THE INTERACTION OF CAUSAL POWERS: A DEFENSE OF MUTUAL MANIFESTATION

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ABSTRACT

There are two competing models of the exercise of powers. In the stimulus-response model, powers remain latent and will be exercised only when they are appropriately triggered by their stimuli. By contrast, the mutual manifestation model depicts manifestations as the interactions between reciprocal powers. This thesis focuses mainly on two aspects of the notion of mutual manifestation: the ontological positions it is related to and the consequences it brings about in the dispositional account of causation. I argue that the mutual manifestation model is preferable to the stimulus-response model with regard both to the ontology of powers and the dispositional account of causation.

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Introduction

A crucial topic in the discussions of dispositions or powers[1] is how they give rise to their manifestations. The common or even orthodox view is often referred to as the stimulus-response model, according to which powers remain latent and will be exercised only when they are appropriately triggered by their stimuli. The disadvantage, if I can say so, of this model is that powers themselves seem inert and passive. On the other hand, C. B. Martin puts forward the mutual manifestation model as an alternative to the stimulus-response model. He depicts manifestations as the interactions between reciprocal powers. Mutual manifestations arise when disposition partners come and work together. Powers thus seem powerful and active on their own.

Due to their different characterizations of powers, the two competing models have different impacts on the ontology of powers. Since powers are inert and passive in the stimulus-response model, it suits those accounts of dispositions that try to reduce them away, such as the categoricalism, which claims that no properties are genuinely dispositional. On the other hand, mutual manifestations are more likely to be welcomed by realists about dispositions, especially pan-dispositionalists, because it suggests that powers are themselves active and do not require other kinds of things to activate. In addition to the characteristics of powers, the two models also differ in another aspect. Each (type of) manifestation belongs exclusively to a (type of) power in the stimulus-response model, whereas mutual manifestations are common products of a group of powers. Because of this, the two models would have different implications on the depiction of effects when it comes to the dispositional account of causation.

[1] In this paper I use the terms “disposition” and “power” interchangeably.

In spite of the dominance of the stimulus-response model, the notion of mutual manifestation has found a market at least among realists of dispositions nowadays, and is also used to base their dispositional accounts of causation.[2] The basic idea of such accounts, as Martin puts it, is "to replace cause and effect by…the notion of reciprocal disposition partners for mutual manifestation" (Armstrong, Martin, and Place 1996, 136). That means we should no longer take causation as a matter of two distinct events, cause and effect, which form a sequence in temporal order, but as mutual manifestation of reciprocal disposition partners, in which the interaction of powers is simultaneous with and metaphysically inseparable from the mutual manifestation.

This thesis focuses mainly on two aspects of the notion of mutual manifestation: the ontological positions it is related to and the consequences it brings about in the account of causation. I argue that the mutual manifestation model is preferable to the stimulus-response model with regard both to the ontology of powers and the dispositional account of causation. My reason on the ontological side is that realism of dispositions is a competitive position. If one holds the realism or even pan-dispositionalism, powers have to be powerful and active rather than inert and passive. As for the account of causation, the notion of mutual manifestation is consistent the polygenicity of effects so that we do not have to make a distinction between effects in causation and manifestations of powers.

The plan of the present discussion is as follows. In chapter one I discuss the ontological background of mutual manifestation, with the focus on the realism and pan-dispositionalism. In chapter two I discuss the problem of the Humean view of causation and introduce the promising dispositional alternative (which is based upon the mutual manifestation model). In

[2] Attempts to build such theories are made by Martin (2008), Mumford and Anjum (2011), Heil (2012), etc.

chapter three I discuss why the dispositional theorists of causation should adopt the mutual manifestation model rather than the stimulus-response model.

Chapter 1 – Dispositions and mutual manifestation

This chapter is mainly concerned with two issues in the ontology of dispositions. The first is whether dispositions or powers are real properties; the second is whether all properties are dispositional or causally powerful. Whether the notion of mutual manifestation is preferable to its rival is partly dependent on the answers to those questions. In this chapter I present some reasons for holding the positions that count in favor of mutual manifestation. Though I cannot provide definitive answers to those hard questions, I hope to at least set up the ontological background for the following discussions of mutual manifestation.

1.1 Realism about dispositions

All powers are powers *to* or *for* something, which is called the directedness of powers to their manifestations. Fragility is the power to break if struck; solubility is the power to dissolve in liquid; combustibility is the power to burn when ignited. The directedness is the feature by which powers are distinct from non-power properties. A power is something that is necessarily directed to a specific manifestation, whereas a non-power or quality[3] is either not directed to a manifestation or at best contingently connected with some manifestation (Molnar 2003, 155). Some people deny that triangularity is a power because they believe that being triangle-shaped does not necessarily dispose the object to a certain effect. On the contrary, the dispositionalist who regards triangularity as a power because he believes otherwise.

At first glance, the distinction between powers and their manifestations presupposes the potentiality-actuality dichotomy. Powers are often taken as items in the realm of potentiality whereas their manifestations in the realm of actuality. The anti-realist view about dispositions is apt to follow from this belief. Some tend to think that dispositions are not real because they

[3] Following Martin and Molnar, I also refer to non-dispositional properties as "qualities".

are not actual. They speak of powers as mere potentialities or possibilities. For example, Goodman claims that "the peculiarity of dispositional predicates is that they seem to be applied to things in virtue of possible rather than actual occurrences—and possible occurrences are for us no more admissible as unexplained elements than are occult capacities" (Goodman 1983, 42). On this view, a piece of fragile glass is one that could break, but its breaking only obtains in some possible world(s) in which it is dropped or struck. If the fragility of an object is just the object's possible breaking, then it is not actual and hence not real.

The anti-realist thesis based upon the de-actualization of powers can be traced back to Hume, who seems to suggest that powers possessed by objects do not exist unless they are being exercised:

> [T]he distinction, which we sometimes make betwixt a *power* and the *exercise* of it, is entirely frivolous, and . . . neither man nor any other being ought ever to be thought possest of any ability, unless it be exerted and put into action. (Hume [1739–40] 1888, 311, original italics)

Similar to the contemporary view mentioned above, he also thinks that a power consists in the possibility of certain behavior of its possessor:

> [W]e consider a person as endow'd with any ability when we find from past experience, that 'tis probable, or at least possible he may exert it . . . power consists in the possibility

> or probability of any action, as discover'd by experience and the practice of the world. (Ibid., 313)

As Molnar reads Hume, "manifested powers are identical with their manifestations" (Molnar 2003, 99), and since unmanifested powers are nothing more than the possibility of their manifestations, a power can only be "actual" or "real" when it is manifested. That is to say, a power is "actual" or "real" only when it is identical with its manifestation, which might be the reason why Hume thinks the distinction between and a power and the exercise of it is "frivolous".

By contrast, realists about dispositions argue for the actuality of powers. One of the key claims they have made is that powers are actual properties of objects no matter whether they are being manifested (or can be manifested). A power remains actual or real even if it will never be manifested. For the realists, whether powers are actual or not is independent of the occurrences of their manifestations. Although powers and their manifestations can be used to explain how things pass from potentiality to actuality, ascriptions of powers to objects are not mere statements about possibilities of certain kinds of behavior, but statements about real features of objects.

The anti-realist view has some *prima facie* implausibilities. One is concerned with the differentiation of objects with only different powers. How could a piece of fragile glass be distinguished from a piece of non-fragile glass, *ceteris paribus*, if fragility is the mere possibility to break. It is common to compare the properties that objects have when it comes to the identity relation between them. We speak of two objects as qualitatively identical when they share all the properties they have, which entails that two objects are not (qualitatively) identical if at least one property had by one is not had by the other. If this is the case and we

accept the anti-realist view about dispositions, then we will have trouble differentiating the fragile glass from the non-fragile glass. On the one hand we intuitively take the fragile glass to be different from the non-fragile glass *just* because of the fragility, which is had by the former but not by the latter, but on the other hand we deny that fragility, as a disposition or power, is a property that is actually possessed by fragile glass.

Maybe the differentiation problem can be explained away by relating power ascriptions to some real properties, saying that dispositions as mere possibilities are based on real properties possessed by objects. Suppose two things have different dispositions only if they possess different real properties, then the dispositional differences between them are the reflection of qualitative differences. This will suffice to distinguish between fragile and non-fragile glass while retaining the view that fragility as a disposition is not a real property.

But there are more problems with the anti-realism. I'd like to discuss two of them in what follows. The first significant problem with the anti-realist thesis is the dispositional explanation of causation, which presupposes the causal potency of powers. In the discussions of causation, it is common to assume that only actual things can be causes or effects, since non-actual entities are conventionally regarded as causally impotent. Thus, given that dispositions can be causes and effects, they are actual entities. Here is an example from Mellor: "Consider a rod so twisted that, when put in liquid helium to make it brittle, it breaks. It's becoming brittle is caused by the cooling and in turn causes it to break." (Mellor 1974, 172) In this case, according to the common interpretation, the power of being brittle is the effect of the cooling and also the cause of the rod's breaking. On the other hand, possibilities are not actual and hence causally impotent. If the power of being brittle is a mere possibility to break, then "change in it could be neither cause not effect" (ibid.). Following this line of thought, if it is assumed that all dispositions can be causes or effects, then no dispositions are mere possibilities of behavior.

Mellor thus concludes that "dispositions are real properties in a sense that rules out any account of them as mere potentialities or possibilities." (ibid., 173)

In addition to the argument based upon the causal potency of powers, Mellor also suggests another objection to the anti-realism, which is derived from the semantic difference between ascriptions of powers and statements of possibilities. As he puts it, "Dispositional ascription entails statements of (admittedly conditional) fact, not statements of possibility. A fragile glass is one that *does* break (*if* dropped), not one that *ca*n break. Whether it *can* break depends *inter alia* on whether it can be dropped, and its being fragile entails nothing about that." (Mellor 1974, 173, original italics) To develop this idea into a full-fledged argument, first we need a formulation of the possibilist analysis of power ascription based upon the Humean view. Here is one given by Molnar:

> At time t object x has the power to ϕ iff it is possible that x ϕ's at t [i.e. If at time t x has the power to ϕ, then it is possible that x ϕ's at t, and if it is possible that x ϕ's at time t, then x has the power to ϕ at t.] (Molnar 2003, 100)

The term "possible" here can be read in two different senses. In the first sense it expresses relative possibility. (In the relative sense "it is possible that x ϕ's at t" means that x' ϕ-ing is possible relative to the conditions that x is actually in at t.) In that case, when we say it is possible that x ϕ's at t, we mean that x' ϕ-ing is possible at t because it is under certain conditions. For example, when we say it is possible that the gasoline burns at t, we may mean that the gasoline's burning is possible because it is in an oxygen-rich environment. Such conditions are usually associated with the corresponding powers (e.g. the condition of oxygen

is associated with the flammability of gasoline). However, the bare proposition "x has the power to ϕ" does not entail anything about the conditions that x is in. The possession of a power or any other properties at a time is independent of the conditions or circumstances in which the possessor is placed. Putting the gasoline in vacuum at t does not deprive it of the flammability, but it makes it impossible (in the relative sense) that the gasoline burns at t. So the first half of the biconditional is false when the possibility statement is read in the relative sense.

In the second sense the term expresses absolute or logical possibility. If the term "possible" is read as expressing logical possibility, then the first half of the biconditional is true. Suppose x' ϕ-ing is logically possible at t. In that case, according to the possible world analysis of possibility, there is at least one possible world (within the accessibility of the actual world) in which x ϕ's at t. Such world(s) can be any random one(s). In the gasoline case, since the worlds in which the gasoline is ignited in air or any other oxygen-rich environment are among the possible worlds in question, "it is possible that the gasoline burns at t" is true when "at time t the gasoline has the power to burn" is true. But something goes wrong with the second half of the biconditional. Suppose x' ϕ-ing is logically possible at t, it can be the case that x does not have the power to ϕ at time t but the power to acquire the power to ϕ at time t, so the logical possibility does not entail the possession of the power to ϕ.[4] Suppose the power in question in the gasoline case is the power to heat the room. In that case, obviously, "It is possible that the gasoline heats the room at t" is true in the logical sense, whereas the gasoline does not have the power to heat because it is not yet burning at t. The power to heat is possessed by the gasoline only when the power to burn is manifested.

[4] "It may be possible for an object to ϕ at a time when it does not actually have the power to ϕ, if it has the power to acquire the power to ϕ." (Molnar 2003, 101)

Since in neither sense of possibility can the biconditional be true, the possibilist analysis of power ascription cannot be held plausibly. (Molnar [2003] takes the same approach in his argument against the possibilist analysis while argues on the second half of the biconditional in a more complicated way.)

In light of these problems with anti-realism, it is plausible that powers are actual properties that are responsible for the possibility or potentiality of their possessor's behavior rather than the possibility or potentiality itself. For the purpose of this chapter I am not going to continue the discussion of arguments for or against realism, but I think what I have mentioned here is fairly enough to let us think of realism as a competitive position in the ontology of dispositions.

1.2 Pan-dispositionalism

Pan-dispositionalism is the position that every genuine property is intrinsically a disposition or power. By saying that a property is "intrinsically" dispositional (or powerful) I mean that its dispositionality is independent of things other than itself (e.g. laws of nature, language, mind, etc.). This is the strongest version of dispositionalism, and may be called "dispositional monism" since it claims that all properties fall into one category. Some also put this thesis in a way that takes properties as that which confers causal powers on their possessors. As Heil puts it, "more precisely, the thesis is that intrinsic properties of concrete objects are distinguished by distinctive contributions they make to powers or dispositionalities of their possessors." (Heil 2003, 76-77) Shoemaker (1980) also seems to contend that a property is that which confers powers on objects that possess it. However, these claims can cause confusion because they seem to distinguish (at least conceptually) properties from powers of their possessors. Properties seem as if they had the ability (which might also be a type of power) to contribute to the powers of their possessors. If that ability is understood as a type of power, then properties are (second-order) powers to confer (first-order) powers on objects. We would then have to

make a distinction between second-order powers and first-order powers. In that case, since properties are second-order powers and the powers they confer on their possessors are first order powers, an object has more powers than the properties it possesses. Pan-dispositionalists will probably disagree with this strange implication. Although they only claim that all properties are powers, I take them as suggesting that a power that a property is is just a power of the possessor of the property—dispositional properties confer powers on their possessors by being themselves first-order powers, rather than being second-order powers which contributes to the first-order powers of their possessors.

The pan-dispositionalist position is far from a contemporary invention. It can be traced all the way back to the Eleatic stranger's test of reality in Plato's *Sophist*:

> I'm saying that a thing really is if it has any capacity at all, either by nature to do something to something else or to have even the smallest thing done to it by even the most trivial thing, even if it only happens once. I'll take it as a definition that *those which are* amount to nothing other than *capacity*.[5] (Plato, *Sophist* 247d–e, original italics)

In this passage, the criterion of reality expressed by Plato's Eleatic stranger is that "something is real only if it can make a causal difference to the world" (Mumford 1998). If we assume that properties are real entities, given that real beings are necessarily powerful, all real properties are powerful. Should a property not confer powers on its possessors, it would fail to

[5] Here is a modified version by Heil: "I suggest that anything has real being that is so constituted as to possess any sort of power either to affect anything else or to be affected, in however small a degree, by the most insignificant agent, though it be only once. I am proposing as a mark to distinguish real things that they are nothing but power." (Heil 2003, 75)

qualify as a real entity. The last sentence of the passage is suggesting even more: "real things are nothing but powers". As Heil reads it, Plato's Eleatic Stranger was expressing the idea that "all there really is to a concrete entity is its powers to affect and be affected by other entities" (Heil 2003, 75). If we assume that concrete objects depend their powers totally on the properties they have, then all there is to the properties are the powers by virtue of which their possessors are real. Therefore, properties are purely powers if they are real entities.

This interpretation of the Eleatic stranger's view of reality seems to completely rule out the existence of categorical, or non-dispositional, properties, since by definition they are not intrinsically dispositional. It also rules out the duel-sided theory as a live option. In the duel-sided theory of properties, a property is dispositional because one side of it is a disposition or power. It is not that properties in their entirety are either powers or non-powers. The distinction between powers and non-powers is not a distinction between different types of properties, but one concerning different sides or aspects of properties (Molnar 2003, 150). Every power has both a causal facet and a non-causal facet, which are referred to as a disposition and a quality respectively. Neither of the two sides are reducible to the other or something else, and neither of the two sides can exist in a property without the other (ibid.). Thus, properties are not purely dispositional, but partly dispositional. However, as Heil claims, "the exciting idea . . . that to be real is to possess causal powers can lead directly to the thought that properties are purely dispositional" (Heil 2003, 97). A duel-sided property with both a dispositional side and a non-dispositional side would be only half real according to the Eleatic stranger's criterion of reality, so it cannot be compatible with the assumption that real things are nothing but powers.

The view that real properties are pure powers is grounded in an assumption about the precondition of empirical knowledge, which can be traced back to Locke. In *Essay* Locke unintentionally suggests that all properties of objects are powers when he is explaining his

usage of the term "quality": "the Power to produce any *Idea* in our mind, I call *quality* of the Subject wherein that power is." (Locke [1690] 1975, 134) The view that qualities are powers to produce any idea in our mind foretells the main argument in favor of pan-dispositionalism. It is an epistemic argument derived from "the causal preconditions of our knowledge of properties" (Molnar 2003, 153). Assuming that empirical knowledge requires causal interaction of some kind between properties of external objects and the perceiver, for S to know that x has F, F must be one of the powers by which S' perceiving F is caused. If F were a causally impotent property, it would be unperceivable and hence unknowable. Suppose we accept the existence of properties that are causally impotent, then what we are talking about would be mystical entities that are inaccessible to our perception, which means we cannot have any empirical knowledge about them.

However, pan-dispositionalism is facing two main problems. The first one is concerned with the shift from potency to actuality in manifestations of powers. The second one is concerned with how the identity of a power is fixed by its manifestation.

As is mentioned at the beginning of this chapter, all powers are powers to or for their manifestations. Since all properties are dispositions or powers according to pan-dispositionalism, manifestations are also dispositions or powers. Thus, a power is a power to a further power, which in turn is a power to a further power, *ad infinitum*. The manifestations of powers would then bring about a problem with the actuality of manifestations. If a power were always a power to or for another power, "nothing would ever pass from potency into actuality" (Mumford 1998), since the manifestations of a power is just the switch to another power. Armstrong, for example, gives an interesting analogy between the working of powers and the re-packing of bags before a journey:

> Can it be that everything is potency, and act is the mere shifting around of potencies? I would hesitate to say that this involves an actual contradiction. But it does seem to be very counter-intuitive view. The late Professor A. Boyce Gibson, of Melbourne University, wittily said that the linguistic philosophers were always packing their bags for a journey they never took. Given a purely Dispositionalist account of properties, particulars would seem to be always re-packing their bags as they change their properties, yet never taking a journey from potency to act. For 'act', on this view, is no more than a different potency. (Armstrong 1997, 80)

But this is problematic for pan-dispositionalism only if powers are taken as pure potencies. I have mentioned above that pure potencies could not be causally powerful, and hence could not be real or actual. Given that pan-dispositionalism presupposes realism of dispositions, this alleged problem based on the potency-actuality distinction does not affect pan-dispostionalism. As long as powers are actual or real properties of objects instead of mere possibility or potentiality of behavior, changes made to the powers possessed by objects are real changes, rather than "mere shifting around potencies".

The second problem that pan-dispositionalism is facing derives from an alleged regress or circle and it cannot be solved by simply adopting the realist view. As a feature of powers, the directedness to manifestations also serves as the basis upon which we differentiate powers. The common view is that the identity of a power is determined by (the type of) its manifestation. It is the manifestation of dissolving that makes a power solubility; it is the manifestation of burning that makes a power combustibility; the power of being red is different from that of being blue just because red sensation is different from blue sensation. The plausibility of this view can be attributed to the thought that the direction of a power (i.e. the effect to which a

power directs the object) seems to be all its particularity can include; there seems no other intrinsic sides or aspects of a power that can individuate itself.

Suppose each power has one (type of) manifestation that is peculiar to it and the power gets its identity from that (type of) manifestation. According to pan-dispositionalism, all properties are powers, so all manifestations of powers are also powers. Given that the identity of a power is fixed by its manifestation, and that the manifestation of a power is itself another power that needs to get its identity from its manifestation, the identity of the manifestation is in turn fixed by a further manifestation. This would generate either an infinite regress or circle, hence "no property can get its identity fixed" (see Lowe 2006, 138).

1.3 The stimulus-response model vs the mutual manifestation model

Some argue that the regress or circle is benign because they think that the identity of a power should be fixed by the relations it stands with other powers (see Holton 1999), rather than totally determined by the only manifestation that it is for. I am not going to discuss what this view would lead us to because I think there is a more effective way to solve the problem raised by the alleged regress or circle. To begin with, let us consider the two models about how powers are exercised.

When it comes to how powers give rise to their manifestations, we tend to think of the conditions or circumstances in which powers manifest. It is common to assume that the right conditions or circumstances trigger powers and thus cause the manifestation, so the right conditions or circumstances are the stimuli of powers and the manifestations are responses that powers give to their stimuli. This is called "the orthodox view" by Mumford, who also refers to it as "the stimulus-response model". According to this model, powers remain latent and will be exercised only when they are appropriately triggered by their stimuli. For example,

dissolving is the response that soluble things give to the contact with certain kind of liquid; breaking is the response that fragile objects give to their being stuck with certain strength; burning is the response that flammable things give to their being ignited. However, this is found inacceptable especially by realists about dispositions because it suggests that powers are passive: they produce no change unless they are stimulated by the right stimuli (Anjum and Mumford 2018, 268-269). Although this model does not render powers causally impotent (they can be part of the causes for their manifestations), something still seems wrong: powers are not able to produce changes on their own. Thus, powers seem intrinsically powerless and it is the stimuli that are really "powerful" in manifestations. Furthermore, pan-dispositionalists would object to the distinction between powers and their triggers because it suggests a bifurcation of reality—powers and their stimuli are "two different types of qualities or entities" (Anjum and Mumford 2017, 78). Since powers are taken to be passive while their stimuli active, stimuli are not themselves powers in this model.

One way to avoid the problems mentioned above is to adopt the mutual manifestation model put forward by C. B. Martin. This model depicts manifestations as arising from partnerships of powers: "the manifestation of a given dispositional state will require the cooperation of some other dispositional states amongst its reciprocating partners" (Martin 1993, 182). In denying that manifestations are the responses powers give in reaction to certain stimuli, the theory of mutual manifestation suggests that "stimuli" are also powers—powers that partner with the powers they "stimulate", so manifestations are the joint and reciprocal work of power partners. Thus, powers are active by themselves and no ontological distinction between powers and their stimuli is needed.

Moreover, the alleged regress or circle seems inevitable for pan-dispositionalism only when dispositions are understood in the stimulus-response model. Notice that the regress or

circle presupposes the single-track account of the nexus of powers. If for each power there has to be one stimulus with which it can be triggered, given that stimuli of powers have also to be powers according to pan-dispositionalism, then each power has to be triggered by another power. Assuming that each power has to get its identity from the power it produces, each power is allowed to produce only one power. Therefore, the nexus of powers will be in single lines which are either straight or round. On the contrary, if we adopt the model of mutual manifestation, then each manifestation is typically the common product of a group of powers. Also, each power is allowed to take part in different mutual manifestations with different partners. The nexus of powers will thus form a web, rather than single lines either straight or round. Since the alleged regress or circle presupposes the single-track nexus of powers, it is no longer a problem in the model of mutual manifestation. (However, since mutual manifestations are common products of reciprocal powers, the identity of a power cannot be determined simply by its manifestation. This will be discussed and hopefully solved in the third chapter.)

Chapter 2 – From two-event model to dispositional theory

In this chapter I focus on the dispositional account of causation. While the received view is that causation involves two distinct events—cause and effect, with the former temporally followed by the latter, there appear some problems with the view that cause is temporally prior to effect. On the other hand, the dispositional theorists argue that each case of causation is about a single event that is called "causing", and that the nature of it is the manifestation of powers. Cause and effect are two aspects of the event and are simultaneous with one another. By adopting the model of mutual manifestation, causation is further depicted as the mutual manifestation of reciprocal powers.

2.1 The two-event model and temporal priority

Let me begin by discussing the two-event model and its problem. In the Humean view of causation, causes and effects are distinct events and causation is characterized by Hume as "a constant conjunction between the cause and effect" (Hume [1740] 2007, 137). That is to say, "every object like the cause, produces always some object like the effect." (ibid.) For Hume, causal relations or constant conjunctions between causes and effects are not the same kind of relations as logical and conceptual ones, which just are relations between ideas. He draws a distinction between two types of truths, those about relations of ideas and those about matters of fact. Relations of ideas are analytic, like logical and conceptual truths, and the denials of them are impossible or self-contradictory. For example, "All bachelors are men" expresses a relation of ideas. In contrast, matters of fact depend on how the world is. The denials of them are possible and do not lead to contradictions. For example, "All bread nourishes" is a matter of fact.

Analyticity is commonly characterized as the inclusion of a concept by another. And if the intension of a concept includes the intension of another, then the former does not have distinct existence from the latter. In the example "All bachelors are men", the proposition is true analytically because the concept of bachelor contains the concept of men: a bachelor is an unmarried man, so the concept of bachelor does not have distinct existence from the concept of men. By contrast, in the example "All bread nourishes", the concept of bread is independent of the concept of nourishment. The relation between bread and nourishment "is something to do with the facts of how the world is . . . and not just a relation of ideas or concepts" (Mumford and Anjum 2011, 113). All bread nourishes because in our world bread does nourish, but there can be other possible worlds in which some bread does not.

Similarly, the distinctness between causes and effects is emphasized by Hume in order to distinguish causal relations from logical or conceptual ones, and a crucial aspect of this distinctness is that causes are temporally prior to their effects. The "perfect instance" of causation, according to Hume, is the two billiard balls example:

> Here is a billiard-ball lying on the table, and another ball moving towards it with rapidity. They strike; and the ball, which was formerly at rest, now acquires a motion. This is as perfect an instance of the relation of cause and effect as any which we know, either by sensation or reflection. (Hume [1740] 2007, 137)

In his description of this case Hume did not clearly identify the cause and effect. It seems in his opinion that the cause is the motion of ball *a* and the effect is the motion of ball *b*, so the causation is between the motion of the former and the motion of the latter. It also seems that

the cause is the impact of the two balls and the effect is the motion of the second ball, so the causation is between the impact and the motion of ball *b*. But no matter what exactly he recognizes as the cause and effect, there are always two events, one temporally followed by the other. This shows a crucial aspect of the distinctness between causes and effects—the temporal priority of causes over their effects. Hume denies that causes can be simultaneous with their effects; they always temporally precede their effects:

> 'Tis evident likewise, that the motion, which was the cause, is prior to the motion, which was the effect. Priority in time is therefore another requisite circumstance in every cause. (Ibid.)

The thesis of temporal priority is intuitively plausible within the two-event model. In the two billiard balls case, according to the common understanding, "first we have the rolling of ball *a*, then the collision, and then the rolling of ball *b*. Ball *a* rolled before its effect in ball *b* rolling." (Mumford and Anjum 2011, 107) Parallel interpretations can be made for many other examples. When a sugar cube is put into a glass of water, it dissolves: first we have the sugar untouched by water, then the contact between the sugar and water, and then the dissolving of the sugar. When a piece of fragile glass falls, it breaks: first we have the motion of the stone, then the impact, and then the breaking of the glass. Two assumptions underlie the plausibility of these accounts: (i) the cause is an event that is distinct from the effect; (ii) the cause produces, or brings about, the effect. Given that the cause is distinct from the effect and the cause produces the effect, the cause must exist before the effect can exist. "Since a cause cannot act before it exists, and an effect does not exist until it is caused", the cause and effect can only be

simultaneous when causation is instantaneous (Molnar 2003, 191). But instantaneous causation, if there is any, seems rather scarce.

Some may think that the collision of the two billiard balls and the motion of ball *b* is simultaneous (or the motion of ball *a* ends at the same time when the motion of ball *b* begins), so the causation looks instantaneous. However, this goes against a physical truth: transfer of energy by collision takes time if the objects involved are not perfectly rigid. As Molnar notes on the alleged cases of simultaneous causation mentioned by Richard Taylor ("the motion of locomotive and the motion of caboose") and Charlie Martin ("the turning of the key and the turning of the lock"):

> These cases do not work because they need the transfer of energy at a *finite rate* from one point to other distant ones. Simultaneous movement could only occur if the bodies that push and pull, and those that are being pushed and pulled, were perfectly rigid. The bodies however can only be perfectly rigid if there could be instantaneous transfer of energy between distant points. (Ibid., 193-194)

That is to say, energy transfer involved in cases of this kind can only reach a finite speed if the bodies in question are not perfectly rigid. Given that no actual thing is perfectly rigid, transfer of energy in cases of this kind can only be performed at a finite rate, and hence cannot be instantaneous. The alleged simultaneity of the cause and effect (the movement of the body that pushes and the movement of the body that is being pushed) only exists in ideal cases where the bodies that collide are perfectly rigid, which involves physical impossibility. In actual cases, energy transfer through collision is accompanied by the deformation of the participants.

The deformation is a process in which the two bodies are both compressed to some extent. Although this kind of processes appear instantaneous to naked eyes, they actually take a tiny amount of time. The billiard balls case is thus like what Mumford and Anjum describes:

> Very slightly, when the balls collide, both *a* and *b* deform. They are not perfectly rigid. They squash ever so slightly against each other and then a pushes b away. While this looks to the naked eye to take no time, it rather just takes a small amount of time. What we actually have is a process rather than a momentary collision. (Mumford and Anjum 2011, 109)

Thus, in the two-event model of causation, the temporal priority thesis seems the only plausible option as to the temporal relation between causes and effects, which in turn seems to confirm the view that causes and effects are temporally distinct events.

2.2 Cause and effect are not temporally distinct events

The view that cause and effect are temporally distinct events (one precedes the other) is faced with a problem of timing because it implies that a cause and its direct effect are closest neighbors on the timeline, which seems against a mathematical truth.[6] I will elaborate this in what follows.

In ordinary language, it is legitimate to say that event A causes event B while there is a temporal gap between A and B. In such cases, what we are probably referring to is a causal sequence with A and B as its terminals. When we say "A causes B" and admit a temporal gap

[6] This idea is briefly mentioned by Martin (2008) without elaboration.

between them, we have just omitted the causal steps between A and B and have highlighted what we are actually paying attention to. When we put aside the ordinary way of talking about causal relations and focus only on a cause and the effect that is immediately produced by it, few would accept a temporal gap between them. The received view that takes cause and effect as temporally distinct events is accompanied by the assumption that no temporal gap is between a cause and its direct effect.

It is easy to see the reason for holding this assumption, because if there were a time gap, we would have to answer the question why the time gap ends and the effect begins. One can either concede that there is no answer to the question or introduce some extra element that is supposed to lead to the end of the gap and the start of the effect. The first alternative leaves the time gap in mystery: "the effect just takes some time to occur even though nothing further changes" (ibid., 111). The length of the interval between the cause and effect is thus a brute fact that does not require any explanation. But few would be happy to choose such an alternative and accept a brute fact. The second alternative involves the introduction of a third element which, together with the cause, initiates the effect. However, few would be happy with the introduction of an extra element between the cause and effect, because that amounts to saying that the cause itself is not sufficient for the production of the effect. Also, even if we take the cause plus the extra element as a more complete "cause", there will still be the question whether there is a temporal gap between the obtaining of the extra element and the effect. If the answer were "yes", we would be facing the same problem and have to choose again between the acceptance of a brute fact and the introduction of an extra element. We will fall into a vicious regress if we keep introducing elements between the cause and effect.

The discussion above suffices to prove that no temporal gap is between cause and effect if we follow the two-event model and temporal priority thesis. Thus, we have two premises on

the temporal relation between the cause and effect in the Humean view of causation: (i) the cause temporally precedes the effect; (ii) there is no temporal gap between them. They together entail that (iii) the cause and effect are closest neighbors on the timeline. However, there seems no such thing as a "temporally closest" event other than an event itself due to a simple mathematical truth. Consider the two following mathematical facts: (a) a line can be infinitely divided into shorter segments; (b) a point on a straight line has no length. Suppose we have a straight line *l* on which there are two different points A and B. From (a) and (b) we know that no matter how close B is to A, the line segment cut out by A and B on *l* can always be further divided into two shorter segments by another point C between A and B. And when point A and C are in question, we are back to the same situation: we can also find a point between A and C which divides line segment AC into two shorter ones. Divisions of this sort can be carried out for infinite times, so there is no nearest point to A on line *l*. If we think of the line as the number line, with A representing number 2, we would have no difficulty noticing that there is no closest number to 2. Likewise, if we think of the line as a time line, on which each point stands for a temporal instant, then we will come to the conclusion that for each temporal instant there is no temporally closest neighbor of it. (Notice that (a) and (b) have parallel versions with regard to time: (a') a period of time can always be divided into shorter intervals; (b') a temporal instant has no duration.)

Since there cannot be closest neighbors when it comes to temporal instants, namely (iii) is false, we have to give up either (i) or (ii). Given that (i) (i.e. temporal priority thesis) is assumed as part of the distinctness of causes and effects, and (ii) is an inevitable consequence of (i), it seems implausible to give up either of them in the two-event model. For the two-event model with the thesis of temporal priority to make sense on its own, (i) (ii) (iii) should have been true at the same time. However, the argument above shows otherwise, so temporal priority thesis should be rejected and the simultaneity of cause and effect should be adopted.

Some people may argue that the thesis of temporal priority can be true without leading to the fallacy of nearest temporal instant, so the simultaneity of cause and effect can still be resisted. The idea is that the objection to (iii) made above is valid by virtue of a narrow understanding of (i). The fallacy of "the closest point" only occurs when we assume that even the beginning of the effect is later than the end of the cause. But when we say that the cause is earlier than the effect, we do not have to rule out the possibility that the end of the cause is simultaneous with the beginning of the effect. Thus, they might urge that the effect starts at the very moment when the cause ends. In the billiard ball case, they might claim that the caused movement of ball *b* begins at the same point in time as the movement of ball *a* ends.

However, I would argue, it is unreasonable for advocates of the two-event model to assume that the cause ends at the same moment as the effect begins, so the objection based on the momentary simultaneity will not work. Suppose the effect begins at the same time as the cause ends. In that case, since the cause and effect are distinct events and the cause produces the effect, the effect is actually produced by the cause before the moment when it ends. In other words, what is actually doing the causal work in this case, or the *real* cause, still precedes the start of the effect. After all, the cause before the very moment has already brought about (the beginning of) the effect, for an effect does not need to be produced when it has already come into being. One might still argue for the momentary simultaneity by saying that the end of the cause just is the start of the effect—two events ontologically overlap at a temporal instant, but that would probably violate the assumption about distinctness.

2.3 Causation as a single event: the dispositional account

A promising alternative to the two-event model as well as the temporal priority thesis is the dispositional theory of causation, according to which the cause is simultaneous with the effect

and causation is not a matter of two events but one. The event which causation involves (or "causing", as Heil calls it) is the mutual manifestation of reciprocal powers.

Consider sugar's dissolving in water. When you put a sugar cube into a glass of water, the sugar cube dissolves. A few moments later solid sugar disappears and you get the sweet solution. The two-model event might lead one to think that the water's enveloping the sugar cube causes it to dissolve. Thus the cause, the water's enveloping the sugar cube, is one event that is distinct from but followed immediately by the resulting event, the sugar's dissolving in the water. However, if we take a close look at what really happens when the sugar cube gets into contact with the water, we will find that the putative cause does not precede the putative effect. The seeming sequence in time is just due to the way we pick out causes and effects. As Kant claims:

> The great majority of efficient natural causes are simultaneous with their effects, and the sequence in time of the latter is due only to the fact that the cause cannot achieve its complete effect in one moment. But in the very moment in which the effect first comes to be, it is invariably simultaneous with the causality of its cause. (Kant 1781: A203)

It is true that the water's enveloping the sugar cube precedes the final product, the sweet solution, but that is because the dissolving takes time. At the very moment when the sugar cube gets into contact with the water, the dissolving seems to begin: while the sugar cube has not yet touched the water, the dissolving has not occurred either; while the sugar cube has got into contact with the water, the dissolving has also occurred. Similarly, at the very moment when the water stops enveloping the sugar cube, the dissolving comes to an end: the dissolving

obviously ends when the sugar cube disappears in the water; if the water were removed at some point after the dissolving begins but has not completed, the dissolving would be suspended at the same time. Therefore, the effect begins and ends at the very moments when the cause begins and ends.

Moreover, as we already know, the water's enveloping the sugar cube is a continuous event and so is the sugar cube's dissolving. We all agree that the dissolving of the sugar cube in water is a process running towards the final product, the sweet solution, and that the process is initiated by the coming together of the sugar and water. If we accept the model of mutual manifestation, then the process of dissolving is the mutual manifestation of reciprocal powers possessed by sugar and water. But it is obviously not the case that the partnering of reciprocal powers is completed instantly and then the manifestation takes care of itself. Whenever the dissolving is running, the reciprocal powers are working together (or the powers are partnering), and vice versa. For if the powers in question ceased to interact after the process has been initiated, what else could keep the process going until it is completed or interrupted? In this case, it is more plausible that causation involves only one event—the continuous interaction between reciprocal powers, rather than a sequence of two events.

To some extent what we recognize as the cause and effect in a case of causation is a matter of pragmatics. In the sugar cube case, the cause might be your putting the sugar cube into the water and the effect might be the process of dissolving; the cause might also be the process itself while the effect might be the final product of the process, the sweet solution. Depending on the cause and effect in question, they can be either simultaneous or sequential. But what is actually doing the work in causation does not vary according to the recognized cause and effect. The causal action that is actually involved in the talk of cause and effect is what Heil calls "causing". "Considered ontologically," as he says, "causes and effects take a back seat to

causings. Causing is where the action is." (Heil 2012, 120) For these dispositional theorists of causation, the causal action or causing that really "cuts ontological ice" is the mutual manifestation of reciprocal powers. If they have to identify the cause and effect in the sugar cube case, they would say that the cause is the partnering of the reciprocal powers possessed by sugar and water and the effect is the corresponding mutual manifestation, i.e. the sugar cube's dissolving. However, in saying that the former "causes" the latter, they are not talking about two different events, but rather two aspects of one event. According to Martin (2008), a mutual manifestation is identical with a partnering of reciprocal powers:

> The two-event cause-and-effect view is easily avoided and replaced by the view of mutual manifestation of reciprocal disposition partners, suggesting a natural contemporaneity. This is not surprising in the least because the reciprocal dispositional partnering and their mutually manifesting are identical . . . It is not a matter of two events, but of one and the same event—a reciprocal dispositional partnering as a mutual manifesting. This surprising identity of what we had dimly thought of as the two-event cause and effect loses its surprise in the clear light of day. (Martin 2008, 46)

The thesis of partnering-manifestation identity is meant to reject the idea that "disposition partners jointly cause the manifestation" because it is liable to revive the two-event view. For Martin, the manifestation is not *caused* by the partnering of reciprocal powers, but just *is* the partnering. He illustrates this point with the two-triangle analogy. When two triangle-shaped slips of paper are put together in the proper arrangement, they form a square. In this case, the two triangles arranged in a certain way just *is* the square. As he points out, "It is not that the

partnering of the triangles *causes* the manifestation of the square, but rather that the partnering *is* the manifestation." (ibid., 51, original italics)

There has recently been some misunderstanding about Martin's identity thesis. Anjum and Mumford (2017) argue that it is inadequate as an account of manifestations because a dispositional partnering usually begins a process that takes time to bring about the full effect. When a sugar cube is put into a glass of water, the dissolving begins instantly, but we have to wait for a while before the solid sugar dissolves completely. They suggest that if a partnering is identical to a manifestation, then the manifestation is completed as soon as it occurs. However, in saying that a partnering is instantaneous so it is not identical with a manifestation that takes time, they might be attacking a strawman. For they have already assumed that the partnering itself cannot be characterized as something that extends through time. Martin affirms in his thesis that a dispositional partnering is identical with a mutual manifesting, but he does not specify his notion of partnering, which leaves room for different interpretations.

How should we interpret the term "partnering"? Answers can diverge due to the ambiguity of Martin's words about it. If a partnering is understood simply as reciprocal powers being brought together, then by no means can the partnering be identical to a manifestation, for it conceptually excludes anything that is the continuation of it. Suppose I put a coin on another one and describe it as one coin's being put onto another; I am not referring to the coin's lying on the other, though it is the continuation of what I describe. Likewise, if a partnering is taken as reciprocal powers being brought together, then it is not the same as the continuous interaction between the powers after they have got into contact with each other.

Martin, as I understand him, is probably suggesting another reading of "partnering": that it is not the *coming together* of reciprocal powers, but the *working together* of those powers. In the sugar cube case, the process of dissolving is a continuous mutual manifestation of the

reciprocal powers possessed by water and sugar. The persistence of the process requires the continuous cooperative work of the powers on both sides. Whenever the two objects are separated, which means that the reciprocal powers in question stop acting together, the manifestation—the process of dissolving—comes to an end at the same time. Obviously, a partnering in this sense is temporally extended, so there is no such conceptual obstacle to the identity of partnering and manifestation. On this understanding, therefore, what Martin is claiming in the identity thesis is that the working together of reciprocal powers does not cause the manifestation that is simultaneous with it, but is instead the same thing as the manifestation.

Chapter 3 – Manifestations and effects

In the last chapter I have shown why the dispositional theory is a better alternative than the two-event Humean view in the account of causation. But it is not yet clear why the dispositional theory should be based upon the mutual manifestation model instead of the received stimulus-response model, especially when we realize that the stimulus-response model is compatible with the simultaneity. In this chapter, I argue that this is due to an important characteristic of causation—the polygenicity of effects. Manifestations characterized by the stimulus-response model cannot be equated with effects, whereas mutual manifestations can. Although the notion of mutual manifestation faces a problem with the individuation of powers, I believe it can be solved by introducing a third element between powers and mutual manifestations.

3.1 The simultaneity in the stimulus-response model

One seemingly radical move made by Martin and others who hold similar positions on the dispositional account of causation is that they are not merely offering a theory in which causation is explicated in terms of the working of powers, but one that downplays the concepts of cause and effect. I said in the introduction that the basic idea of such accounts is "to replace cause and effect by . . . the notion of reciprocal disposition partners for mutual manifestation" (Armstrong, Martin, and Place 1996, 136). According to these dispositional theorists, we should no longer take causation as a relation between distinct events, the cause and effect, that form a sequence in temporal order, but as mutual manifestations of reciprocal disposition partners in which the cause is simultaneous with and metaphysically inseparable from the effect.

As is shown in the last chapter, the thought that drives the switch from the Humean account to the dispositional one is that the cause is simultaneous with the effect in a strong

sense. There are two senses of simultaneity in play here: a strong sense and a weak sense, both of which are referred to as "simultaneity" because of the ambiguity of the term in ordinary language. In the strong sense of simultaneity, the effect temporally overlaps the cause in every instant when it occurs and vice versa. (That is to say, there is no temporal instant when the cause is occurring whereas the effect is not and vice versa.) In the weak sense of simultaneity, however, the effect only needs to partially overlap the cause on the time line. There can be moments or periods when the cause is occurring whereas the effect is not, and vice versa. Strictly speaking, for the effect to be simultaneous with the cause in the weak sense, it only needs to overlap the cause temporally for one instant.

It is already suggested in the last chapter that dispositional theorists of causation would not discuss the simultaneity in the weak sense, since that will face the difficulty of accounting for the start or end or persistence of the manifestation in question. Suppose the cause starts before the effect does, that is, the activation of the disposition in question is ahead of the beginning of the corresponding manifestation. In that case, the temporal gap between (the beginning of) the cause and (the beginning of) the effect would be inexplicable and the coming into being of the manifestation would become a mystery, so the cause is not even partially ahead of the effect. Suppose the effect ends before the cause does, that is, the continuous activation of the powers keeps going while for some reason the manifestation ends at one point. This is just another inexplicable situation, since a power has to manifest (and keep manifesting) when it is properly activated according to our assumption about dispositions in the first place. So the effect cannot end before the cause ends. Suppose the cause ends before the effect does, that is, the activation of the power stops but the manifestation is still happening. In that case, it is again inexplicable why the manifestation continues when the power is no longer being activated, so the cause cannot end before the effect ends.

Although the strong simultaneity of cause and effect is entirely consistent with the dispositional account, it does not necessarily lead us to the notion of mutual manifestation. According to the received characterization of dispositions, namely the stimulus-response model, manifestations are activated not by the coming together of reciprocal powers, but by powers being triggered by their stimuli. If the stimulus-response model is applied to the account of causation, we will need to assume that a manifestation is an effect of a disposition being activated by a stimulus. However, this does not necessarily lead to the consequence that the effect (manifestation) is not simultaneous with the cause (the activation of dispositions) in the strong sense. People tend to think that the stimulus-response model cannot accommodate the strong simultaneity because they believe that a disposition is stimulated at a moment whereas a manifestation is typically a process that takes time. For example, when gasoline's flammability is stimulated by a spark in an oxygen-rich environment, the combustion begins and will last for some time until one or more of the conditions for the combustion changes. But physics tells us that the actual trigger of the combustion is not the spark itself, but the energy or heat provided by the spark or any other triggers of the same kind. Energy or heat is also what keeps the process of combustion going. The burning of the gasoline produces energy or heat, which keeps igniting the rest of the gasoline that is not yet burning. This kind of interpretation can be given of many other examples, such as the breaking of glass and the dissolving of sugar. In the stimulus-response model, as long as the stimuli of powers are properly identified, I believe that the cause is also simultaneous (in the strong sense) with the effect.

Thus it seems that the model we use for understanding the manifestation of dispositions does not make a significant difference to the temporal relation between cause and effect. Some might argue that to replace the two-event model which regards a cause and its effect as (temporally) distinct events we do not have to adopt the model of mutual manifestation; the stimulus-response model can equally do the job. Indeed, in order to refrain from taking the

activation of powers and the corresponding manifestation as two temporally distinct event, one only need to identify the stimulus of a power as a continuous factor. The case of combustion as described above serves as a good example for this point. In that case, the disposition in question is the flammability of gasoline and the stimulus in question is the energy or heat. Suppose the cause is the flammability being stimulated by the energy and the effect is the corresponding manifestation, namely the combustion of the gasoline. Since the activation of flammability by certain amount of energy is continuous rather than momentary, the simultaneity of the cause and effect is right at hand.

3.2 The distinction between effects and manifestations

No matter which model is in use, it is common for some advocates of the dispositional theory of causation to equate effects in causation with manifestations of powers. From their point of view, there is no distinction between effects and manifestations in cases of causation. They do not talk about "effects" as a separate type of entities when the exercise of powers is in question. In the case of a sugar cube dissolving in water, the stimulus-response model tells us that the dissolving of the sugar cube is triggered its being enveloped by water, so the manifestation is an effect of a disposition being activated by a stimulus. Similarly, the mutual manifestation model tells that the dissolving of the sugar cube is a mutual manifestation of the reciprocal powers possessed by sugar and water, so the manifestation is an effect of the interaction between those powers.

However, others find it problematic to blur the line between manifestations and effects in a theory of causation, including some who also advocate the dispositional account. For example, Mumford claims that "powers manifest themselves in contributions to events, rather than straightforwardly in events themselves" (Mumford 2009, 104). That is to say, manifestations are powers' contributions to effects rather than effects themselves. Here I'd like

to introduce the proposal by Molnar, who thinks that "we must sharply distinguish between effects and manifestations" because effects are polygenic while manifestations are not (Molnar 2003, 195). As the claim suggests, his view is derived from a feature of causation—polygenicity. The term "polygeny" is borrowed from genetic biology and it basically refers to the phenomenon that the production of a biological trait is typically determined by more than one genus. Analogously, the polygeny in causation is that an effect is typically produced by the exercise of multiple powers. (You may already notice that the polygeny in causation is consistent with the notion of mutual manifestation, since mutual manifestations are produced by different powers acting reciprocally, but I'd like to postpone the discussion of mutual manifestations until I have dealt with the problem of the stimulus-response model.)

The polygeny in causation is intuitively universal as we can hardly think of any practical case in which the effect is not attributed to multiple powers. Consider the cases of mechanical stability in which some objects exert forces on each other while remain static as a whole. For instance, my sitting on the chair is caused, roughly speaking, by the gravitation of my body towards the earth together with the chair's resistance to the pressure I put on it. Both forces contribute to the static status I am in so we can say that the effect is polygenic. The case of mutually propping cards is another such example. When two playing cards are propped up against one another, they can stand upright on the table. Their remaining upright is a result of the two cards working together with the table, which obviously involves the exercise of multiple powers.

Not only do cases of stability involve the contributions of multiple powers, so do cases of motion. Molnar's favorite example is the case of two horses pulling the barge down the canal:

> Two draft horses are pulling a barge by ropes, one from one side of the canal, the other from the opposite side. The direction of the pull by each side is at an angle to the canal itself. The outcome is that the barge moves straight ahead, . . . although nothing pulls it along the straight line. This shows the difference between manifestation and effect neatly: the manifestation of each horse's power is a force along an angled direction, but no movement along this direction occurs, only the combined force of the two pulling sides is effective and it results in a straight-ahead movement. (Ibid., 195)

However, for these examples to make sense in the argument for the distinction between effects and manifestations, Molnar has to assume that powers manifest independently (rather than mutually) in each of those effects, otherwise the effect will just be a mutual manifestation of multiple powers. Thus, in addition to the polygenicity of effects, Molnar's view also indicates a one-to-one correspondence between powers and manifestations, which derives from a well-received view about the identity of powers. In the disposition literature, it is common to assume that powers are individuated by their manifestations—a power is distinct from other powers just because it has a unique manifestation. This means for each power there has to be a manifestation that is exclusively the manifestation of it. Because of the polygenicity of effects and one-to-one correspondence, Molnar claims that effects in typical cases of causation are combinations of multiple contributory manifestations rather than manifestations of single powers. In his picture, each power involved in a case of causation has its own manifestation that contributes to the effect.

Molnar's attempt to distinguish effects from manifestations has rejected the plausibility of equating effects with manifestations characterized in the stimulus-response model because the one-to-one correspondence between manifestations and powers is a feature of that model.

Recall the received interpretation of typical examples of manifestations: dissolving is the response that soluble things give to their contact with liquid; breaking is the response that fragile objects give to their being stuck; combustion is the response that flammable things give to their being ignited in an oxygen-rich environment. In each of these interpretations, the manifestation is always peculiar to a specific power, and all the other factors which also contributes to the manifestation are seen to be different from the power in their metaphysical natures. Those factors are either seen as the stimulus of the power or the circumstances in which the power can be stimulated. Since a manifestation in this sense belongs exclusively to a power and effects are typically produced by multiple powers, effects cannot be simply equated with manifestations of powers.

In spite of Molnar's claim that "we must sharply distinguish between effects and manifestations", we can still maintain a dispositional theory in which effects are equated with manifestations. Molnar's conclusion is untenable because he does not take into account the model of mutual manifestation. As I have mentioned above, this model depicts a manifestation as something arising from a partnership in which some powers acting reciprocally. In denying that manifestations are the responses powers give in reaction to certain stimuli, the theory of mutual manifestation advocates that the so-called "stimuli" or "circumstances" are also powers—powers that partner with the powers they "stimulate" or "activate", so manifestations are the joint and reciprocal work of power partners. The polygenicity of manifestations is thus a necessary consequence of the notion of mutual manifestation: the dissolving of the sugar cube is not just the exercise of solubility, but rather the interaction of sugar's solubility and water's solvency; the breaking of glass is not just the exercise of fragility, but rather the interaction of fragility and the power(s) of the breaker; the combustion of gasoline is not just the exercise of the single power, flammability, but rather the mutual manifestation of flammability, temperature, oxygen's power to help combustion, etc.

Now that the polygenicity of effects is entirely consistent with the notion of mutual manifestation, Molnar's distinction between effects and manifestations can be contested based upon this notion. When reciprocal powers jointly bring about an effect, each of the powers does not have its own manifestation that *contributes to* the production of the effect. Rather, they mutually manifest, and the mutual manifestation just *is* the effect. Thus, we do not have to think of the manifestation of each power as an intermediate step in the production of the effect. Mutual manifestations are polygenic, just as typical effects are.

3.3 The individuation of powers

Although the polygenicity of mutual manifestations enables us to retain the assumption that effects are manifestations of powers, it "then threatens our claim that the manifestation determines the identity of the power" (Anjum and Mumford 2017, 87). Actually, the individuation of powers is a problem for this model even before the distinction between effects and manifestations are considered. The common view on the individuation of powers is that a power gets its identity from its manifestation, and this is plausible because the thing to which a power directs it possessors, namely the manifestation, seems to be all its particularity can include. On this view, two powers are different just because they dispose their possessors to different types of behavior.

However, when the notion of mutual manifestation is on stage, powers cannot be individuated in the same way. Mutual manifestations arise from the interaction of power partners, so they are products of power partnerships instead of single powers. If we assume that the identity of a power is determined by a manifestation that is peculiar to it, then a power inside a mutual manifestation partnership (a group of powers that jointly produces a certain manifestation) cannot be distinguished from the others in the same partnership. Since most powers do not manifest by themselves according to this model, manifestations typically belong

to partnerships of powers rather than single powers, which means only certain groups of powers can be individuated based upon the mutual manifestations they produce. In the sugar cube case, the dissolving of the sugar cube in water is not a manifestation peculiar to the solubility of sugar but rather the common product of the solubility of sugar and the solvency of water, so the manifestation of dissolving only individuates the power partnership that consists in solubility and solvency. Since these two powers have the same manifestation in this case, they cannot be differentiated from each other by simple looking at their manifestation.

The mutual manifestation model also allows a power to partner with different groups of powers, which makes things even more complicated. Given that different mutual manifestation partnerships bring about different manifestations, a power can take part in the production of different manifestations. For example, an apple can fall to the ground both in the air and in vacuum. When the apple falls in the air, the movement is a manifestation produced by a power partnership with air resistance as a member; but when the apple falls in vacuum, the movement then is a manifestation without the participation of air resistance. The two movements are clearly different: in the air the acceleration of the apple will be affected by the air resistance, and if the initial position of the apple is high enough it will eventually reach the highest speed at which it can fall; whereas in vacuum the apple can keep accelerating until it hits the ground. If the gravitation of the apple when it falls in the air is the same power or disposition as the one when it falls in vacuum, as most people will believe, then the power or disposition can take part in different mutual manifestations without losing its identity. This means the identity of a power cannot be fixed by its manifestation. If we were to retain the assumption that a power gets its identity from its manifestation, we would have to admit that the gravitation of an apple varies in different kinds of movement it takes part in, which is simply counter-intuitive.

In summary, the mutual manifestation model causes two problems for the individuation of powers: (i) A manifestation does not belong exclusively to a single power but a group of powers, which makes it problematic to distinguish between powers inside a mutual manifestation partnership. (ii) A power does not always have the same (type of) manifestation; it can take part in different (types of) mutual manifestations without losing its own identity, which makes it impossible to fix the identity of a power by its manifestation.

3.4 The identity of powers in the mutual manifestation model

Nevertheless, there has to be something unique to each power which distinguishes itself from other powers it interacts with, otherwise it would make no sense to talk of them as different powers. Recall that Molnar and Mumford suggest a revisionism of the term "manifestation" when they try to save the assumption about power identity from the polygenicity of effects. They think that manifestations of powers are not effects themselves but contributions that powers make to their effects, so effects are combinations of contributory manifestations. Molnar admits that "an exercise of a power does not always have the same effect" (McKitrick 2010, 80), but he believes a power always makes the same contribution to those effects, no matter how different the effects are (Molnar 2003, 194). In saying that a manifestation is a power's contribution to its effects, Molnar and Mumford indicates that the power can still get its identity fixed from its manifestation, though the term "manifestation" is used in a different sense (see also Anjum and Mumford 2017, 87).

Although Molnar contends that "an effect is an occurrence that is the result of the interaction of several powers", he disagrees with the mutual manifestation model in that he thinks "a power always has the same manifestation" from which it gets its identity (McKitrick 2010, 80). The revision to the usage of "manifestation" (that manifestations are powers' contributions to effects) does suit the individuation of powers in his context, but it seems

problematic from other perspectives. The contribution that a power makes in the production of an effect is not observable in most cases, since typical effects do not consist only of a single manifestation.[7] But it seems contradictory to talk about a manifestation as something unobservable, since the term "manifestation" suggests something that is "manifest". Admittedly, philosophical terms do not have to adhere to the restrictions of meaning in ordinary language or colloquial usage, but Molnar and Mumford's view (i.e. the revisionism of the term) would still run the risk of identifying "manifestations" arbitrarily. Consider the contributory manifestations in the case of two horses pulling the barge. What can those manifestations in Molnar's sense be? In the quotation, on the one hand, he identifies the manifestation of each horse's power as the "force" (along the angled direction) each horse exerts on the barge. So the combination of the contributory manifestations is the combined force of the two forces and the straight-ahead movement results from the combined force. We could also, on the other hand, suppose that the manifestation of each horse's power is the resolved movement on the exact direction the horse pulls the barge, so the actual movement of the barge is the combined movement of the two resolved movements. This explanation seems even more tempting because when only one of the horses were pulling the barge, the movement would be exactly one of the two resolved movements. However, Molnar denies the view of the combination of motions, claiming that the resolved motions do not actually exist: "The trouble for the naïve realist's story is that if the forces are exercised simultaneously, then these separate motions do not actually take place. The only actual motion of the barge is [straight-ahead]." (Molnar 2003, 197) Here I take him as suggesting that when the power of each horse is exercised separately, the manifestation is the motion along the direction of the force; whereas when the powers are interacting with each other, the manifestation of each is just a force. Thus, the manifestation of

[7] Similarly, Mumford says that "[only] in the laboratory situation, we might then be able to produce an event that is produced by just one power manifesting itself". (Mumford 2009, 104).

a power can still vary according to the causation it takes part in, which makes it problematic again to get the identity of the power fixed by its manifestation.

Since Molnar and Mumford's view would have difficulty making itself consistent, I think we'd better consider the one-to-many correspondence between powers and manifestations as an alternative. As I have argued in the last section, the mutual manifestation model causes two problems for the individuation of powers: (i) a manifestation does not belong exclusively to a single power but a group of powers; (ii) a power can have many different (types of) manifestations. These two problems, in my opinion, can be solved by modifying Molnar and Mumford's view about the identity of powers. They are on the right track in terms of the claim that powers are individuated by their contributions, but they are mistaken in that they equate powers' contributions to effects with their manifestations. In the dispositional account based upon the mutual manifestation model, there is no intermediate manifestation between powers and their effects; effects are just mutual manifestations of reciprocal powers. Thus, to solve the problems of individuation, "contribution" should be introduced as a third element in the manifestation of powers: a contribution is not a manifestation, but one that relates a power to (probably many) mutual manifestations. The idea is that although powers mutually manifest, each of them have its unique contribution to the manifestations. The identity of a power can thus be fixed by its contribution to the mutual manifestations rather than the manifestations themselves.

By positing a third element between powers and their manifestations, I am making a revision to the way in which a power gets its identity. Except for the claim that manifestations are contributions to effects, I follow Molnar and Mumford in believing that the identity of a power is fixed by its unique contribution. As Molnar claims, a power makes exactly the same contribution to any effect of which it is a part of the cause, no matter how different those effects

are (Molnar 2003, 194). There is always something unique to each power which distinguishes itself from other powers it interacts with and a power is allowed to contribute to the production of many different effects while keeping its identity. However, the identity of a power is no longer tied up with a manifestation that is peculiar to it but with the "contribution" it makes to mutual manifestations. A power can take part in multiple, maybe myriad, types of mutual manifestations, while its contribution to each of them is always the same.

Conclusion

I have argued that manifestations of powers or dispositions would better be understood through the mutual manifestation model. On the ontology of powers, it gets along well with realism of dispositions and pan-dispositionalism, both of which I think are competitive or at least acceptable among the alternatives. Also, it seems to me that the patterns of the exercise of powers should be kept consistent with the ontological theories rather than the other way round, so it is important not to put the cart before the horse. The model of manifestations that we adopt just is a way to characterize the working of powers, and that should be no reason to confirm or disconfirm some ontological position in the first place. Thus, it is important not to misinterpret the conclusion that I reached in the first chapter. I speak for mutual manifestation because I don't see good reason against the realism and pan-dispositionalism within the range of ontology, not because it "confirms" the realism or pan-dispositionalism. Nor do I think that mutual manifestation is a better alternative than the received view in terms of other ontological theories. As I said in chapter one, I have no definitive answers to those ontological questions involved. If someone came up with a striking argument against the positions that mutual manifestation depends on, it would also prove my belief wrong.

In the dispositional theory of causation, the polygeny in causation is strong reason for believing in the notion of mutual manifestation. Manifestations characterized by the stimulus-response model belongs exclusively to the corresponding powers, which means they cannot be equated with effects due to the polygenicity. By contrast, mutual manifestations are perfectly consistent with the polygenicity of effects, since they are identical with the interactions of reciprocal powers according to the model. Mutual manifestations are polygenic, just as typical effects are. Admittedly, the stimulus-response model can be saved by taking effects as combinations of contributory manifestations and that even have an advantage in terms of the

individuation of powers, since the identity of a power can still be fixed by its manifestation. However, advocates of this view seem to have difficulty keeping their claims consistent. As I have shown in chapter three, if manifestations are taken as contributions to effects, the contributory manifestation of a power in a polygenic result could be different from the standalone manifestation of that power.

On the other hand, the price that we have to pay for adopting mutual manifestation is that a power can no longer get its identity from its unique manifestation. Mutual manifestations are not attributed to single powers and a power can take part in multiple mutual manifestations with different partners. However, as I have shown in chapter three, this problem can be solved by introducing "contribution" as a third element between powers and mutual manifestations and allow the identity of a power to be fixed by its unique contribution. The third element seems inevitable once the polygeny of manifestations are accepted, which, I admit, might be a disadvantage of the mutual manifestation model after all.

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