it tells us nothing more than is contained in the premises. With an ampliative inference, we aspire to get more out of an argument than we put into it, thereby making a real gain in knowledge. Induction is the foremost example; one that makes the risks apparent. As Strawson (1952: II, ch. 9) was keen to point out, inductive inference is not, and never was intended to be, deductively valid. That wouldn't matter at all as long as it were a form of inference that was in some other way reliable. As is well understood, however, inductive inferences are to some extent unreliable. Such a form of inference, which is often thought of as vital to theoretical knowledge, seems able to take us from what we think we know only to something that is known less securely.

There can be little doubt that we seek theoretical knowledge with a broader scope than the particular matters of fact furnished to us by experience. We can gather data: that one particular thing is the case, that a magnitude is of a certain value, that an experiment has produced a certain outcome, and so on. In addition, we need more general truths that we can apply to a wider range of circumstances than the known particular facts. We want to use our experience to make predictions, for instance, and to gain a deeper understanding of the nature of things so that we can offer explanations and develop new technologies. Data alone can give us none of this unless we are prepared to take a risk and infer from the observed to the unobserved.

The 'problem' of induction is one of the great difficulties in epistemology. There is a tradition that implores us to regiment our methods so that induction finally becomes secure (Bacon 1620). Were we to eliminate human error, reliability would be assured. Another tradition remains defiantly sceptical (Hume 1739), arguing that inductive inference can only be fallacious.

We wish to offer a different perspective. Inductive inferences are clearly insecure. But that's as they should be. The insecure nature of such inference reflects quite well the tendential nature of the natural world. Overlooking this point has led to misguided approaches in both inductivism and its purported rival

falsificationism. If one thinks that the outcome of an inductive argument should concern what is always the case in nature, then such a conclusion is always susceptible to counterexample. There are regularities in nature, to a degree, but they are not absolute (Cartwright 1999, Mumford 2011a). Suppose we think instead that the target of inductive inference should concern only what tends to be. Such an aim would be justified if you think our world is a world of tendencies instead of a world of absolute regularities. And, with that, it seems one would be in a position to reassess the worth of inductive inference. It would still be an insecure inference, admittedly. But if that insecurity matches accurately the tendential nature of the world, then it can hardly be a criticism of induction. Indeed, any method that supposedly delivered universal and unqualified conclusions about the workings of nature would always be overreaching.

2 Generality

Not always did we conceptualise nature in terms of absolute generality. Aristotle thought of what was the case *for the most part*: a matter that still would require empirical discovery from our experience. The Aristotelian view persisted into medieval philosophy with Aquinas (Chapter 2). It was allied with a commitment to *natures*: essentially causal powers that were directed towards ends. With the rejection of irreducible powers and final causes in mechanistic philosophy, Boyle (1674, 1686) being an ideal representative of such a view, a different way of understanding came to the fore. To fill the explanatory gap left by the subtraction of powers and final causes from our ontology, we instead started to describe the world in terms of the universal laws of nature (see Ruby 1986 and Feser 2014: 69–72 on the historical and philosophical origins of the concept of a law of nature). At that point, inductive inference became a problem. We think this problem was generated by a particular non-tendential conceptualisation of the world: one that we find flawed.

Instead of individual powers, singularly directed towards their manifestations, the framework of laws is distinctive for its generality of scope. The law consists of a universal truth applying to all particulars of a certain kind, for instance, that all Fs are Gs. We might take as instances that all heated iron bars expand, that all electrons have negative unit charge, that all pairs of material objects attract each other to a degree, which is a function of their masses and distance apart, and so on. Such general knowledge, if we had it, would be useful because of its universal application. If one knew the general truth, and one knew that a particular iron bar, which had never before been heated, was about to be heated, one would be in a position to make an infallible prediction about its subsequent behaviour.

But what are such laws of nature? There are two main accounts of laws, one deflationary and the other realist. The deflationary account is the empiricist one, which tell us that laws are just statements of the universal regularities there happen to be in nature (Hume 1739: I, iii, Psillos 2002) or best possible systematisations thereof (Mill 1843: III, iv, 1, 317, Ramsey 1928, Lewis 1973b: 73). Hence, there is allegedly nothing in nature that necessitates all ravens being black.

Each raven being black would be a contingent truth, as would the aggregate of all such truths, which happen to form a general truth of universal scope. As Humeans put it, there are no necessary connections in nature but instead just a collection of local matters of particular fact (Lewis 1986b: ix), some sets of which collectively constitute regularities.

Anti-Humeans have sought a stronger conception of law. If a law is just a regularity, then it cannot explain its instances because it is constituted by those instances. Furthermore, the empiricist account cannot distinguish accidental regularities or coincidences from genuinely lawful ones. Some things that happen all the time do so by pure chance whereas others are due to the 'governance' of a law of nature. As a solution, Armstrong (1983) proposed the theory in which a law of nature is the holding of a relation of natural necessitation, N, between the universals F and G. A law is thus a higher-order relation of natural necessitation, the relata of which are properties, hence N(F,G). However, a commitment to generality remains in Armstrong's theory. While all Fs being Gs does not entail N(F,G), because of the possibility of coincidental regularities, N(F,G) entails that all Fs are also Gs. One might assert that any adequate theory of laws worthy of the name must at least support such a universal claim, even if the law is not constituted by it.

Now whether we have either a deflationary account of laws or a realist one, it leaves us with a problem of how we could have knowledge of such a law. The law has universal scope while our experience gives us knowledge only of particular things. This universal scope is one of the features that makes inductive inference a problem. The two accounts of law might differ slightly on just how big a problem this is. The regularity account takes into its scope all the Fs and, one assumes especially for four-dimensional variants of the view, that this means everything that is, ever was and will be F. How we could possibly know something to be true of all such Fs is one thing, with our spatiotemporally finite and located point of view. Nagel (1986) emphasises this gap between our located experience and the aims of science. But the realist takes on an additional epistemic burden because their laws are supposed also to sustain counterfactuals; that is, they concern anything that could be F even though, as a matter of fact, those things are not. In the case of Armstrong's theory, for instance, the law relates through natural necessitation the universals involved in the law and not merely the particulars that instantiate those universals. Hence, the law that relates being heated iron and expanding applies equally to an old brown shoe. If this shoe were an iron bar and heated, it too would expand.

Prima facie, it appears incontestable that any such general nomological truths cannot be inferred unaided from our experience of regularity. As the standard arguments go, unless you have experience of everything that is F, how can you be sure that they will all be alike in also being G, even if every F you have so far experienced was G? All swans were once believed to be white and then a sub-species was discovered, Cygnus atratus, which are black. Just one exception disproves the general rule. And Hume (1748: IV) added to the debate the further sceptical point that even if we did find every F, and see that it is G, we would have no grounds to know that the future would be like the past anyway. The Fs

that have existed to date could be an unrepresentative sample, and we have no reliable knowledge of how big a proportion our sample is of the total number of things that are F. We cannot, then, even assert that Fs are probably Gs.

That inductive inference is to an extent fallible is thus a consequence of the assumed generality of its goal. No inference from our limited experience to what is always the case is valid, once such generality is assumed. But generality is a presumption also of falsificationism, the great Twentieth Century rival to induction. Falsification is therefore no less problematic than induction, contrary to how it is usually presented.

Offered as a broad approach to scientific discovery, falsificationism gives us a number of innovations. One is to allow that the context of justification can be more important than the context of discovery in providing the scientific credentials of a theory. Where the theory originally came from matters less than how we try to justify it: through testing, for instance. And if a theory is unfalsifiable, it is not scientific at all (Popper 1934/1959: 40–2). However, one alleged motivation for rejecting the inductivist view, which is enshrined as a principle of falsificationism, is the idea that a general theory is to be rejected if a counter-instance to it is found. If we think that all swans are white, and then find at least one black swan, the theory has to be rejected outright. This principle is further exploited when it underpins a claim of logical asymmetry between confirmation and falsification. We can never know a general theory to be true, because of the possibility of some undiscovered exception to it, but we can know a general theory to be false, if we find such an exception. Science, Popper goes on to argue, should proceed on the basis of testing and rejecting theories, rather than seeking the impossible, which is to prove them true. But we can see that this all rests on an assumption that is shared with inductivism and it makes even greater argumentative use of it. The assumption is again that theories are – and should be – of general scope. One can only say that a single exception falsifies a putative law if one is assuming the law to be absolutely general. If it is anything less than that, then single exceptions, or even a limited number of them, could be perfectly consistent with the law.

Some such problems of falsificationism are well known. The Duhem–Quine thesis already casts doubt on the claim that one exception is an adequate ground to reject a theory. This thesis is simply that it is always possible to amend one's theory to accommodate the apparent exception so that it no longer is one, or: 'Any statement can be held true come what may, if we make drastic enough adjustments elsewhere in the system' (Quine 1953: 43). Only with the assumption of a theoretical general scope, however, is any fancy footwork needed at all. To that extent, we might criticise the Duhem–Quine thesis too for assuming generality; this thesis at least assumes that apparent exceptions to a theory are something that needs to be explained away in order to preserve generality. Perhaps theories don't need any special amendment of this sort.

It is worth stopping to consider, then, just how plausible is the assumption of generality in nature. We have in turn said that the assumption is shared by inductivism, falsificationism and even some critics of falsificationism. Doesn't that show it must have at least an initial appeal?

We are not the first to point out, however, that as a simple statement of the facts, universal regularity in patterns of events or properties looks hard to find. We should first separate two kinds of cases. There are some examples where the regularity does seem confirmed: for instance, in the cases where all water is H_2O and all electrons have negative unit charge. We will come back to these kinds of cases shortly. We do not think they suffice to vindicate a regularity view of nature, nor inductive inference at all, because these statements are not inductive discoveries even if they are a posteriori discoveries. In the second kind of case, we find a degree or regularity but where there is also a possibility of exception. Consider the example of ravens being black. Clearly there can be exceptions to this, nevertheless. A raven might be dipped in whitewash or be an albino. And not every heated iron bar has expanded: not if it is also being compressed at the same time. Nor does the gravitation law describe how everything actually behaves. Some objects dropped near the surface of the Earth don't move directly towards it. Perhaps the wind or their own aerodynamic properties makes them take a different path. The point strikes not just against the regularity theory, as we explained. Falsificationists would have some comparable problems. Not everyone who smokes gets cancer, for instance. It would be a crass philosophy of science that pronounced this evidence a refutation of any causal link between smoking and cancer.

Now the defender of absolute regularity in nature might claim that these instances are all a cheat. The law about ravens is clearly not meant to apply to those of them that have bathed in whitewash and the law of gravitational attraction isn't falsified every time an aeroplane takes off. The theory, they might protest, is not a naïve regularity theory but a more sophisticated one. It is about ravens that are not painted other colours and are not albinos and objects that don't have other interfering factors in their way. The rocket that blasts off into space is not literally defying gravity; it is simply subject to a stronger upward thrust. This latter statement is of course true. But this move is no small departure for the regularity theorist nor any other supporter of generality. It is a concession that generality is not a *de facto* truth.

What then is it? Suppose one says that the generality is an idealisation, as seems credible. But then in virtue of what is it that in putative ideal conditions – presumably free from of all kinds of possible interference – things would behave in the prescribed manner? There is one way to answer this question, though it offers no comfort to the regularity theorist. The answer takes us back to the causal powers of things, for which laws were supposed to be the better alternative. This is a line that will be pursued shortly, below.

We are now, however, in a position to offer up our main conclusion, though it is one to which we will be adding further detail. If the generality assumption is false, if nature does not work that way, then it means that we have seriously misconceived the business of inductive inference. This need not be an attack on induction as a whole, if we take it broadly to mean a kind of ampliative inference from the observed to the unobserved. We should still be looking to form our theories in the light of what we have experienced, for instance, at least some of

the time. And some theories can be better empirically supported than others. But induction, understood narrowly as the inference from all observed Fs are G to all Fs are G, observed and unobserved, not only fails to hit its target, it was aiming for the wrong target in the first place. If nature is about what tends to be, then there are no such truths of the relevant target kind to be found, by any sort of pertinent inference, and even if we knew everything.

Before that, and before we offer our own account of induction, let us consider one other assumption behind the standard justification for inductive reasoning. This is an assumption that the more confirming instances we find, then the more likely is the theory to be true. This assumption is challenged, to an extent, by falsificationists who answer that it still only takes one counterexample to make the theory false, despite any number of supposed confirmations. But the assumption is backed by some of our scientific practices, for instance in trials on drugs, where evidence of correlation is considered better the higher the number of the sample (Howick 2011, Kerry, Eriksen, Lie, Mumford and Anjum 2012).

There are some clear counterexamples to this principle, however. In a sense, there is a diminishing return on the weight of each new confirming instance. Beyond a certain point, each new 'confirmation' tells us less and less. Would the 10,001st case tell us anything more than the 10,000th? It is far from obvious that there is an imperative always to gather more data (Anjum and Mumford forthcoming: ch. 12, 26, Rocca, Anjum and Mumford 2018). Perhaps more importantly, there are obvious cases where counter-induction makes sense. Things can wear out, for instance. There might be a threshold at which a mechanism ceases to function, and each successful usage takes it closer to that threshold. A car that has travelled 200,000 miles is less likely to travel the next mile, all else being equal, than one which has travelled only 20,000 miles. It is clear, then, that if we are to support some form of revised inductivism, it had better address more than simply the objection from a lack of generality in nature. Ampliative inference from the observed can be a useful part of scientific methodology but, we urge, only when situated within a context of other forms of supporting evidence.

3 Tendential regularity

It may be that at least part of the appeal of a regularity conception of reality is that we don't know of any alternative. It could be thought, for instance, that we have no basis for action unless we know that we can rely on expected outcomes occurring. And it might be said that there can be no theory construction unless it can be abstract and have a completely general scope. Unless there are some truths along the lines of all Fs are Gs, then one might wonder how anything is left of science. There might be still some matters of particular fact. We could still have data. But how could we do anything useful with those data unless there is some general rule that allows us to make inferences about the future and hypothetical cases. For the deductive-nomological method (Hempel 1962) to work, for example, it requires a premise of general scope – the scientific theory – that allows us to draw such inferences.

But there is an alternative. In this section, we will lay the groundwork for our dispositional account of induction. To do so, we will first make the case for a world of tendencies: one in which there can remain meaningful theory formation and technical application. We will briefly consider and reject an attempt to re-assert a generality view that doesn't admit tendencies. Crucially, we will then distinguish a number of different kinds of claim that have been sometimes run together. In particular, we will expose the attempt to treat induction for causal inferences in the same way as for categorical claims, whereas the two should be treated as fundamentally different.

First, what is a tendential regularity? It would be an error to think that because there are not absolute regularities, then there are no regularities at all. We don't have a stark choice between complete uniformity and random chaos. For a world to be scientifically apprehensible, tendential regularities would be enough. A tendency could be evident, for instance, in a raised incidence of some phenomenon, where the incidence is less than universal but detectably above levels of pure chance. Were cancers to be distributed among the population at random, for instance, then each person would be equally likely to suffer, irrespective of any other facts about them, including their lifestyle choices. However, what we are more likely to see is a raised incidence of some cancers among people of a certain category, whether they find themselves in such categories by lifestyle choice (such as smoking) or accident (exposure to radiation). Such statistical evidence clearly would not support a general claim that all smokers get cancer, but it could support the 'lesser' claim that smokers tend to get cancer and where the tendency can be given a specification of strength or degree. Some tendencies come in small degree, though could still be important nevertheless if it is a tendency towards something as serious as fatality. Other tendencies are much stronger, such as the tendency of heated metals to expand. But the point is that the less-than-universal regularity doesn't preclude us from the core businesses of science: prediction, explanation and technical application. It may make us more guarded and less categorical about our scientific pronouncements. But this accords completely with the experience of science anyway, in which claims are theoretical, provisional and with a margin for error or statistical probability.

Suppose we have a theory in which we believe some variable, L, produces a tendency towards another, M. We may have formed such a theory on the basis that of those things that are L, 40% have been recorded also to be M. We might then estimate that if we were to create the conditions for the instantiation of L, then there is a 40% chance of M occurring also. There are different bases on which we might form this estimate, such as whether we hold a frequentist or propensity theory of chance (Chapter 3), but we need not go into that here. It seems nevertheless perfectly plausible that this inference, concerning the tendency of L, is an outcome of inductive evidence as it is based on the experience of what has been observed in the past. It would be similar to what Reichenbach (1949) called the straight rule. The kind of prediction that issues forth, with its statistical element, is also scientifically admissible. But it accords, too, with our belief and experience that sometimes even the best predictions can fail to come true.

In our example, we predict there is only a 40% chance or 'risk' of the next instance of L being also M. So in this case, M is not even more likely than not. Nevertheless, this is a perfectly usable prediction. Were we to have a series of instances of L, for example, we might expect 40% of them to be M, and we would be disappointed in this expectation if only 20% were M or if 70% were M. Something will then have gone wrong. Again, though, we know that predictions are fallible and defeasible in that there could be an intervention from unforeseen factors that skews an outcome. And the outcomes that are skewed might have been in the original 40% observed incidence of Ls that are M. In that case, the original sample from which we formed an inductive inference would have been unrepresentative of the true tendencies of things. This shows that one cannot salvage the infallibility of induction simply by resorting to a probabilistic variant of regularity, as Reichenbach could be accused of attempting to do. An inference from a 40% proportion of M given L in observed cases to 40% in the unobserved cases can be based on some evidence but it clearly remains a fallible inference.

Regarding technical application, this again remains entirely possible if we are dealing with a world of tendencies. In technologies we aim to harness and utilise the tendencies of things, while also to minimise the risk of failure or malfunction of those tendencies. But we of course know that the latter is ineliminable. A smartphone has a number of more or less reliable capacities or causal powers, and the designers will seek to maximise the strength and dependability of the tendencies those powers bring. We proceed on such an endeavour knowing that it is always possible that those powers fail to manifest. Sometimes the system simply crashes and the designers may see it is their responsibility to fix any bugs or omissions. But other causes of failure may be considered beyond the manufacturer's control. The phone will stop working if immersed in water, for instance, or crushed with a hammer. But the idea seems plausible that in design we are working with components that bring some capacity to the mechanism within which they are located, each playing a role of tending towards a particular outcome inside the context in which they sit.

Now it might be replied again that the tendency view misrepresents the case against the pure regularity theory. Suppose the supporter of the general account of nature maintains that as long as the smartphone is left alone, it will serve its function perfectly well, and even do so with perfect reliability. It might be claimed that the reliability occurs only under certain favourable conditions, therefore. Clearly the operational capacity of a delicate piece of technology cannot function no matter what but is always designed to work within a certain limited set of circumstances. This is indeed the case but, still, it is not clear that such a claim really supports a universal regularity view rather than a tendency view.

Suppose one limits the scope of the generality by saying something of the form; all As cause Bs as long as they are in conditions C, where C is completed by some adequately detailed set of circumstances. The problem is that this can no more than put the problem back a stage; it can never eliminate it completely. It remains the case that even in those conditions C, A would only tend towards

B, because there would still be a susceptibility towards failure. A could still fail to cause B, even in conditions C, either through malfunction or because of some additional intervention. It seems hard to see how one could rule out non-trivially the possibility of additive interferers (Chapter 1, Section 4), regardless of the conditions in which something is situated. And if we end up with a claim that all As cause Bs unless they don't, then clearly the project has failed.

Instead, the idea that the capacities of things manifest themselves only in selected – we can say ideal – circumstances, is better understood as supporting the view that science should be about uncovering the real causal powers of things as evidenced in their tendencies. When we say that A causes B, if in ideal circumstances, what better way of reading this than to say that it is of the nature A to dispose towards B? The claim should be taken as an attribution of a tendential nature rather than a contrived absolute regularity.

Such an analysis allows us also to explain why there are some instances of absolute uniformity in nature but also how they are to be known without the aid of inductive inference. We noted that there was a class of truly general regularities, such as that all electrons have negative unit charge and that all water is H_2O. The latter example may well have been an outcome of empirical investigation but that is insufficient for anyone to conclude that it is an inductive truth. Instead, it is best understood as a claim about the nature or essence of water. Consequently, this is not to be treated as a causal claim, or even a tendential one – vulnerable to the problem of induction – but, rather, as a categorical claim. Categorical claims typically express a relation between different classes of things, such as identity, classification or essence, which are not the types of relations that need to be *ceteris paribus* qualified (Mumford and Anjum 2011a: ch. 7). That humans are mortal, for instance, requires no specification under which conditions they are so. This means that statements of the form 'all Fs are Gs' require a different logic from causal statements, even if these latter are stated as universal, as 'all As cause Bs'. The universal categorical claim states that something being an F entails that it is also a G, while a causal claim is not an entailment. The latter exhibits the dispositional modality; entailment couldn't.

A statement about the constitution of water would rightly be about every portion of water. Similarly, that electrons are negatively charged applies to all electrons because this is (part of) what it is to be an electron. It is, furthermore, a dispositional property of electrons to attract or repel other things with charge. But whether it actually does attract or repel anything else is a causal matter, contingent upon how it is situated.

4 A dispositional theory of induction

Nevertheless, some have urged that, if only we follow the right scientific procedures, we can generate theories about which we can be as certain as we would be about the conclusions of deductive arguments. This amounts to an attempt to transform causal claims into entailments, meaning that they would no longer be vulnerable to the problem of induction.

Bacon, for example, had a dream that if we had the right scientific methodology, it would deliver empirical theories that were guaranteed to be true. The goal of his new organ – the *novum organum* – was a method that was capable of delivering truths almost mechanically. We feed in the right data, turn the metaphorical handle and a true theory comes out. This sounds a lofty ambition for science; yet the idea that as long as the right methods are followed, science is capable of producing certain knowledge is central to the philosophy of positivism. Surprisingly, it is also shared by some dispositionalists, for instance, Ellis. Seeing that our world is a world of causal powers, Ellis suggests, effectively underwrites inductive inferences and again makes them entirely dependable. This is because he sees powers as necessitating their manifestations; so, if we just know of the powers and their situation, from experience, then we can know with certainty what they will produce. He explains:

> If one believes, as Hume did, that all events are loose and separate, then the problem of induction is probably insoluble. Anything could happen. But if one thinks, as essentialists do, that the laws of nature are immanent in the world, and depend on the essential natures of things, then there are strong constraints on what could possibly happen. If the new essentialists are right, then things must act in ways that depend on their intrinsic properties or structures, and on how these things stand in relationship to other things. Consequently, it is a necessary truth that things of the same natural kind must always behave in exactly the same ways (or range of ways with the same probabilities), if they are in circumstances of the same kind.
>
> (Ellis 2002: 134–5)

Ellis's suggestion is that Hume's basic argument is defeated. If the behaviour of a particular is down to its powers, rather than a matter of mere contingency – in which anything can follow anything else – then we do have a solid basis for assuming that the future behaviour of things will be like their past behaviour and that the unobserved cases will be like the observed.

We have already provided reasons why this misrepresents the relation between a power and its manifestation, which is not one of necessity as Ellis claims. We have argued elsewhere that Ellis's position elides from it being a necessity that members of kind-K have power P to it being necessary that K-members manifest P (Mumford and Anjum 2011a: 83) We saw a similar fallacy in Bhaskar's reasoning in Chapter 2. Gelignite is explosive, for example, and it might be so necessarily, but it is never a matter of necessity that it explodes. There is thus no causal necessity to underwrite an inductive inference that will support a completely general theory. However, rejecting this strong version of induction based on necessitating powers does not mean that we have to accept a Humean inductive scepticism either. There is, after all, some strength in the no miracles argument, most famously formulated by Putnam: 'The positive argument for realism is that it is the only philosophy that doesn't make the success of science a miracle' (Putnam 1975: 73). In lots of areas, science is a success. It does allow us to

achieve much technologically, to predict with a high degree of regularity and to explain. This would be tantamount to a miracle if the world really was a loose and separate Humean mosaic. But, crucially, to satisfy the demands of the no miracles argument, we do not need a world of necessities either. A more or less reliable world would suffice. If the world is a world of tendencies, then the success of science is no miracle. If there is something in the world that tends to be, science can function quite effectively. But we also don't want the failures of science to be miracles either – perhaps devilish ones. Were the world to be a world of necessity, we could perhaps explain the cases where science works, but we could not explain why predictions can fail even when based upon all the best empirical evidence.

If we acknowledge both the successes and occasional failures of science, then, it suggests that we cannot have a world of pure contingency but that we do not have one of necessity either. A world of what tends to be accords with the existence of a science that is reliable and yet fallible. There are no miracles either way.

A justification of induction is possible, though not if it exaggerates its power. We should understand induction in the broad sense, as concerning an inference from the observed to the unobserved. Critically, it should not be taken as either (a) an inference from particular matters of fact to a claim of universal scope, or (b) requiring the certitude of its conclusion. We propose, instead, a justification of induction in which it is (b') more or less reliable but nevertheless fallible, and (a') an inference of the dispositional natures of things from their observed behaviour. In favour of our interpretation, we have claimed it matches a world in which things tend to be, in which even well-informed inductive inferences can be subject to predictive failures, but in which science is a qualified success.

However, we also take it to be a mistake to suppose that induction, even a form that recognises the dispositional nature of reality, is the only scientific method that one needs. We wish to justify inductive inferences of a certain kind but only within a context supported by others forms of empirical evidence. It is not as if science, or even our common-sense, builds theories of the world from experience of regularity (we say tendential regularity) unaided. Where our theories are about what tends to be, there is a place for both induction and falsification, suitably modified and moderated, as well as other experimental techniques of intervention and exploration in which we gain knowledge of the causal mechanisms that are responsible for more or less reliable behaviour.

If we see induction as part of a host of approaches to theory development, which ideally work in conjunction in hope of a degree of agreement, then we can take it as part of a picture that tells us what the natural causal powers of things are and how they dispose. There is then a theoretical basis for accepting a position that we call methodological pluralism. We take the causation in nature to be one thing, and we have argued elsewhere that it is irreducible (Mumford and Anjum 2011a). Given that there is not something else, such as constant conjunction, to which causation is equivalent, then there is effectively no single symptom we could look for as a guaranteed indicator of the sort of connection we seek. Some such connections issue in regularities but not all do. What if they are not fully tested in a series of trials, for instance? And sometimes we are able to find that

causes make a difference but not always. Difference-making is a symptom of there being a cause, but there can be causes without difference-making, where there is overdetermination, and difference-making without causation, as in the case of *sine qua non* necessary conditions. Similarly, in some cases we can discover underlying mechanisms of causal powers, but not always, as in the case of structureless subatomic particles like quarks and leptons.

The image of knowledge that this supports is one in which we must consider various forms of evidence in forming, testing, revising, sometimes rejecting, developing and understanding theoretical knowledge about the way our world works. If there were one true infallible method – the Baconian ambition – things would be so much simpler. Instead, we have to form hypotheses, which sometimes have their basis in the observation of tendential regularities. To get to the point where we can make a claim to knowledge, however, we have to bring in many other considerations. No such empirical discovery occurs in a metaphorical vacuum and thus we have to consider how well an initial hypothesis coheres with our other theories. And as a hypothesis develops, we might then form a view which can be tested, for example through knock-out or add-in experiments. Furthermore, there is an understandable caution about claiming we know a theory to be true – where it is a theory that concerns a causal connection – if it is based only on statistical evidence of a tendential regularity. It could be dismissed as a 'mere association' until an explanatory mechanism is found.

Not all forms of potentially corroborating evidence can be found in every case. There could be knowledge of causal mechanisms without the backing of correlation. This can happen in pharmacy, for example, where on the basis of a hypothesis, often invoking contextual knowledge, a new drug is likely to be synthesised and patented before being approved for clinical trial. We think the drug works in theory and need to know whether it works in reality. Alternatively, there are cases where we know of a correlation without knowing the full details of the underlying mechanisms, a position which cancer research was in for many years. However, we could still think of an ideal position in which to be scientifically: a position in which there is a rough agreement from various methods pointing in the same direction. A theoretically plausible hypothesis may have been formed, for example, which is 'confirmed' in a tendential regularity, has been tested rigorously for falsification and has withstood those tests, has some structural or mechanistic backing to the tendential regularity, can be shown that such a mechanism makes a difference, and so on.

The discoveries springing forth from such a methodologically pluralist approach can still qualify as knowledge of truth. Our account of science thus falls within the scope of scientific realism, which is concerned, among other things, with whether the entities invoked in our best scientific theories are real or merely of instrumental value (Psillos 1999: xvii). The methods may be of instrumental value, insofar as they can help us to identify the symptoms of the natural connections between entities that many of our scientific theories are tracking. But those entities, such as the causal powers themselves, are not merely of instrumental value. They are real existents, on our account: in some cases known directly from

experience, as with our own agential powers, and in other cases known through a range of evidence, drawn from different scientific techniques. Inductive claims, concerning what will tend to happen, based on what has been observed as tending to happen, have a place within this realist theory of science. Induction, understood in the proper dispositional way, is one among the plural methods we adopt in order to get at the ontological reality.

We can now summarise our main conclusions. Theoretical knowledge is tentative and fallible. And yet, given that science is successful to a degree we cannot ignore, it seems we tend to know some of the truths. We have presented two philosophical accounts of the world. In one, nature contains general regularities which are of universal scope. Some say that these are the result of governing laws of nature. If one accepts such a view, as many have, then the goal of induction is to discover those general laws from our limited experience of some of their instances or falsify them if they fail to satisfy the criterion of generality. The other view is that our world is a world of tendencies. If it is, then at least one problem of induction goes. It was never possible to find in nature general causal truths that could be known with certainty. On the tendential view, all natural causal processes can fail. An idealised regularity can be understood as the attribution of a disposition to some particular, or set-up: one which will tend, but no more that tend, to be manifested in events. The traditional view of induction accepted a form of inference that was failing to hit its target, we argued, but we can also say that it was aiming for the wrong target anyway. We should think of induction not so much in terms of inferring law-like regularities from our experience but, the much safer inference, of what tendencies there exist in nature. If science is about the discovery of what things are disposed to do, then this does not require that we complete the impossible task of observing A being followed by B in every instance, nor of trying to infer such a redundant possibility from our limited experience.

A dispositional inductive inference is fallible; it does not deliver certainty. We are open about that. But our experience is indeed of fallibility. We are not here endorsing the pessimistic meta-induction (Laudan 1981). That says something too strong: because we have believed theories in the past that turned out false, we should also believe our current theories to be false. Our account says, rather, that it is a perfectly natural and acceptable feature of causal inference that it be inductive and fallible. The success of science doesn't require otherwise. A good inductive inference, especially one backed up by a range of other methods and evidence, will tend to get it right. It will tend to track the truth. We have no guarantee that it will succeed. But that is a feature of empirical knowledge that we really should embrace rather than hope to cast out.

Part V
Ethics

9 Value

Dispositions and ethics

With Svein Anders Noer Lie

1 Metaphysics in ethics

Is there much of a connection between dispositions and ethics? It would seem not if one judges by the dearth of papers and books on such a topic (the Smith, Lewis and Johnston 1989 symposium is a rare exception). Dispositions have become a central issue in philosophy but the focus of attention has been on all the metaphysical issues they raise (Mumford 1998, Molnar 2003, Kistler and Gnassounou (eds) 2007, Handfield (ed.) 2009, Marmodoro (ed.) 2010, Groff and Greco (eds.) 2013 and Jacobs (ed.) 2017). Are they real properties? What is their causal role? How do they relate to categorical properties? These are worthy debates and they are ongoing. We need not await a definitive solution, however, before considering the role of dispositions in other areas.

We will argue that despite the relative neglect of the topic, dispositions and dispositionality are absolutely central to ethics. We will go so far as to suggest even that they are a precondition for some of the key debates and concepts. Ethics rests on a number of notions that are either dispositional in character or involve real dispositions – some say powers – at work. We will not argue for the reality of dispositions here. Others attempt that elsewhere. But it is worth recalling Molnar's claim that the reason to accept real powers into our ontology is the work that they can do (Molnar 2003: 186). We want to add to that the work they do in moral philosophy. Virtue ethicists have seen this where they follow Aristotle's understanding of virtue as a disposition (= *hexis*, see Aristotle 1955, *Nicomacchean Ethics* 1105b: 25–6). What we say here will go well beyond simply the virtues, however. Dispositions have a far broader use in ethics than only accounting for virtue.

Our argument is that the key notions that support the possibility of ethics are ones best explained ontologically by the existence of dispositions. We offer a big picture, which shows how a dispositional interpretation unites various moral phenomena. Moral responsibility is a precondition for a substantial part of ethics, for example, and it is a thoroughly dispositional notion requiring the dispositional modality. But moral responsibility also depends crucially on there being agents who hold that responsibility. Agency requires there to be both autonomy and intentionality and each of these involves the causal powers of the agents. Moral responsibility also depends on there being normativity. There must be something
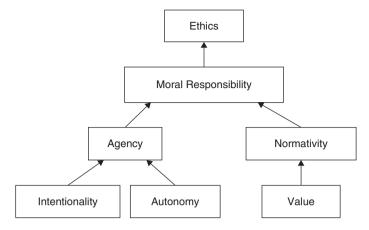
Figure 9.1 The architecture of ethics.

that ought to be (or ought not to be) if we are to hold agents to account. And normativity rests ultimately, we suggest, on the existence of value. Finally, we will argue that value itself is plausibly best explained as a mutual manifestation between the powers of perceivers and objects. The full moral architecture for which we argue is represented in Figure 9.1, where the upward arrows represent the lower phenomena underpinning the relatively higher phenomena. Ethics thus appears, if this picture is credible, to be dispositional all the way through.

It has to be said that the recent lack of a connection drawn between ethics and the metaphysics of dispositions is not a singular oversight. There are grounds on which to claim that philosophers have treated metaphysics and ethics generally as separate and unconnected spheres. The roots of this, we suggest, lie within the rise of empiricism and an acceptance of Hume's fact–value dichotomy (Hume 1739: Bk III, I, section I). What is to be valued, on Hume's account, is sharply separated from what there is in the world: from the facts and from the metaphysics. The consequence of the dichotomy is to demolish the bridge from metaphysics to ethics. Science deals with what there is: professing to be neutral, objective, descriptive and quantitative, while in no way determining the prescriptive and some think subjective matters of what we should value.

As Jonas (1984: 44), Putnam (2002), Lie and Wickson (2011) and Lie (2016) have pointed out, however, the fact–value dichotomy is not metaphysically neutral. It needs the support of a particular metaphysical thesis to stand as an inescapable truth. If we understand everything in the world as either purely contingent (the matters of fact) or necessary (relations of ideas) – a view we will call *modal dualism* – there seems to be no room left for value. Value, we will argue, essentially involves the dispositional modality, which is neither pure necessity nor pure contingency. Hume has, therefore, a sphere of metaphysics that automatically excludes value. It is this metaphysical basis of the fact–value dichotomy that the dispositional view can challenge. We will offer an account of value that permits it to be brought back into nature and weakens the sharp distinction Hume

had drawn between fact and value. The upshot is that while we do not challenge Hume's claim that you cannot *derive* an ought from an is, the right metaphysical basis at least makes value possible. Dispositions, it thus seems, are vital to ethics.

2 Moral responsibility

We take it that a precondition of much of ethics is that there is responsibility. Not all responsibility need be moral. In a lifeless universe, a planet could be responsible for casting a shadow on its moon, but it is not morally responsible for doing so. It is moral responsibility that concerns us in ethics and we will say later what makes a responsibility a moral one. It will be normativity, and ultimately value, but we set them aside for now. Ethics is not concerned only with moral responsibility, however. One might discuss whether there are objectively exist-ing moral properties, for instance, setting aside issues of praise or blame. Perhaps dispositions would have an explanatory role there too. For this chapter, however, we will restrict our discussion to that part of ethics that is premised on there being moral responsibility, which is arguably still a large part.

What should we say about moral responsibility? We note first that it is primar-ily a causal notion. The best account of what it is to be responsible for something is that it is to be a cause of it. Such a view requires qualification, however. It is the paradigm case of responsibility that involves causation but there is also a non-paradigmatic case that doesn't. We say this because, as Moore (2009: ch. 3) ably shows, another ground for responsibility is omission. Suppose we stand idly by while a man drowns in a lake, refusing even to throw him the float to which we have easy access. We might then have responsibility for his death even though we did nothing (and, in this case, *because* we did nothing). Omissions are not causings (Mumford and Anjum 2013) but, rather, absences of causings. While we can have responsibility without causation, however, this should not deflect us from acknowledging the close connection between responsibility and causation. The core case, and arguably the one in which there is most responsibility, is the one in which causation has occurred.

Consider our drowning man, again. We tend to feel that someone has the greatest responsibility for his death if they caused it, for example if they pushed him in. Moore (2009: 56) discusses a case that perhaps brings this more into focus. Two men are tasked with bathing babies. The first watches the infant sink under the water and drown, without intervening to save her. The second actively pushes and holds the baby underwater until she is dead. Both are morally respon-sible for terrible deaths. Our intuition, however, is that among these two horrific crimes, the act is even worse than the omission. The act caused the harm while the omission 'merely' failed to prevent it.

We thus defend the view that moral responsibility is primarily a causal notion. And we think also that causation is a thoroughly dispositional notion, follow-ing a rich vein of literature in which causation is the exercise of causal power (Bhaskar 1975, Harré and Madden 1975, Cartwright 1989, 1999, 2007, Molnar 2003, Mumford and Anjum 2011a). We can also say what it is for someone to

be a morally responsible cause, namely through exercising their agency. But first we should explain more about the dispositional modality and its connection with moral responsibility.

We argue that moral responsibility rests on the dispositional modality. This is a crucial but still relatively novel idea that, we argue, applies to many of the notions of Figure 9.1 that we will say are vital to ethics.

Much of modern metaphysics seems to present us with a choice between Humeanism, in which all is purely contingent and, as Hume says, 'loose and separate' and anti-Humeanism, which urges a necessitarian view of the world. Lewis is probably the most influential advocate of neo-Humeanism in which all is contingent. The world – each world in his case – is depicted as a mosaic of isolated, discrete and unconnected things (Lewis 1986b: ix). The reaction to Humeanism has taken the form of necessitarianism. Armstrong (1983) has a weak version, in which laws of nature involve natural necessitation relations but these are ultimately contingent: they might have been otherwise. A number of fully blown necessitarian theories of nature have, however, been promoted (Harré and Madden 1975, Mumford 2004, Bird 2007).

The application of this essentially logical distinction to nature, however, where there is a stark choice between pure contingency and necessity, is a mistake. Hume claimed that to believe in powers was to believe in necessities in nature. He was then able to argue persuasively that there was no necessity in nature. Any natural cause could be prevented or there was at least the possibility of prevention (Hume 1739: 86–7). And if we could have the typical cause for an effect but without the effect, due to the presence also of a further interfering factor, then that cause does not necessitate its effect even on the occasions where it successfully produces it. The details of this argument have been given elsewhere (see Chapter 1).

Hume set a trap into which his opponents indeed fell. Many defenders of powers accepted his characterisation of powers as necessities but could then be defeated by an argument from prevention and interference. But that is the wrong characterisation of powers and, particularly, of their modal force.

The idea of the dispositional modality is that powers in nature tend, but no more than tend, towards their outcomes: their manifestations. When a match is struck, for example, it tends to light. But it doesn't always and there is never a guarantee that it will. Even if the match does light, we could still say that had there been another factor present, high humidity for example, it need not have. If we can add further factors to affect the outcome, then clearly, we are not talking about necessity as classically conceived in philosophy, where outcomes would be unaffected by additional factors. Yet disposing towards an outcome is more than that outcome being one completely contingent possibility among many others. Breaking is not just one mere possibility for a dropped and fragile thing among all the rest, such as it catching alight or turning into a chicken. There is a special and far more intimate connection that fragility has to breaking than it has to catching alight. Of all the possibilities, the power selects a subset towards which it disposes. If in nature we have a modal connection that seems to be something

considerably more than pure contingency, but considerably less than necessity, then it seems that we must permit a third modal value, and this is what we call the dispositional modality. It is a challenge to the modal dualism of necessity and pure contingency. The dispositional modality seems to be the natural one, by which we mean the modality of natural causal processes.

Metaphysicians may need more persuasion but it is not our task here to prove the dispositional modality of nature. Our purpose is to show its application in ethics. We will see that this dispositional modality applies to a host of ethical concepts, the first being moral responsibility.

The metaphysics of modal dualism, which we believe reflects that of Hume's fork, arguably leaves no place for moral responsibility. One could also suggest that it is what raises free will as a problem. The argument is as follows. Prima facie, one cannot be responsible for what happened of necessity. If it *had* to happen, then it seems one had no control over it. One could not have done otherwise. Necessity, then, permits no moral responsibility. But pure contingency would seem to fare no better. There has to be a stronger than purely contingent connection between one's actions and outcomes if one is to have responsibility for them. With pure contingency, anything could happen. When we throw water on flames, it could increase them, or cause an explosion, or they could turn to dust. (We will discuss the possibility of there being a contingent but constant conjunction between actions and outcomes later, in Section 3.) It seems, therefore, that for moral responsibility, which we say is a precondition of ethics, we need something that is neither necessity nor pure contingency but in between (which we pursue in Chapter 10). The connection between cause and effect must, we argue, exhibit the dispositional modality. Responsibility seems premised on the grounds that there is something – the object of ethical evaluation – that succeeded in causing an outcome but without necessitation. It could have failed to do so. And yet it must have had a more than purely contingent connection to that outcome; it must have had at least a disposition to have produced it.

The latter point seems closely reflected in our evaluations of moral responsibility. Occasionally an outcome is produced by a cause that had only a negligible disposition towards producing it. Suppose through a coincidental alignment of other factors, a man eating an apple in the street leads to a second man robbing a bank. Was the first man responsible for the bank robbing? Hardly at all, one would think, though it would depend on the detail of the story. One's evaluation would be based, presumably, on the idea that there is no significantly strong disposition towards bank robbing from apple eating. The extent of responsibility seems aligned to the strength of the disposition involved (as argued in Mumford and Anjum 2013). A man who explodes a bomb in a busy town square has a very great responsibility for any deaths that result because exploding bombs tend to kill. They have a significantly strong disposition towards that outcome. The case also shows that a lack of necessity is entirely consistent with responsibility. It would be no defence for the bomber to claim that they have no responsibility because their planting of the bomb did not necessitate the explosion. It didn't. A bird could have come and pecked free the fuse wire in time. But it is adequate

for such responsibility to have produced harm even if one didn't ensure it. Having created conditions for a significant disposition towards it is enough.

3 Agency

We said that one has responsibility in the paradigm case for what one has caused, allowing an exception for the case of omissions. But we can also see that causation alone is insufficient for responsibility. In the first place, we should restrict the claim to what has been caused through agency. It is possible to cause harm or good without responsibility where the outcome was an accident or unintended consequence. A man with cerebral palsy, for instance, could kick out in a spasm and connect with a bystander. But he is not morally responsible for the resultant harm even though he is causally responsible for it. In the opposite case, it may be more likely that someone would wrongfully claim credit for an unintended good they have caused, but parity of reasoning suggests that they have no true right to claim praise.

What is the reasoning in these cases? We again give an answer in terms of powers. One is responsible not simply for what one has caused but for one's actions; in other words, for what one has caused as an agent. As depicted in Figure 9.1, however, there are further details to be given in terms of intentionality and autonomy. To be an agent is to deliberately and freely exercise one's causal powers in order to bring about some effect. It hardly needs saying that this is one reason why it is usually human beings that are held morally responsible for what they cause. There is plenty of harm caused by nature, in volcanoes, hurricanes and earthquakes, and caused by predatory animals, but without agency we do not hold these things morally responsible even though they are causally so. In contrast, humans are usually powerful actors. We have a wide range of causal powers that we are able to deploy with purpose to bring about outcomes. Our powers are not always something we control, though, as the cerebral palsy case illustrates. When a power is under one's control, one is able to choose when and how to deploy it.

But how much do we need to commit to realism about such powers in order to gain the notion of agency? Is the existence of agents itself proof of the reality of powers? It would seem surprising if it was. The thought would be that while agency is clearly a causal notion, it is a notion that is entirely neutral on the abstruse metaphysical issue of what causation itself consists in. Would we really want to say, for example, that there are agents only if the dispositional theory of causation were true? And there are different dispositional theories of causation, so we would have to identify a particular variety of the theory that was adequately realist about powers.

It is worth stating nevertheless that a case can be made for it only being in real empowerment that we have genuine agency. This sort of argument has been given by Groff (2013, 2016) and Steward (2012), for instance. The argument has a resemblance with the aforementioned point that one wouldn't have responsibility if there was a wholly contingent relation between one's actions and their outcomes.

Suppose causation consisted in a purely contingent regularity, as Hume's constant conjunction account suggests. When an agent causes some outcome it would mean, according to this view, that there was a regularity between a type of action – a person's bodily movements or whatever – and a particular kind of outcome. The movement would be constantly conjoined with the outcome. When she kicks a football, for instance, it moves rapidly away with momentum and direction. For the kick to have caused the ball to move, however, all kicks at footballs, administered by various people at various times, are followed by those balls moving away.

If there is nothing more to causation that a contingent regularity, therefore, whoever kicked the ball merely performed a bodily movement that was part of a pattern of constantly conjoined events. On Hume's theory, the only reason we think the kick caused the ball's movement is that it is part of the regular pattern. One could never infer from a single instance, for example, that the kicking made the ball move.

The question now is whether this leaves us with a credible theory of agency. Can one really be the agent unless one brought something about? And could you really have the close interest in your actions that you obviously do if they never brought other events about but, in line with the theory, merely were followed by those events in a way that resembling events also were? And would you have such an interest if you realised that there was no real connection between what you did and what it produced? Everything is loose and separate, according to Hume (1739: 54), so there really is only pure contingency between one thing and another. Hence, Hume's inductive scepticism would apply. There would be no rational basis for assuming that the future would be like the past. Any such view would spring from custom and habit. Rationally, the ball is just as likely to turn to dust when you kick it as it is to move away with momentum.

Groff's (2013) charge is, therefore, that unless the causation that is involved has sufficient power, agency would not deserve the name and we would have no rational basis for acting as we do. Deflationary theories of causation weaken agency so much that, if that were all we had at our disposal, it would no longer be justified to call us agents. With that would also fall moral responsibility and thus a major part of ethics. If we genuinely produce outcomes, we can be held morally responsible for them. If we can produce nothing, it looks like we have no responsibility. Without a stronger-than-contingent connection, it looks like we could not even have responsibility for our omissions; for if all is contingent then omitting to throw the drowning man a float has no stronger nor lesser connection to him drowning than if one throws it instead.

4 Intentionality

Agency is not a simple matter. At least two further dispositional notions are required for it. The first is intentionality and the second is autonomy. Being an agent requires an ability to form intentions, where intentions are one among the class of mental phenomena that exhibit the quality of intentionality, according

to Brentano (1874). The kick caused by a spasm does not count as agency because there was no intention behind it.

The connection between intending and responsibility is a complex one, however. It seems necessary to separate the issue of unintended consequences, for which one often is held morally responsible. Agent *a* may intentionally bring about X without realising that X will bring about Y, where *a* did not intend Y. One could intentionally discard a cigarette that then causes a fire without intentionally causing a fire. Moral responsibility may rest in foreseeability though the connection between this and responsibility is complex and disputed (Moore 2009: chs 8–10). As in the case discussed earlier, causation provides the paradigmatic grounds for responsibility. But there could also be non-paradigmatic cases, so could we say the same of intentionality? Paradigmatic cases will be intentional even if there are some non-paradigmatic cases where we attribute responsibility without it.

We say that intentionality is a dispositional notion. In the simplest sense, this means only that it is an ability, of minded creatures. It is a power that they sometimes exercise but often don't, when sleeping for instance. But intentionality is also dispositional in the more sophisticated sense that it exhibits the dispositional modality. If we stick to the case of intentions, for that is the intentional phenomenon most relevant to moral responsibility, we find the dispositional modality evident in the following. In the first place, one knowingly aims only for that which is less than necessary. One might unknowingly aim for the necessary, but it is irrational to both know and understand that X is necessary and to aim for X. Suppose one believes that it is metaphysically necessary that a person can only be in one non-overlapping place – a spatial region – at one time. Then plausibly it is irrational to aim at that. And intentionality falls short of necessity in another, more obvious way. What one intends to bring about is not necessitated. We may intend to bring happiness to another and do everything in our power to succeed in that intention but we have to acknowledge that there is always the possibility of failure. This could be explained in just the way the dispositional modality was explained. There could be something else – an additive interferer – that gets in the way of the intended outcome. The person whom we intend to make happy receives bad news, for instance. The actual outcomes of our intentional acts are therefore not entirely in our control, since we cannot control all the factors outside our own acts that might interfere with the intended outcome.

Yet clearly there is more than pure contingency at work. When one intends, one intends some more or less specific outcome out of all those that are merely possible. We can call this the intentional object of the intention, but it has long been acknowledged that there is a degree of unspecificity (Molnar 2003: 64). One intends to buy an ice-cream, for instance, but maybe not any specific kind, nor usually a particular token of a kind. The intention focuses on a range of target actions that are a limited subset of all the many actions possible.

This seems entirely analogous to the causal case. Fragility disposes towards breaking, which is a limited but also unspecific range of possibilities. Apart from a very exceptional case, a fragile object disposes to breaking generally rather than

towards breaking at a particular time and place and in a particular way even though, of course, if the vase does break it will indeed break at a specific place and time and in a specific way.

Such is the closeness of the notions of dispositionality and intentionality that both Place (1996a, 1996b) and Molnar (2003: ch. 3) have tried to explain dispositions in terms of intentionality. They see dispositions as directed towards their manifestations and capable of exhibiting intentional inexistence. Intentionality is the criterion of the dispositional rather than of the mental, and the mental counts as intentional only to the extent that it itself is a dispositional phenomenon.

We argue that Place and Molnar have the direction of explanation the wrong way round. Intentionality doesn't explain dispositions but dispositions explain intentionality. We follow instead the tradition of Armstrong (1968: chs 7–11) in which intentionality is explained in causal dispositional terms, which holds the prospect of a naturalisation of intentionality. The modality of intentionality derives from the dispositions upon which it rests. And although we have concentrated on intentions because of their relevance to moral responsibility, what we say goes *mutatis mutandis* for other intentional phenomena, such as beliefs, hopes, perceptions, and so on.

5 Autonomy

The cerebral palsy case fails to count as agency for lack of both intentionality and autonomy. The kick that the sufferer administers to the bystander is not an act of agency because there was no intention to kick. But an intention to kick alone is inadequate because the sufferer also has no control over their movements. In this respect, the sufferer lacks autonomy (though there are many other areas in which they will have it). In other words, the sufferer of cerebral palsy is not an agent with respect to the kick even if they had an intention to kick at the time they did it. Without control over their movements, the intention to kick had no relevance to the movement with which it coincided.

We should take autonomy as a second condition on agency, therefore, distinct from the issue of intentionality. Clearly there can be the first without the second. One could be free to visit Kazakhstan without ever having the intention to do so or have the intention to visit North Korea without ever having the freedom to do so. No doubt there are prisoners who intend to escape yet of course lack the liberty to do so. We are equating notions such as autonomy, freedom and liberty here, while in some contexts others may find it useful to draw distinctions between them.

The dispositional nature of autonomy was evident in our notions of agency and responsibility. You are not autonomous if your movements are necessitated but nor if they are completely contingent. The connection between your desires and behaviour cannot be a wholly contingent one. To be free you must be both able to do something, an ability that complete contingency between desire and behaviour would disallow, but you must also be able not to do so, which necessity would disallow.

There is much more to discuss on the topic of autonomy. What does it really involve? Is it relative to certain interests and types of domain? You may in the physical sense be free to drop litter but you are not legally free to do so. On many of these issues there will be a close connection between autonomy and powers. If we consider the issue of negative versus positive conceptions of liberty, for example (Berlin 1958), we might reason along the following lines. From a negative conception of liberty you are free to do X merely if there is no rule against doing so. You would thus be free to play the violin even if you have no ability with it because you were never taught. Liberty is sometimes used in this way. But from a positive conception, a notion of empowerment is more to the fore. Freedom is not just about absence of constraint but, according to some, about getting what you want. And thus empowerment – the having of relevant powers – becomes a vital ingredient of the positive conception. Here, you are free to play the violin, or swim, or speak Norwegian, only once you have the power to do so. The more powers one has – the more one is able – then the more one is free. Most such powers are acquired, through training and education, and thus these become sources of freedom. And on this dispositional account of autonomy, one cannot assume that all citizens are equally free just because they are subject to the same laws. That might be the case on the negative conception but clearly if some are more empowered than others then it seems quite defensible to say that they are freer.

This completes our dispositional account of agency. We said that it was one of two conditions for moral responsibility. And we said that agency had two further preconditions for its paradigm instances: intentionality and autonomy. These, we argued, are disposition-laden notions. We need not claim that these two concepts exhaust agency, however, nor that we have found all that is dispositional about agency, but a complete account is not our aim. We seek only to show that there is after all a close connection between dispositions and ethics, hence metaphysics and ethics.

6 Normativity

We have thus far followed the left-hand branch of our proposed moral architecture, as depicted in Figure 9.1. Agency, we said, was a requirement of moral responsibility. But there is another requirement, which we think of as normativity. The thought is that agency would not itself be adequate for moral responsibility were it not for there being some things that we ought to do and other things that we ought not to do. Many of our actions have no or only a negligible moral value. Suppose you make a sound in private, quietly humming a tune to yourself. You can have a non-moral responsibility for the sound produced because you causally produced it. But, for there to be a specifically moral responsibility, there needs also to be a normative dimension that impinges on our actions. It can be safely assumed that in most circumstances it is neither the case that one ought to hum in private nor that one ought not to hum.

As a rule of thumb, when one acts as one ought, one's actions are morally acceptable or even praiseworthy. When one acts as one ought not, one's actions

are morally unacceptable or blameworthy. When one's act goes above and beyond what one ought to do, one's action is supererogatory (a term introduced by Urmson 1958). And many of our other moral notions spring from this. The notion of an obligation, for example, comes from there being something that we ought to do. But what, one may wonder, does this have to do with dispositions?

In a now familiar move, we will first claim that normativity is a dispositional notion to the extent that it too exhibits the dispositional modality. That one ought to do X does not necessitate X. We ought to be kind to animals, for instance, but animal cruelty nevertheless exists. But that one ought to do Y says more than that Y is a mere possibility. There are many things that you could do but only a selective subset of them are the actions that one ought to perform, and similarly for those one ought not to perform. So, if one ought to be considerate, then this says more than that consideration is one possible way of behaving: merely one among many possibilities. It is favoured or selected in some way: targeted as the special subset of all the possible actions to which one's actions should be aimed. This is structurally parallel, we argue, to the way that breaking is a subset of possibilities to which powers dispose and kicking might be the subset of actions towards which an intention could dispose. We have, therefore, the same dispositional modality, for 'ought' requires something that is more than purely contingent but less than necessary.

An attempt to fit normativity into the two traditional modalities creates problems. In considering 'deontic modality', Vetter (2015: 216), for instance, gives the example 'you may now go out and play' as indicating that going out to play is now a possibility. But this ignores the fact that someone can go and play without permission. And, on the same theme, she says later that 'A child's knowing that she is unable to do a cartwheel in the classroom (dynamic modality) and her knowing that she is not allowed to do a cartwheel in the classroom (deontic modality) both have the same result, at least in a rational and obedient child: she will not attempt to do a cartwheel in the classroom' (Vetter 2015: 244). But note the need for the qualification – rational and obedient – which can be taken as an admission that even when you ought not to X, it is nevertheless still possible that you X. The qualification is not necessary for what Vetter calls the dynamic modality; if the child is incapable of performing a cartwheel, then she simply cannot. This contradicts Vetter's assessment, a few sentences later, that 'the basic function of the different types of modal knowledge is the same'. Actually, we agree with her that natural and normative modality are the same but only because both are dispositional. In contrast, Vetter tries to ignore the dispositional aspect of normativity so that it fits her traditional account of possibility and necessity.

There is a possible objection to our account of the modality of normativity, which comes from a broadly Kantian perspective. Suppose one thinks that reason dictates morality, for instance, then what one ought to do becomes equated with what you rationally *must* do. Would that mean that morality necessitated our actions? It may be that you have no choice but to obey the categorical imperative, for instance. But this is to confuse two issues. It may be a matter of necessity

what the precepts are; they state what you should or must do. Reason might dictate that you should treat each person as an end in themselves, for instance. But even if such a precept were necessary, it clearly does not necessitate that it is acted upon. People can have failings of rationality and morality. Evidently, we can fail to do what we should. When we use the term 'must' in a normative context, whether we have a Kantian perspective on moral imperatives or not, it clearly allows the possibility of failure. Someone might be cruel to animals even if they (normatively) must or should be kind to them. The necessity of a precept is not, therefore, the necessity of an action. In this sense, it remains right to say that normativity concerns what is short of necessity. And this seems correct given the point that if an action were necessitated then any precept is redundant.

Given the modal similarity between dispositionality and normativity, one might wonder whether one of them comes first and can be used to explain the other. E. J. Lowe (1987b,1987a) suggests a normative account of nature in which dispositions can be understood in normative terms. An acorn ought to grow into an oak tree, for instance. But we do not think that dispositionality can be explained in this way. Again, we take dispositions to be basic. They are parts of the natural world, like properties borne of particulars. They are open to empirical investigation and testing.

What one could think instead, therefore, is that the existence of dispositions could provide a basis on which to naturalise normativity and evidence for such a proposal would be found in the fact that normativity has a dispositional nature. The modality of normativity betrays its dispositional origin. How might such an account proceed? One example could be Hume's view that morality is based on empathy for others: an ability that has the dispositional modality written all over it. We may choose to exercise it but it is far from necessary that everyone does. And there may be other credibly naturalistic accounts of the dispositional origin of normativity too. We will now proceed to develop another, which focuses on the notion of value.

7 Value

There is some basis for normativity in the theory of value. The connection would plausibly be something like this; we ought to bring about what is valuable (peace, freedom, kindness) and ought to avoid that which subtracts from value (meanness, destruction, violence). Or one might think of it this way: unless there is something ultimately of value, then normativity seems without foundation. How could one maintain normativity without value? Suppose one thought that, although nothing really was of value, it was nevertheless worthwhile having normative constraints on behaviour so as to maintain law and order. But such a view would be founded on the idea that law and order are valuable. If one didn't think so, nor had any other foundations on which they could rest, one would reject the associated norms.

Value remains a mystery, however, particularly for metaphysicians. Guided by the fact–value dichotomy, one is tempted to believe that metaphysics should deal

only with the facts, concerning the way the world is, and nothing to do with what ought to be. How the world ought to be is left to the moral philosophers or theologians to decide. But this dichotomy may itself rest on a metaphysical premise that could be challenged (see Lie 2016 for a detailed discussion).

We argued in Section 2 that the dispositional modality was required for moral responsibility. The reason this seems to appear on the value side of the dichotomy may be, however, because modal dualism allows no place for it on the fact side. Modal dualism, as we understand it, is simply the view that there are just two modal values: necessity and contingency. Hume's fork is a statement of such a view. All knowledge of the natural world, he contends, concerns either matters of fact, which for him are loose and separate, unconnected and thus entirely contingent, or it concerns necessities, which are mere relations of ideas and a priori (Hume 1748: IV, Pt 1, 25). Once we accept this dualism, it is, following the dispositional nature of moral responsibility we have offered, impossible for value to find a place on the natural side of the dichotomy, within the realm of facts. Morality and normativity are cast over to the value side.

We have rejected the modal dualism of Hume's fork. If we restrict our metaphysics to the two traditional modal values of philosophy, then we miss what is arguably the most natural and important: the dispositional modality. It is the modality we find in causation and it thus figures in virtually every naturally occurring event. If that is right, then the dispositional modality is as naturalistic as anything and on that basis deserves its place on the fact side of the fact–value dichotomy. And yet, we have argued, it is also the modality of moral responsibility and of normativity. Does that bring those two domains closer to the natural realm of facts? Does it offer a prospect for the dissolution of the dichotomy altogether?

As we have already indicated, one way in which normativity and thus a part of ethics could become one with the realm of facts would be if it could be naturalised in some way. We also offer hope that such a naturalisation could be cashed out in dispositional terms. Perhaps the biggest challenge to such naturalism would be the values themselves. Those brought up on the fact–value dichotomy find it hard to see how value could possibly be a part of the natural world. But we offer a sketch for a theory that, if what we have said so far has had any ring of truth, might sound like a credible starting point.

A dispositional theory of value has potential. It seems able to reconcile a standard opposition of objectivism (or realism) versus subjectivism. A realist position would see value residing in the objective, mind-independent qualities of things or objects. Subjectivism, in contrasts, states that all values reside in minds and in the eye of the beholder. Which of these is right? Arguably neither. If a pure subjectivism were true then there could be no meaningful disagreement about values, whether they be moral or aesthetic. Each judgement would be purely a statement of personal preference, which could not then be contested in the way that we believe is possible and indeed seems meaningful. But if objectivism were true, then there would be values in a world even if it contained no minds, which is also hard to swallow. Could anything really matter in such a

mindless universe? Would earthquakes or volcanoes be bad things if they affected no minded creature?

Objectivism and subjectivism both have their attractions but also their repulsions. A dispositional theory of value might bring us the best of both worlds. In such an account, value would be described as a mutual manifestation between perceivers and objects. The value does not belong to either the perceiver or the object exclusively but is produced by them jointly as a result of them coming together. This is to apply Martin's (2008: ch. 5) mutual manifestation framework for the manifestation of a disposition. Rather than dispositions being depicted as passive, standing in need of a stimulus in order to manifest, Martin models them as manifesting when they find the appropriate partner for their mutual manifestation. A soluble substance and a solvent such as water are mutual manifestation partners that can produce dissolving, for instance. Unlike the stimulus–response account, the mutual manifestation partners are of equal status: both active and genuinely productive of their effects. (For a refined version of Martin's model, see Anjum and Mumford 2017b.)

Objectivism and subjectivism are both wrong, therefore, if value is a mutual manifestation between mind and world. The model suggests more or less equal partners productive of the phenomena. Hence it is not as if either the world or the perceiver is the sole originator of value. It could not occur without both. There has to be some feature of the world towards which perceivers are disposed to respond favourably or unfavourably, valuing that feature positively or negatively. The world has a disposition to provoke that reaction and the perceiver needs a disposition to have the reaction. If we put them together, then we have the possibility of value. Empathy, discussed by Hume, could be one such sort of disposition that we have to respond in a certain way to situations that we apprehend.

We should also acknowledge, however, that human nature exhibits an array of preferences. We don't all have the same dispositions to respond to the same worldly features in the same way. We thus differ in our aesthetic and moral tastes. If this purely were a subjective matter, it would be no use debating those tastes. But we are also talking about features of the world and what reactions they are disposed to prompt. In that context, there is nothing absurd in arguing with someone that they have atypical, uneducated, crude or even insanely skewed aesthetic or moral sensibilities. Meaningful disagreement is thus possible.

If something like this account is plausible, value could indeed be part of our natural world, therefore. It would of course be a part of the natural world that contained minded perceivers, with their dispositions to respond positively or negatively to the world and its events. But this would be enough to call the fact–value dichotomy into question.

8 Coherence

We have presented a big picture. There are many stages at which our argument can be challenged on points of detail. We have tried to be open about where those

points might be. The strength of the argument, we hope, is in the coherence of the whole picture.

We have argued that there is after all a close connection between dispositions and ethics that has largely been ignored, especially since the advent of empiricist philosophy. We have tried to explain how ethics, or at least a sizeable portion of it, is ultimately grounded in the dispositions of things, including the powers of people. And we argue that the existing separation of metaphysics from ethics is itself due to a metaphysical position, a Humean one, which we think cannot be sustained. Some know this as Hume's fork but we have tried to distil its essence as a form of modal dualism. The error of such dualism is that it omits the dispositional modality and, as we have argued, this modality is the one that is crucial in understanding so many moral phenomena. And as it displays a modality that has a rightful place in the natural world, in causation, it could well be the vital clue that allows us to see a way in which ethics could be naturalised.

10 Free will

Causation is not your enemy

1 The problem

Causation plays a vital role in the free will debate so it is among the top priorities that it be understood right. There is a view, for instance, that merely being subject to causal laws is already enough to compromise our freedom or eradicate it completely. This trades on an alleged link between causation and determinism. Dennett, for instance, articulates the thesis of determinism thus: 'Determinism is the idea that every event has a cause, which has a cause, which has a cause, in a causal chain that goes back to the Big Bang, if you like, and that there are no events without causes – undetermined events' (Dennett 2010: 2). Causation then looks to be the enemy of free will and something we need to escape. There might be a temptation to look for free will in an ability to step outside the regular causal nexus. This would be a mistake, we allege, effectively attributing supernatural powers to agency. Even if our minds have a degree of exemption from the laws of nature – for instance, if some version of Cartesian dualism is true – our physical bodies surely don't. The actions we perform thus have to comply with the causal laws, as at least something of us, if not the whole, is a part of the natural world.

We shouldn't look for freedom in counter-nomic abilities. And we don't have to. The problem we have with Dennett's statement, and many other commentaries on the free will problem, is thinking of causation as the enemy of freedom. It is not. We should think of causation as something that is on our side: on the side of freedom. It is through the exercise of our own causal powers, for instance, that we get what we want and we would be helpless without them; hence, helpless without causation. Why, then, start with the assumption that it is something to be escaped?

We argue in this paper that causation has been systematically misconceived over a long period, especially in its connection with issues of modality, and this error has had a particularly significant and damaging influence on the direction of the free will debate. A tight connection has been drawn between causation and necessity, for instance, and this has been highly problematic to those seeking any kind of credible libertarian stance on free will. It is necessity that is the threat, we claim. Causation is seen as part of the problem of free will when really, we should be looking to it as part of the solution.

2 Freedom's dilemma

A dilemma afflicts our attempts to form a coherent understanding of free will and it is to resolve this dilemma that we need a better understanding of how causation works; specifically, how it relates to the possibility of its effects. The dilemma was articulated by van Inwagen (1983) and in a more succinct form by Mumford and Anjum (2015a).

As the standard dilemma goes, under determinism we are slaves to necessity. If what we do is necessitated, then we are not free because we have no genuine choice or other possibility open to us. This violates the principle of alternate possibilities, which some think is important for a libertarian theory of free will. To be free, you must have been able to do otherwise. There have to be alternate possibilities for you. If determinism is true, you have no alternate possibilities; hence, the appearance of free will is illusory. This is van Inwagen's *consequence argument* (1983: 16, ch. III).

But if indeterminism is true, the situation looks no better. Aren't we then just slaves to chance? The problem here is that even though there may be alternate possibilities available, where determinism is false, it looks as though no one has control over their actions. This violates the principle of ultimate authorship. Freedom – indeed agency generally – requires that we are the authors of our own actions. If we do not control the things that we do, then they are not properly actions and we are not agents. In what sense would we act if what we did was to some extent a matter of chance? Could we really be said to be in control, in those circumstances? And without control, there is no responsibility for what is done. Under indeterminism, therefore, the appearance of free will is again illusory. This is what van Inwagen (1983: 126–50) calls the *Mind argument*, after the journal in which it often appeared (e.g. Hobart 1934 and Smart 1961).

This looks bad. There is no free will if determinism is true and no free will if indeterminism is true. Determinism and indeterminism seem to exhaust all the possibilities. It is easy then to take this as a conclusive argument against a libertarian conception of freedom. The dilemma explains some of the attraction of instead opting for a compatibilist solution. One can hold a compatibilist position, saying that free will is compatible with determinism, if one is willing to give up the principle of alternate possibilities, for instance (Frankfurt 1969, 1971, Beebee 2013: 146–50). But not everyone likes that. There is a feeling that it perhaps requires an exercise in doublethink to believe that an action can be both free and determined. The consequence argument, among others, trades on this incompatibilist intuition.

Even if compatibilism does make sense as a solution, one might still think that if libertarianism were defendable, it would always be better to have that kind of freedom than the compatibilist kind. A motivation for compatibilism is sometimes simply that there is no conceivable alternative. Hume (1748: VIII), for instance, conceded that he could think of no better solution to the problem than compatibilism (which is also clear in Hobart's 1934 'Free Will as Involving Determination and Inconceivable without It'). We can reconstruct

Hume's argument within the framework outlined above. He could see no sense of freedom in randomness, so he chose compatibilism, effectively retaining the principle of ultimate authorship while relinquishing alternate possibilities. But suppose we can do better than Hume and find a way of resolving the dilemma, thereby validating a libertarian conception of freedom. Wouldn't that be better? We could have the strong sense of free will – that is, one that retains both principles of alternate possibilities and ultimate authorship – and not have to resort to compatibilism as a fall back.

   To do that, we argue here, we need a better understanding of causation. If there is a straight choice to be made between determinism and indeterminism, it looks like there can be no free will. Part of the difficulty has been to see how there is any other option than these two. There is one, we insist, but the key to it is getting causation right, in particular the proper modality that holds between causes and effects. To see this, we should first motivate the connection between our freedom and causation and thus how we need to be causes in order to act. The free will problem is then seen as a problem of causation, and primarily a modal problem, produced when they are not conceived accurately.

3 Three …, no, four options

We have already seen that there are three standard positions one can adopt with respect to the free will debate:

i   *Determinism*: all is necessary so we have no free will
ii   *Libertarianism*: determinism is false and we have free will
iii *Compatibilism*: free will is compatible with determinism

As typically stated, option (iii) is of a different character from (i) and (ii). They commit on whether there is free will or not, whereas (iii) is simply a statement of compatibility, which (i) and (ii) deny. We could think of it as a putative logical truth, saying that determinism and free will can co-exist. This is not a commitment to free will even though it might be assumed so automatically. Given the discussion around determinism and ultimate authorship, it should be clear that there is also a significant fourth option. This is almost always ignored, perhaps because it looks like the worst option of all. Determinism could be false but we still have no free will because, in the chancy world, we have insufficient control in order to be able to act. We might, thus, call this least palatable view stochasticism:

iv   *Stochasticism*: determinism is false but we still have no free will

What this shows is that the libertarian has more work to do than simply show determinism to be false (as Kane 2014 urges). In a way, that's the easy part, although largely an empirical matter. A libertarian needs more importantly a positive account of how we can be free in an indeterministic world. That determinism

is false is a necessary but clearly not a sufficient condition for free will. The big question, therefore, becomes the other, more neglected one: not of how free will is compatible with determinism but of how it's compatible with indeterminism. Hume held that free will and determinism were compatible partly on the ground that he thought free will and indeterminism were incompatible. The libertarian needs it exactly the other way round; free will is incompatible with determinism and compatible with indeterminism. The task, then, is to provide a credible account of how we can or do have free will in an indeterministic world.

We take it that causation will be central to any credible libertarian position. Causation is crucially what gives the agent freedom. Contrary to Dennett's view, then, causation cannot be the enemy of free will. It's what we need to the extent that we have to be the causes of our own actions. Causation is at the heart of and at least a *sine qua non* for freedom. Let us, therefore, consider a little more why the attitude to causation in the free will debate is so often contrary to this view, which we think prima facie appealing.

4 Determinism and necessity

In Dennett's own account, he goes on to say that determinism is a red herring, by which he means that such determinism is compatible with free will. But he does not challenge this way of articulating determinism, which is where we think the true red herring hides. The commitment in Dennett's account amounts to the view that an event is determined just in case it is caused, and this is the view we reject.

It is worth noting, in case it is thought that Dennett's characterisation of the position is an isolated aberration, that his connecting of determinism and causation is not unique. Watson ((ed.) 1982: 2), for example, speaks as if we are robbed of free will simply in virtue of our actions having prior causes. Both Clarke (2003: 3–4) and Earman (1986: 13) treat determinism as an explicitly causal thesis. This certainly fuels the idea that we gain freedom only by escaping causation, given that causation is seen as the engine of determinism.

Causation need not, however, be directly involved in the understanding of determinism. It is not something that essentially plays a role in the articulation of determinism nor, we would argue, in determinism itself, considered ontologically. Causation appears in statements of determinism, we venture, only as a proxy for what determinism is really about, which is necessity. Others have seen this. Kane (2011: 4) speaks of determinism as a conditional necessity. Laplace used the metaphor of a machine, which is able to produce outcomes infallibly and he then introduced the idea of the demon (Laplace 1814: 4) who is able to deduce future history from the current state of the world and its laws, which he would be able to do only if they necessitated the future.

If causation is not inherently about necessity, then it is not part of that threat to free will. However, many writers on free will, especially anti-Humean causal realists in their metaphysics, have thought of necessitation as the only way in which genuine causal production could work. The idea is that a cause produces

its effect by, in some worldly and natural way, necessitating it. Hence, we have the notion of natural necessity (Swoyer 1982, Fales 1990, Shoemaker 1998) as an account of how real, non-Humean causation is supposed to work. Russell (1913: 194), in contrast, argued against the reality of causation precisely because the 'notion of cause is so intimately connected with that of necessity', and he was at the time a sceptic about necessity. The view is widespread and not only held in philosophy. Heisenberg (1959: 81–2) and other physicists argued there was no room for causation in Quantum Mechanics, for example, on the grounds that there seemed to be no necessity of outcomes in the quantum realm (Chapter 4). The argument could count against causation only if it essentially involved necessity. The PSR, articulated by Leibniz (1714: section 32) seems to play an implicit role in motivating such a view. As discussed in Chapter 1, it appears deeply engrained in our post-Modern way of thinking philosophically. There is no way we can demonstrate this historical conjecture, of course, but it lends weight to the thought that there has to be a sufficient reason for a cause producing its effect. The sufficient reason is the rational mirror or the worldly necessity. This means that if there are two similar causes and the first produces a particular effect, but the second doesn't, then there must be some relevant difference between them, whether known or unknown; that is, some sufficient reason why the first was productive of the effect and the second wasn't.

Perhaps if there was no other coherent understanding of causal production, such reasoning would go through. If causation entailed necessity, and necessity entailed determinism, then causation would jeopardise freedom. We think the first step of that argument can be blocked, as we will argue shortly. If we take that out of the reckoning momentarily, however, we can see that the mere presence of necessity in determinism is sufficient to make it a threat. Free will is a problem if the past necessitates the future, or there is only one possible future, hence no alternate possibilities. These are ways of articulating determinism and how it affects free will that make no mention of causation at all. Causation only gets dragged into the debate around this issue, we maintain, because it is assumed to be the means by which necessity is introduced into the world. It is depicted as the carrier of natural necessity.

5 We need to be causes

We will now move on to the positive aspects of our proposal. We start by motivating the claim that we need to be causes, if we are to be free agents. After that, we will progress to a consideration of the modality of causation and show how there is at least one account of it that seemingly would allow both the principle of alternate possibilities and the principle of ultimate authorship to be true. This resolves the classic dilemma of free will and solves the modal problem of free will. In doing so, we are showing how one can be a compatibilist about free will and indeterminism. But we then have to make some case that, in addition to this compatibility, we do indeed have free will. The 'we' in this case refers to rational thinkers, who in the possession of certain rational abilities become free agents.

As such abilities can be held to some degree, greater or lesser in different agents, then there is no reason in principle why some non-human animals cannot also be agents (Steward 2012), again in some degree.

First, then, authorship of our actions requires that we be causes of them (for instance, Alvarez 2013, Vihvelin 2013 and Chapter 9). Without causation, we are impotent: disempowered. Causation is vital to our agency in at least two ways. First, we want that our decisions are causes of our bodily movements; for instance, that a decision to raise a hand is indeed accompanied by the raising of the hand. Second, we want such actions to be connected to intended outcomes, such as a raising of a hand attracting someone attention. It does so only if the hand-raising causally affects that person, getting them to notice via a perceptual experience. Alternately, the hand-raising could be for the purpose of lifting a box, which means that we want our bodily movement to causally interact with the box. Causation is what allows us to get what we want as agents; it is what allows us to act.

Suppose it were otherwise. What would we get from being free of causation, such as in an entirely stochastic world in which nothing is causally connected to anything else? This avoids the threat of determinism, certainly, but lands us with another threat just as big. Our decisions wouldn't be causally connected with any bodily motion. A decision to raise the hand wouldn't make it do so. It could only do so through coincidence but most of the time it wouldn't raise, or some other movement would occur. And any bodily movement that occurred wouldn't be connected to any particular outcome. The hand's lifting of the box wouldn't cause it to rise. It could instead turn green, remain stationary where it is or make the sound of a frog. This stochastic world is not one that gains us freedom at all and shows us that we really should want to be causes.

Now perhaps it might be said that it is not causation that really does the work of free agency. Rational agents act for reasons, for instance, and reasons are not the same as causes (see Davidson 1963). Thus, while a world of causation is perhaps required for us to function effectively as free agents, it is not *qua* causers (i.e. that which causes) that we are free, but *qua* rational deliberators. Reasons are normatively evaluable, for instance, to the extent that you can have good and bad reasons for action, whereas there cannot be good and bad causes. We accept the power of this distinction but have two relevant points that show it is not undermining of the importance of our basic position. In the first place, the arguments above concerned what occurs after deliberation has occurred and a decision has been made. Without causation, we are unable to act on those decisions; that is, to exercise our agency. This issue remains even if reasons are a fundamentally non-causal matter. But, second, a naturalistic account of normativity, and by extension of reasoning, is not yet ruled out, as we will discuss below in Section 7. As well as being caused, and an action, a decision could be a cause of action. Causation, in that case, would remain the unrivalled central component in our freedom.

There is, however, a different view of libertarian freedom inspired by Kant (1781: B559–86). This view accepts that causation itself is deterministic but

rejects that we as agents are restricted by it. We have agency, which means that we are able to act as causers, but we are able to escape the causal necessity that would otherwise act upon us. Effectively, this means that we are able to step outside the causal nexus of the world or, as some would understand it, break free from the laws of nature.

We do not want to take this route. Why allow humans this special power and how do they have it? Why a different rule for us than other parts of nature? We reject both claims integral to this Kantian position. We say that agents are restricted by causation to the extent that causes act upon them, in other words, make them do things. We are not, then, free to do just anything, given that we are a part of the natural world. But we also say that causation is not deterministic in the natural world. Hence, causes acting upon us can produce changes in us but that does not mean that they did so through necessitating those changes, as the PSR would have it. The causes that we enact are of the same character as the causes acting upon us and thus agents are not special cases, as the Kantian view suggests. And nor do we need different types of causation for agents, as is suggested when some divide agent causation from event causation (see O'Connor 2011). Causation is just one thing.

We conclude that it is through the exercise of causal powers that we are agents and through which we have gained free will. The last thing we need is to be liberated from causation, then, if that would thereby enslave us to matters of chance. It is clear, however, that causation has been misunderstood in terms of determining, necessitating and controlling. In contrast, we should think of causation in terms of power, tendency, influence, counteraction and mutual manifestation partnerships. It is necessary, then, that we now consider the detail of how such a non-necessitating notion of causation would work. Equally important, we need to see how it would avoid collapse into a Humean view where anything can follow anything, which would come dangerously close to a stochastic world.

6   Dispositional modality for the sake of free will

To resolve the classic dilemma, we invoke the tendency view of causation. Causes genuinely produce their effects. But this does not require that they necessitate them. Causing an effect is not the same as guaranteeing it. Causal dispositionalism offers an alternative account of causal production in which it involves a sui generis modality of tendency or dispositionality. Causes tend or dispose toward their effects with varying degrees of strength in different cases. They often succeed in producing those effects but, even when they do so, they did not through any necessitation.

The important part of the theory is not the negative argument against necessity, however, but the positive proposal that causes involve the dispositional modality. This modality can be characterised as less than necessity but more than mere contingency. How does the dispositional modality avoid the dilemma? We saw that necessity threatened the principle of alternate possibilities, while pure contingency threatened the principle of ultimate authorship.

We rejected as undesirable an account in which the causes that we enact are of a different character from the causes found in the rest of nature. The importance of the dispositional modality is that it allows both alternate possibilities and ultimate authorship while granting that the causes acting upon agents and the causes enacted by agents are of exactly the same modal kind. Causation is the same thing whether it is agents involved or inanimate objects.

In the first place, there will always be alternate possibilities, given that no cause ever necessitates its effect. This follows straightforwardly from acceptance of the dispositional modality, which is always short of necessity. Hence, although a stone may have broken a window, there was an alternate possibility in which it didn't: for instance, where a mattress was resting against the other side of the window and assisted the glass in absorbing the impact. Once the dispositional modality is accepted, alternate possibilities come easy. They are, indeed, ubiquitous. The trick has always been to gain alternate possibilities while not losing control over, or responsibility for, our actions. But we see how this can be done even in the inanimate case. Where the stone is thrown and the window does break, in most cases we would think the thrown stone was responsible for the breakage. The stone's impact caused the break in virtue of it being a causal power of the stone that made the glass break. It produced the breakage, or, to use Martin's (2008) terms, the stone and window were mutual manifestation partners for the break. Furthermore, it is clear that the stone broke the glass and was thus responsible for the breakage even though its doing so could have been prevented. A mattress could have absorbed the impact. But this shows that lack of necessity does not undermine causation in any way, and thus does not undermine causal responsibility either.

The classic dilemma for free will is not about causal responsibility of inanimate objects; however, it is about an agent having authorship of their actions through an exercise of free will. Does the story of the stone and the window carry over to the case of agency, then? We argue that it does. We will see, however, that solving the modal problem of free will does not solve the free will problem *tout court* and this means we will have to consider what sorts of powers are the basis of free will.

Let us start, then, with a worked example of agency. We will use a standard example, which is Austin's (1956: 218n) golfer. This has been discussed subsequently but we add a further type of case. The golfing case is useful because it raises questions of desert and reward – though not over very serious matters – which bring the issue of causal and agential responsibility into focus.

In the first scenario, a golfer exercises her causal powers, both mental and physical, and hits the ball towards the hole, and it goes in. There are various powers the agent needed to master and deploy. She made a decision on what she wanted to do and how she wanted to do it. She sized up the shot, calculating its intended direction and force, which needed a good eye for the lie of the land and memory of required effort in similar shots. She then also needed the steady hand and smooth swing to execute the shot. If she did all this and sank the ball, there's no doubt that she was responsible. She deserves the credit; she might even

win a trophy. Let us just stipulate that there was no other causal explanation of why the ball went it. It wasn't radio controlled, for instance, or pulled on a string by a confederate. Only through some sort of subterfuge would we ever think of the successful putt as not being the agent's action and thus not to her credit. Significantly, because the modality of causation is the dispositional modality, it does not undermine such responsibility. The golfer exercised her causal powers in a way that tended towards success. She got the result she was trying to get, sending the ball straight and true into the hole. Her ultimate authorship of this action remains the case even though there were possible circumstances that could have prevented it. The wind could have blown a twig into the ball's path just at the wrong moment, diverting it away from the hole for a miss. More obviously, a jealous opponent could have run up and kicked the ball away just before it dropped into the hole. The action didn't necessitate the outcome, therefore, but was its cause nevertheless. And such an interference could have occurred at any point during the exercise of the golfer's agency, not just after the ball sped away from the club. An opponent could have nudged her just as she was taking the shot, or distracted her while she was trying to calculate the shot, or slipped her a mind-altering drug so that she never chose to make the shot at all. These things were all possible but they didn't happen. The golfer made the shot, but she did so without guaranteeing its result.

This illustrates what we all know; you need a little luck to exercise your agency successfully. No one who ever acts can control everything that could possibly interfere with and prevent the intended outcome. We could try to control all we can and mitigate against some possibilities. But something happening depends upon countless other things not happening, many of which are beyond our control. What the first scenario shows, is that if you exercise your powers and succeed, it is true that you caused the intended effect and thus that you were the ultimate author.

What, though, of the opposite case? Let us consider a second scenario, which is an important test of the credibility of the theory. In the first scenario, the account gives credit where it's due but it is equally important that we don't give credit where it's not due. In this new case, then, the golfer tries to get the ball in the hole as before but this time plays a bad shot. Maybe she miscalculated, had a lapse of concentration, didn't spot an undulation of the green or just lost control of her swing. The shot is going some distance wide, but in this case an outside interference diverts the ball and it ends up in the hole. This could be, for instance, that the wind blows a twig into the ball's path, which then changes the ball's direction through a collision. Should we give credit to the golfer for apparently sinking the putt? The intuition is that we should probably not, but does the account we have offered give that same result?

We say that it does. In this second scenario, the golfer did not exercise a power that tended towards successful completion of the action. Because the action was badly executed, the ball was tending towards a miss. There is then a significant difference between this and the first scenario, even though they both end with the ball in the hole. In the first case, the golfer's action was tending towards the

sinking of the putt even though its succeeding required for there to be no outside interference. In the second case, the shot was not tending towards the hole and got there only because of the outside interference. It is for this reason that we think the second golfer does not have ultimate authorship of the outcome; that is, causal responsibility for it. If left alone, the ball would not have tended to go in. The first golfer's ball was tending to go in, which is why it doing so depended on it being left alone.

The theory gives us a credible account of what is happening in both scenarios, therefore, and the modal problem of free will is solved. The causes acting upon agents may tend them towards certain outcomes, including tending them towards making certain decisions, but they do not necessitate any such outcome. Therefore, there are alternate possibilities. And the causes enacted by agents oftentimes succeed, which means that they have causal responsibility in those cases. Therefore, there is ultimate authorship. A world of dispositional modality in natural causal processes permits satisfaction of both principles. Neither determinism nor a stochastic indeterminism would.

7 Your normative powers

That something exercises its causal powers is clearly not enough to give it free will. A table exercises its power of gravitational attraction when it rests on the ground but it is not an act of free agency when it does so. It matters, then, which specific powers are being exercised. Some are powers of willing – as in free *will* – and others are not. What counts is that we have the power to decide and choose, which we are capable of exercising some of the time. How do we have this ability? Is it primitive? Is there a simple will power that humans have and tables do not?

We think the situation is not quite that. The ability that humans and possibly some other animals have to make choices is a complex one that doubtlessly has a number of component powers. There is an account, for instance, in which it is a necessary condition of having free will that an agent be capable of higher-order thinking; that is, of having thoughts about their thoughts (Frankfurt 1971, Mumford and Anjum 2015b). But it matters also what particular higher-order thoughts one has. A crucial matter for free will is that one can have normative thoughts about one's first-order thoughts.

Suppose we have a case where an agent has a thought that <I want *x*> (using angled brackets to mark the content of the thought). It is possible to have a variety of types of higher-order thought about this desire. For instance:

a   I had that same thought only yesterday
b   I'm determined to get my way on this
c   It's a nuisance to be subject to such wants

These higher-order thoughts do not have explicit normative content. It is arguable that b and c have some implicit normativity although a doesn't appear to

have any at all. But a–c contrast with d and e. If we are capable of normative thinking we can also have thoughts such as:

d   I ought not to want *x*
e   I don't want *y* but I ought to

Normative thought allows one to think what ought and ought not to be. Of course, normative thinking need not be about oneself. One can see a man harm a dog and think that he ought not to. But free agents are both normative and self-reflective thinkers, hence capable of thinking about what they ought and ought not to do, and even what they ought and ought not to *want* to do. Freedom requires not just that there are alternate possibilities but also that an agent is capable of understanding what some of them are, which are within their power to realise, and capable of making a decision between them not just on the basis of their wants but also in accordance with their accepted norms.

   This no doubt requires a whole cluster of interrelated powers acting together, which would require an architectonic account of personal dispositions (see Figure 9.1, Chapter 9). One must be capable of seeing what is the case but also imagining what could be the case and considering what ought to be, taking account of what you want there to be. This all takes place within a context in which agents are also patients, constantly acted upon. A man walking in the sun on a hot day can be caused to dehydrate through the sun's action. This man's *thought* that he is dehydrated is also caused, indirectly, by the sun acting upon him. And while there is no necessity in this, or any other effect, the sun could also be the cause of his desire for drink. But higher-order self-reflection means that we are more than simple stimulus–response mechanisms. This man can still think whether he ought to drink. In almost all scenarios, he can and should, and his freedom is not compromised by the fact that the desire had causal antecedents outside of himself. He was still exercising his agency in choosing to satisfy the desire that the hot sun had given him. (Importantly, he can also choose what to drink, informed by what he thinks he ought to drink: a cold beer or a fresh orange, carrot and ginger juice, for instance.) But there are other scenarios in which he chooses otherwise: that he ought not to drink (tragically, he is lost in the desert with a child and little water and chooses that he shouldn't drink, despite his thirst, but save the water for the child).

   From where does this crucial normative power of agents come? The power is not magical. Our normative powers are certainly special but they are not *that* special. While the details are still a riddle, normativity ought to have an ultimately naturalistic explanation. A lot of that will again reside in understanding the role of the dispositional modality, as argued in Chapter 9. That normative notions are dispositional in character, exhibiting again a modality that is between necessity and pure contingency, suggests that they are grounded in the causal powers of the agents who create such notions. What should be added to that, however, is also the causal powers found in higher-level social entities. This is because normativity should be accepted as a necessarily social phenomenon, generalising

Wittgenstein's (1953: secs 269–75) private language argument. Norms can be correctly understood and applied only relative to the judgements of a group. Arguably, a solitary individual could not think normatively about what ought or ought not to be, and what he or she ought or ought not to do.

If this is so – and a serious argument will have to be advanced in another place – it tells us that our free will is dependent upon us being situated within a norm-using society in which we can develop a self-reflective conscience. Indeed, a sharing and mutual contesting of those norms – rational and moral – will be one of the factors that turns a mere plurality of individuals into a society, especially one that assumes its constituent members to be free agents and thus ends in themselves. The idea that free will evolves, then, is not merely a biological claim (as in Dennett 2003). Our freedom will have evolved as we became more and more of a society, with free agency as an emergent phenomenon of that society.

8 Compatible with what?

In the traditional division between compatibilism and incompatibilism, we see that many philosophers have thought there to be a tension between free will and prior causes. They effectively thought of free will and causation as incompatible. We saw the reason why; they thought causation entailed necessity, which then entailed determinism. For instance, Libet's (1985) neuroscientific experiments show at the most, if they show anything at all, that conscious decisions have prior causes. This impinges on the debate only if you think that free will is incompatible with prior causation.

The real threat, we argued, was necessity because free will seems to be incompatible with determinism *qua* necessity (Mumford and Anjum 2014a also offer a defence of this kind of incompatibilism). This result is not alarming to any adherent of the dispositional modality for it is just an instance of the more general thesis that causation is incompatible with necessity, and thus with determinism *qua* causal necessity. Once that move has been made, the possibility is open for a re-appropriation of the term compatibilism. Our view is that free will is certainly compatible with causation. It is not something an agent needs to escape in order to be free. Indeed, how would free will be possible other than through causation: allowing agents who are active, exercising causal powers in response to the worldly causes that affect them? The problem has been that many have thought the only way causation can work is through necessity and this has led them to assume that free will is threatened by causation *per se*. We have shown that it is not. Once causation and necessity are separated, you can see that causation is not your enemy.

Afterword
The Golden Mean

Philosophers have played the cards they were dealt. But it's a bad hand. In trying to understand the modal nature of the world, we have consistently tried to fit what we find into the two notions of necessity and pure contingency. We have argued in this book that a number of philosophical problems have been generated by the limitations of the standard framework. What is not purely contingent must be necessary, and what is not necessary must be purely contingent. On a number of topics, however, we have shown how a stark choice between these two alternatives is inadequate. To make progress, we need a third option – the dispositional modality – and this is what we have offered.

The individual topics that we have considered were chosen because they show that understanding the problems within a novel framework of deep tendencies is how we can make progress. Old problems get dissolved. We considered a range of issues, from the very abstract that concern mainly philosophers (logic and metaphysics) to the practical that concern everyone (ethics and freedom). A reader might think that in each case a solution has been offered that has some credibility: at least some ring of truth, even if there are other theories that purport to do the same. But there is a feature in our favour that we have tried to illustrate in this book. While there might be one approach to solve the problem of induction, another to explain free will and then a third to account for conditionals, we have instead offered a single innovation that solves all these problems and more. Acceptance that the world is a world of tendencies, where theories concern what tends to be, is an idea that has unifying explanatory power. We do not have an ad hoc solution for each individual problem. We tried to show that the idea of a dispositional modality has an independent motivation; it just seems to be the way the world is. And then once such an idea is embraced, many things that seemed to be difficulties – sometimes irresolvable – were suddenly explained. It is, therefore, an additional argument for the dispositional modality that there is a pattern of explanation running through different contexts.

What we have said might seem immodest. Are we not proposing a revolution: a modal revolution? Evidently, we are overturning the standard picture – the received view – in which talk is permitted only of two modal values. We cannot deny this. Despite the historical antecedents, which we outlined, acceptance of

a deeply tendential view remains so very rare. For the most part, we saw that our predecessors backed away from fully endorsing real tendencies and lapsed into the familiar comforts of necessity and possibility. We might not be the first, but we still wish to make it clear that we subscribe to a challenging thesis.

Nevertheless, a case can be made that we are the ones urging moderation. We declare: 'resist extremism!'.

If our analysis is correct, then the dominant orthodoxy of modal dualism effectively forces its adherents to adopt one of two extremes. Everything, they say, is either necessary or, if it's not, then it's purely contingent. Instead we urge that the truth lies somewhere between two such poles. Our position takes the path of the Golden Mean. The account is thus parallel to Aristotle's idea that virtue was the mean between two extremes.

It can be seen that this model applies in several of the cases discussed in the preceding chapters. Humeanism declares the world to be a world of pure contingency, for example. Opponents, seeing only two options in front of them, then feel obliged to adopt a world of necessity. But neither will do, we have argued. Neither of these options successfully captures the world in which we live. Rather, they can be thought of as the views that would be situated at the extreme ends of the range of modal options. We, instead, have identified the moderate position; the world's modality is situated somewhere in between. This is the dispositional modality, we say: a strength of modality that is weaker than necessity but stronger than pure contingency.

And there are several more cases. In epistemology, we saw that there is a choice to be made concerning empirical knowledge: a choice between inductive scepticism and deductive certainty. Neither will do. Each is too extreme. The moderate position is situated between, with what we call a dispositional theory of induction. Similarly, we offer a moderate dispositional position between well-known dichotomies: between subjectivism and objectivism in aesthetics and the theory of perception; between constructivism and realism in the normative sphere; between facts and values; between necessity and possibility in modal logic; between loss of freedom and loss of control in the free will problem; between randomness and determinism in causation; between agents and patients – where every cause contains a mixture of active and passive. And there are other topics besides in which we effectively defend the Golden Mean between traditional extremes.

The traditional extremes come from the hand we were dealt: a received view of modality with only two values, neither of which properly applies. According to Aristotle's analogy, an extreme is a vice, and the two modalities have indeed become the vices of philosophy, creating problems that seem irresolvable with the limited tools we have been given. And any problem of one extreme view is of course not solved by lurching towards the opposite, for this too is also a vice: an overreaction.

Our primary aim in this book has been to show that we need not settle for the hand we were dealt. The traditional view of modal dualism – that necessity

and possibility are all the modal resources we need – is comforting. A perfectly consistent modal logic has been developed, for instance. There are cases where we know how to apply these two concepts. But it doesn't fit the world. The dispositional modality is now on the table. Modal dualism, no matter how tempting it seems, is perfectly resistible.

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