

THE MATERIAL MIND: REDUCTION AND EMERGENCE

Max Kistler

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Cognitive Abilities as Macroscopic Dispositional Properties

1. Introduction

A number of cognitive abilities are the subject of reductive explanations. However, the interpretation of the significance of these explanations remains controversial. In Chapter 1, I analyzed a case of reduction of an elementary psychological ability.

We have seen that neuroscience has discovered the neurophysiological basis of certain forms of simple learning, in particular sensitization and classical conditioning, during which an animal acquires the ability to react in an appropriate and differentiated way to external stimulation. It seems to be natural to consider the result of such learning as the acquisition of a disposition.

The dispositional conception is as appropriate for the mental states of naive or “folk” psychology as it is for the cognitive states postulated by scientific psychology. The meaning of the statement “Mary is intelligent” seems to be equivalent to a series of conditionals about the conditions under which her intelligence manifests itself: if Mary were given a complex mathematical problem, then she would solve it easily. If faced with a difficult choice, then she would act on the basis of a balanced appreciation of the advantages and disadvantages of the various alternatives open to her. Similarly, as we saw in the example of the classically conditioned state of *Aplysia*, the states postulated by cognitive psychology are often characterized dispositionally. For example, “the *Aplysia* has learned to react with CS to the perception of R” means that, “if the *Aplysia* were exposed to CS, then it would react with R.”

However, the reality of dispositional properties has been challenged. It is controversial whether vases have a real and causally efficacious property

that corresponds to their fragility. In the same way and for the same reasons, it is controversial whether Mary has real properties that correspond to her intelligence or her memories.

A vase falls from the top of the shelf onto the tiled floor. Unsurprisingly, it breaks. Is the fragility of the vase one of the properties that contributes causally to the fact that it breaks? If the answer is yes, then the fact that a mental property is dispositional no longer counts as a reason to deny that it has causal powers. What makes fragility a dispositional property? The concept of a dispositional property is that of a property characterized essentially by a subjunctive conditional or counterfactual.¹ An object is fragile to the extent that, under otherwise normal circumstances, it would break if it fell from some height onto a hard surface. It is not necessary for the event described by the antecedent of this conditional to ever occur: it is possible to have a dispositional property that does not manifest itself, and it is even possible to have one that *never* manifests itself. Dispositional properties are distinguished from categorical properties by the fact that the latter are not characterized with the help of subjunctive conditionals. The property of an object of being spherical is attributed according to a criterion that involves only the actual world: all of the points on the surface of the object are at the same distance from its centre.

Armstrong (1968, 88; 1997, 70–71) defended the idea that dispositional properties can be causally efficacious, in particular by bringing about their manifestation, in a situation in which they are put to the test. In the case of the vase, its falling is a situation in which its fragility is put to the test, or “tested,”² and its manifestation is the vase breaking. Prior, Pargetter, and Jackson (1982) sought to show, on the contrary, that dispositional properties (or dispositions³) are incapable in principle of causal efficacy. This can be ex-

1 The relevant concept is that of subjunctive conditional because it is not necessary for the antecedent to be false in the actual world, which, strictly speaking, characterizes counterfactuals (Mellor 1974). Nevertheless, I will follow the current usage in this debate and speak interchangeably of subjunctive conditionals and counterfactuals.

2 In an otherwise normal test situation (I will come back to this condition later), the disposition manifests itself. See Carnap (1936–37); Goodman (1983).

3 Many dispositional properties have *different* characteristic manifestations in *different* types of test situations. Mellor mentions mass as an example of such “*multi-track*” dispositional properties (2000, 760): in a situation in which its possessor is subjected to a force f , mass m gives it both the disposition to acquire an acceleration f/m and the disposition to exert the force mm'/r^2 on another mass m' situated at a distance r from it. Fragility is another dispositional property that gives

pressed by saying that they are *epiphenomenal*. However, this disagreement conceals a partial consensus on the interpretation of the nature of dispositions: the dispositions at issue in this debate are macroscopic and in principle reducible to a microscopic basis. The terms “macroscopic” and “microscopic” are used here in a broad sense: the properties of a whole are macroscopic in relation to the microscopic properties of its parts. In the controversy over the efficacy of dispositions, everyone agrees that the only causally efficacious properties are microscopic properties of the reduction base. Since it is generally presupposed that these properties themselves are not dispositional, the reduction base is also called the “categorical basis” of the disposition. The disagreement concerns only the question of whether a given macroscopic dispositional property inherits this efficacy because it is identical to its reduction base, which is Armstrong’s position,⁴ or whether it is epiphenomenal because

its possessor different dispositions: the disposition to break in a certain type of situation and the disposition to crack in another type of situation. Similarly, the high temperature of a flammable gas is a dispositional property that gives the gas not only the disposition to be at a certain pressure but also the disposition to explode. In the case of such properties, the distinction between *dispositional property*, or “power,” and *disposition* is important. I will come back to this distinction later in the chapter. Nevertheless, I will often refer to dispositional properties as “dispositions” in contexts in which this is not likely to introduce confusion between the dispositional property and the different dispositions to manifest itself that it gives its possessors.

4 In the general context of analyzing the logic of the reduction of one scientific theory to another, many authors follow Causey’s (1977) thesis that the reduced property and the reducing property are *identical*. In Locke’s writings, one can find both passages defending the doctrine of the *identity* of dispositions (or, in his terminology, “powers”) with their microscopic and categorical basis and passages expressing the idea that dispositions are only *dependent on* this basis, the thesis that I defend in this book. Locke seems to express the first doctrine when he says that “whiteness or redness are not in it [i.e., in porphyry] at any time, but such a texture, that hath the power to produce such a sensation in us” (1689, Book II, Chapter VIII, para. 19). Colours are identical to a texture, a categorical microscopic property of the basis of reduction; properties of the latter category can be causally efficacious when they produce in us the experiences by which colours manifest themselves when we look at coloured objects. But other passages seem to be compatible with the second doctrine: “Colours and Smells . . . and other the like *sensible Qualities* . . . are in truth nothing in the Objects themselves, but Powers to produce various sensations in us, and *depend on those primary Qualities*, viz. Bulk, Figure, Texture, and Motion of parts” (Locke 1689, Book II, Chapter VIII, para. 14); here Locke says that sensible qualities are *dependent on* texture and other “primary qualities”: that is, on categorical microscopic properties rather than identical with them. I express essentially the same idea by saying that microscopic properties *determine* macroscopic dispositional properties. To say, as Locke does, that secondary qualities are “powers to produce various sensations in us,” seems to be compatible with the thesis defended in this chapter, according to which macroscopic properties can be conceived as dispositions that can cause certain effects, such as sensations.

it is distinct from it, the so-called functionalist position defended by Prior, Pargetter, and Jackson (1982).

In this chapter, I will challenge this consensus on the monopoly of microproperties over causal efficacy by showing that macroscopic dispositional properties can be causally efficacious while being distinct from their reduction bases. The importance of this debate lies partly in the impact of its outcome on the conception of mental properties. If the conception of dispositional properties defended here is coherent, then it allows us to think that our desires, beliefs, and other psychological properties give us dispositions to think and act but nevertheless contribute causally to the actions through which these dispositions manifest themselves. I will begin by defending the thesis of the causal efficacy of dispositional properties against a number of very general arguments before turning to the more specific reasons why Armstrong and the functionalists deny that microreducible macroscopic dispositions have causal efficacy of their own.

2. General Arguments against the Efficacy of Dispositions

Of the reasons that have led many philosophers to deny the efficacy of dispositions in general, the most important are the following.

First, dispositional properties are not causally efficacious because they are not observable. I cannot enter here into the controversy over scientific realism: that is, the thesis that theoretical predicates used in science refer to real objects and properties, even when these objects and properties are not directly observable. However, to disarm this argument against the efficacy of dispositions, it is sufficient to note that the impossibility of observing them directly characterizes the dispositional properties of being magnetized, or hard or brittle, in the same way as theoretical properties such as the property of being an electron or that of having a spin of $\frac{1}{2}$. From a realist perspective, unobservable theoretical properties can be causally efficacious. Thus, the mere unobservability of dispositions does not provide any specific reason for denying their efficacy.

Second, another argument is that non-occurring properties cannot be efficacious and that a property cannot be both dispositional and occurring. However, the argument that dispositions are non-occurring is motivated by the following fallacy. Dispositional properties seem to be non-occurring (and

therefore incapable of causal efficacy) because they are characterized in a conditional or hypothetical way. The property (or disposition) possessed by any French citizen over the age of eighteen to be potentially, or conditionally, president of the republic is not sufficient to give her the powers of the president. Now all that can be inferred legitimately from this observation is that the disposition does not have the causal powers of its manifestations. This provides no reason to doubt the possibility that the disposition itself gives other powers to its possessors, for example (provided that other conditions are met) to run for president. It is the manifestations of the disposition and not the disposition itself that exist only conditionally or hypothetically. It is fallacious to conclude that a disposition does not occur from the fact that its manifestations do not occur. Therefore, there is no good reason to deny that dispositions are occurrent, even during periods when they do not manifest themselves.⁵

Third, dispositions are permanent states, or static properties, whereas only changes can be causes. There are two ways of interpreting the thesis that mental states do not belong to the logically appropriate category for being causes. According to the first, suggested by Ryle, their temporal permanence prevents them from being causes. I can pass you the salt at the dinner table out of politeness, but politeness is a character trait that characterizes me for a considerable period of time, far beyond the duration of the meal. So my politeness cannot provide a complete causal explanation of my passing you the salt at that moment. The causal explanation of an action — an essentially dated event that takes place at a specific moment in time — requires reference to a dated entity: the cause must be something located temporally and spatially close to the action in question; in short, it must be an event too.⁶ The nature of events is controversial, but all conceptions acknowledge that events are located in time. According to Ryle, to find the cause of my act of passing you the salt, we must therefore ask the question “what made him pass the salt at that moment to that neighbour?” (1949, 98). This question cannot be

5 This point was clarified by Martin, who points out that a disposition is “something that is fully real and actual (unlike some of the manifestations). . . . Dispositions are actual continuants that predate, outlast and may exist entirely without the existence of their manifestations” (1996, 166). See also Mumford (1998, 74).

6 The principle of sufficient reason requires that there be a specific factor at the moment in time when the effect occurs to explain causally why the effect occurred at that moment rather than before or after it. The principle of sufficient reason is valid only in a deterministic framework.

answered by mentioning a mental disposition but only by identifying an event that took place just before the action: “He heard his neighbour ask for it,” or “he noticed his neighbour’s eye wandering over the table” (98). Dispositions cannot be causes because they lack temporal specificity: causes precede their effects, being contiguous to them in time, whereas a disposition typically exists long before the event that it causes as well as after it.⁷

It might be objected that this argument gives too much importance to the intuitions of common sense. We can accept Mill’s (1843) thesis that the distinction between causes that trigger an event and permanent conditions that are less salient but equally necessary for that event is irrelevant to the philosophical characterization of causes. It is undeniable that in most contexts in which we are interested in causes we are more inclined to consider changes rather than stable factors as causes.⁸ But from a scientific point of view — and therefore, following Mill, from a philosophical point of view — such stable factors can contribute to an effect just as much as changes. We are therefore justified in regarding them as causes “philosophically speaking” (Mill 1843, Book 3, Chapter 5, para. 3). If I apply electrical voltage to a copper wire, the change in voltage certainly causes a change in the electric current flowing through the wire. But a constant voltage also contributes, along with the resistance of the wire, to the causal determination of the current. Voltage and resistance are stable yet causally efficacious properties of the wire.⁹ The static or permanent nature of dispositions shows at most that an event that consists of a change cannot be caused by an event that has only static dispositional properties. But nothing prevents dispositional properties from being causally efficacious.

Two other arguments against the causal efficacy of dispositions have an affinity with the argument that stable states cannot be causes. First, dispositions

7 For the same reason, objects that persist in time cannot be causes: an entity that exists before and/or after the moment that precedes a certain effect cannot be the cause of that effect, although of course it can be a constituent element of a cause appropriately situated in time. See Fales (1990, 54); Steward (1997, 137, 142); Kistler (1999b, 2006a).

8 The pragmatic factors in the context of the explanation and the interests at stake form the basis for the distinction, among the factors that contribute objectively to causing an event, between “the cause” and background factors. See Mackie (1965).

9 “But though we may think proper to give the name of cause to that one condition, the fulfillment of which completes the tale, and brings about the effect without further delay; this condition has really no closer relation to the effect than any of the other conditions has” (Mill 1843, Book 3, Chapter 5, para. 3).

are *facts*, whereas only *events* can be causes. Ryle uses this argument to justify his thesis that the explanation of an action on the basis of mental dispositions, in particular motivations, is never causal. As he puts it, “motives are not happenings and are not therefore of the right type to be causes” (1949, 97). Helen Steward (1997) takes up this argument by pointing out that, when we attribute a disposition to an object, we are referring to a fact, not an event. According to Steward, facts are entities determined by language; for this reason, they lack causal efficacy, although it might be relevant to mention them as part of an *explanation*. This argument has the same source as the previous one, for it is difficult to form event expressions (i.e., expressions referring to events) from dispositional predicates because dispositions are permanent, and it is more natural to conceive of changes than permanent states as events. However, this argument presupposes the Davidsonian conception of the distinction between facts and events, according to which events are particular entities, whereas facts are linguistic entities whose identities are determined by the meanings of the words that designate them (see Davidson 1980). This is not the place to delve into the complex debate on the nature of events and facts (see Kistler 1999a, 1999b, 2006d). I would simply like to point out that the Davidsonian conception has the hardly acceptable consequence of denying the existence of differences, among the properties of a given event, with regard to their contribution to the production of a certain effect event, beyond the pragmatic differences between good and bad explanations. Consider a red billiard ball *R* that hits a white ball *B* at rest with a central elastic shock, so as to set it in motion by transmitting its momentum *M*. Now compare two causal explanations of the fact that *B* has momentum *M* after the shock. The first says that it is the fact that *R* has *M* when it hits *B* with an elastic shock that is causally responsible. The second says that it is the fact that *R* is red when it hits *B* with an elastic shock that is causally responsible. Clearly, the first is not only a good or relevant explanation but also true, and the second is not only a bad explanation but also false. This difference in truth value has its objective basis in the causal relation itself. One way of conceiving of this basis is to say that what makes the former true (its “truth-maker”) is the fact that there is a relationship of causal responsibility between the fact that the red ball possesses *M* before the shock and the fact that the white ball possesses *M* after the shock. Conversely, the second (pseudo-)explanation has no truth-maker because there is no relationship of causal responsibility between the fact that the ball in motion is red before the impact and the fact that the white ball has

M after the impact.¹⁰ If this reasoning is correct, then it is legitimate to attribute a causal role to facts, namely that of being terms of the relation of causal responsibility. Thus, the fact that attributions of dispositions normally have a factual, not an eventual, format does not constitute a reason to doubt their capacity to be causally responsible for their manifestations.

Second, Squires (1968) tried to show that the hypothesis according to which dispositions are causes leads to an infinite regress. To explain why a disposition manifests itself on certain occasions but not always, he proposes that it is necessary to postulate the existence of a second disposition: the disposition of the first disposition to manifest itself. Now, of course, this second-order disposition too might or might not manifest itself. Therefore, we need to postulate a third-order disposition to manifest itself and so on. Armstrong (1973, 419) replies by comparing this regress to the infinite series of facts that accompanies any fact *p*: the fact that it is true that *p*, the fact that it is true that it is true that *p*, and so on. We can account for this by distinguishing a linguistic concept of fact, according to which there are indeed an infinite number of different facts, from a “Russellian” concept¹¹ of a single fact underlying all of these linguistic facts. Or we can, as Armstrong suggests, distinguish between the linguistic expression of a fact and what makes this expression true, its truth-maker. This makes it possible to say that the infinite series of facts accompanying *p* has only one truth-maker, namely *p*. According to the first analysis, there is only one real disposition that corresponds to a unique Russellian fact; according to the second analysis, the unique truth-maker of the infinite series of higher-order dispositions is the first-order disposition, just as *p* is the truth-maker of all of the higher-order facts in the series. Both analyses put us in a position to reject the infinite regress objection by arguing that the apparent infinite series of dispositions

10 I have developed this argument for the existence of facts, based on the truth-makers of causal explanations, in Kistler (2002b, 2014).

11 The terminology is due to Bennett (1988, 41). According to Bennett, the identity of a “Fregean” fact is determined by the meaning of the linguistic expression used to express it. The Fregean facts designated by two expressions are identical only if their linguistic expressions can be the subject of an a priori reciprocal derivation, based solely on their meaning (35–37). Conversely, “we sometimes use definite descriptions as though they were Russellian, regarding them merely as pointers to their referents” (39–40). In this sense, two statements can express a single “Russellian” fact even if their meanings are not equivalent (i.e., if the statements cannot be derived from each other a priori).

described by Squires is merely an artifact of language and has only a single fact as its truth-maker, containing a single disposition.

Let us now turn to the most important objection that Molière made famous when he ridiculed the supposed explanatory and causal power of the “dormitive virtue” of opium. Dispositions cannot be among the causes of their manifestations because dispositions are linked to their manifestations by an analytical and therefore necessary relation, whereas causality is a contingent relation. Given that opium has the dispositional property of making people sleep — it possesses dormitive virtue — it seems to be true for purely conceptual reasons that one falls asleep when one has taken opium. It seems that the possession of dormitive virtue cannot be the cause of the fact that the opium smoker falls asleep, because causal relations are always contingent, whereas the conceptual link between a disposition and its manifestation is necessary.¹²

It often happens, at least in my kitchen, that a fragile object breaks after falling on a hard surface. Now it is part of the *meaning* of the predicate *is fragile* that objects to which it applies break when they fall on a hard surface under ordinary conditions. Consequently, the argument continues, since this fragile object fell on a hard surface, the judgment that it broke after it fell is analytical. This implies that, in the sentence “the vase that fell on a hard surface broke because it is fragile,” the word *because* designates not a causal relation but a relation of analytical implication based on the meaning of the word *fragile*. So it seems that fragility cannot be one of the causes of the vase’s breaking.

The inference to the causal impotence of dispositional properties appears to be valid only if we neglect the fact that the conditionals analytically implied by attributions of dispositional properties are *counterfactual* conditionals and if we forget that the evaluation of these counterfactuals presupposes the determination of a *context*. The judgment “if this fragile vase fell on a hard surface, then it would break,” is true only in certain contexts. The *general*

12 Along these lines, Mackie states that “intrinsic powers or specifically dispositional properties in the rationalist sense would violate the principle that there can be no logical connections between distinct existences” (1977, 366), where by “rationalist” he means the doctrine according to which the disposition is not at the same time categorical but purely conditional in the sense that the presence of the disposition makes the manifestation “logically necessary.” Mackie then argues against this position on the ground that dispositions are causally efficacious.

conditional, which applies to any fragile object, must make explicit reference to the context in order to be true. “ x is fragile” implies analytically that, “if x falls, under *ordinary conditions*, then x will break.” Fragility does not manifest itself in all test situations. Even a fragile vase dropped on a hard surface does not necessarily break. We can imagine exceptional circumstances in which the hard surface is mounted on springs and absorbs the shock and others in which the vase and the surface contain powerful magnets that repel each other. These situations are certainly “far-fetched”; however, to show that there is no necessary link (because there is no analytical link) between a fragile object falling onto a hard surface and breaking, it is enough to show that *there are* situations, however unusual, in which the former is not followed by the latter. What follows analytically from the fact that the fragile vase falls on a hard surface is only that it breaks *if the circumstances are otherwise normal*. However, the fact that the fragile vase falls on a hard surface does not imply analytically that it breaks, *tout court*. The fact that it breaks, therefore, remains a contingent fact, and nothing prevents the fragility of the vase from being a factor that contributes causally to its breaking.

Cognitive predicates are dispositional insofar as their meaning can be characterized counterfactually (i.e., by subjunctive conditionals). However, it is not correct to analyze their meanings, following logical behaviourism, with counterfactual statements without a *ceteris paribus* clause. According to Hempel (2002, 17), the statement (*) “Paul has a toothache” has the same meaning as the statement (1) “Paul weeps and makes gestures of such and such kinds,” which describes observable behaviour, and with the statement (2) “At the question: ‘What is the matter?’, Paul utters the words ‘I have a toothache,’” which expresses a conditional. Let us admit that it is true that often, or typically, or in ideal or normal circumstances (I will come back to these distinctions later), for a subject x , if x feels pain (Fx), then x weeps (Wx). But feeling pain is neither necessary nor sufficient for weeping. The fact that Paul feels pain (Fp ; F for feeling pain and p for Paul) is not necessary for the fact that Paul weeps (Wp): Paul can make gestures “typical” of a toothache because his gums hurt and not his teeth, because he is an excellent actor,¹³ or because his motor cortex has been stimulated directly from outside in such a way as to trigger this behaviour, without it being caused by Fp . Nor is Fp

13 Or a Putnam-style “zombie.” See Rey (1997, 153).

sufficient for Wp : Paul might hold back and repress the visible signs of his suffering, or ignore the pain, which therefore is not manifest in his behaviour, because he is too busy with an activity occupying his attention.¹⁴ The presence of the dispositional property — and, in (2), of the triggering condition — is not in itself sufficient for its manifestation. For this reason, the link between the dispositional property and its manifestation is not necessary, and the conditional statement that expresses this link is not analytical. There is therefore nothing to prevent the possibility that the fact that Paul feels pain (Fp) is causally responsible for the fact that Paul weeps (Wp).

It is true that it is analytical to say that, *in general*, fragile things break when they fall or that they tend to break when they fall. This is a consequence of the fact that such subjunctive conditionals express the meanings of dispositional predicates. However, a conditional of this kind is analytical only when it contains the clause “in general.” Yet the judgment that a particular glass broke because of its fragility is neither trivial nor analytically implied by the attribution of fragility to the glass. In particular circumstances, a glass might not break when it falls, and it might break for some other reason. The doctrine of the triviality of explanations that mention a dispositional cause rests on a confusion between generic statements such as “the fact that opium possesses a dormitive virtue is causally responsible in general for the fact that the smoker falls asleep” and the particular causal judgment “the fact that the opium that p smoked at t possesses dormitive virtue was causally responsible for the fact that p fell asleep at $t + \Delta t$.” The first statement is analytical because it expresses the meaning of the expression “dormitive virtue.” But the second statement nevertheless can express a causal relation, instead of being analytical, because dormitivity alone is not a sufficient condition for sleep.¹⁵ Even when it is truly causally efficacious, it produces the effect only in certain circumstances, such as those that prevail for p at t .

A particularly clear way of showing that the presence of the disposition is not, with the test situation, sufficient for the manifestation is to find possible situations in which the characteristic manifestation does not occur because

14 Putnam (1963) observes that this could be the case systematically; we would then be dealing with “super-spartans” whose conceivability shows that there is no analytical link between the presence of the mental state and the behavioural manifestation that we consider typical.

15 “The causal basis and the striking are not jointly a glass-complete cause of breaking, since the glass does not break” (Bird 1998, 228).

the circumstances contain a factor that acts against the tendency typically produced by the disposition. The absorption of opium by the human organism always produces a tendency to fall asleep, but this tendency does not always result in falling asleep: if *p* has taken the precaution of absorbing an antidote to opium, perhaps an exciting drug, then he might not fall asleep. Goodman gives the example of the attribution of the dispositional predicate “is inflammable” (1983, 39). From the fact that the particular piece of wood *w* is inflammable, one cannot infer the following counterfactual conditional about *w*: “If *w* had been heated enough, it would have burned” (39). This is because it is easy to find situations in which the attribution of the disposition is correct, whereas the conditional is false, for example when *w*’s environment does not contain (enough) oxygen. The presence of the disposition and the triggering factor characteristic of the disposition do not, therefore, comprise a strictly sufficient condition for the existence of the effect. In the case mentioned by Goodman, the effect does not occur in a situation in which a condition not explicitly mentioned, the presence of oxygen, is *lacking*. In other situations, it is the *presence* of an interfering factor that prevents the manifestation from occurring. These two types of situations show that the proposition that attributes a disposition to a particular object does not imply a strict counterfactual conditional about that particular object, linking the triggering to the manifestation.

A distinction must be made between situations in which an interfering factor prevents the manifestation of the disposition from occurring by depriving the object of the disposition and situations in which the disposition remains present (see Mumford 1996, 1998, 86; Bird 1998, 229–30). Examples of situations of the first type include the brittleness of a metal alloy object, which disappears when annealed, or the flammability of wood, which disappears when wet (see Mumford 1998, 86). This type of situation does not call into question the thesis of the implication of a counterfactual by an attribution of disposition to an object, because at the moment when the characteristic manifestation of the disposition does not occur, even though the test condition is present, the object no longer possesses the disposition. The “finkish” dispositions described by Martin (1994) fall into this category. In Martin’s thought experiment, a device that Martin calls an “electro-fink” is built in such a way that the disposition never manifests itself when it is triggered. A live electric wire has the disposition to give an electric shock to those who touch it (if their feet touch the ground and if they are not wearing

insulated shoes). However, the electro-fink ensures that the disposition disappears if and only if someone touches the wire. It never manifests itself in the characteristic test circumstances. With respect to the test-manifestation pair — <touch the electro-fink electric wire, receive an electric shock> — the circumstances are never “ordinary.” Contrary to appearances, Martin’s electro-fink is just an extreme case of a perfectly ordinary phenomenon. The electrical circuit in every modern home contains a mechanism whose operating principle is the same as Martin’s electro-fink: a differential circuit breaker.¹⁶ To take account of this type of situation, Lewis (1997) suggests requiring that the attribution of a disposition to an object is correct only if the object possesses the causal basis of the disposition for a certain period of time and at least until the moment of the expected manifestation: if x possesses the disposition D to respond with manifestation M to stimulus S , and if Δt is the period of time that elapses between S and M , then, if x is subject at t to S and if x preserves D until $t + \Delta t$, x will manifest M at $t + \Delta t$.¹⁷

The counterexamples invented by Martin refute the thesis that an attribution of a disposition implies a counterfactual conditional $\langle D \ \& \ S, \ M \rangle$ (where D represents the disposition, S one of D ’s test conditions, and M the characteristic manifestation of $D \ \& \ S$), because in the situations in which a fink is present the disposition disappears in the test situation. But there are also situations in which the disposition remains present yet the characteristic manifestation is absent in a test situation.

There are situations in which a disposition is present in a situation that typically triggers the manifestation but the manifestation does not occur because it is prevented by the presence of an antidote (Bird 1998).¹⁸ An antidote

16 Lewis (1997) and Malzkorn (2000) have attempted to analyze the meanings of attributions of dispositions using counterfactual conditionals that do not use a *ceteris paribus* clause and avoid refutation by cases such as the one imagined by Martin.

17 This formulation differs in several respects from that of Lewis (1997, 157). Lewis assumes, in accordance with the functionalist doctrine, that there is a causal basis B different from the dispositional property D itself, which, together with S , causes the manifestation M . According to functionalism, D itself is causally inert. Lewis also holds that the counterfactual is both necessary and sufficient for the presence of the disposition. Lewis’s analysis shows that Mumford (1998, 85) is wrong to judge that the situation described by Martin refutes the thesis that an attribution of a disposition implies the truth of a counterfactual conditional.

18 Johnston (1992) and Molnar (1999, 2003) speak of “masks”: they hide the disposition by preventing it from manifesting itself. The existence of such interfering factors is well known, although its importance has been recognized above all in the debate on the existence of strict laws of

is a factor that prevents the characteristic manifestation of a disposition from occurring in a situation in which the triggering factor is present. Let us assume that caffeine is an antidote to opium (Campbell 1860) in the sense that the sleep-inducing effect of opium does not occur when the subject takes both opium and caffeine. Given the existence of caffeine, it is possible for a person to have the dispositional property because of the absorption of opium without it manifesting itself in sleep. This shows two things. First, it is not true to say “for any person x , if x takes opium, x falls asleep,” although it is true to say that “for any person x , if x takes opium in otherwise normal circumstances, x falls asleep.” Second, given that the implication between the attribution of the dispositional predicate and the manifestation is not analytical, nothing prevents the disposition from causing, in ordinary circumstances, its manifestation. This conclusion applies generally to all dispositions, insofar as there are antidotes for every disposition and every characteristic test situation: that is, situations in which the antidote prevents the manifestation even though the disposition is present. The spring installed under the hard surface, which absorbs the shock, is an antidote to the fragility of the vase.

Here are two other reasons why the link between a dispositional property and its manifestation is not trivial. First, if I explain the breaking of a glass by the fragility of the glass, then I am referring to a property that also has other characteristics apart from leading to breaking when falling. It allows us to characterize the *way in which* the glass breaks: it differs from the way in which the glass breaks if it has the property of explosiveness instead of fragility. Second, the dispositional property is an intrinsic property (Mumford 1998, 138–39). Therefore, attributing causal responsibility for a certain effect to a dispositional property contains the information that the causal responsibility does not belong to the circumstances: a mine placed on the ground would also have the consequence that, if the glass falls, then it breaks, even if the glass is not fragile. But in these circumstances, it would be wrong to attribute the property of being fragile to the glass. Accordingly, when we explain why the glass breaks after falling, saying that its fragility is causally

nature. See Carnap (1956); Stegmüller (1983); Cartwright (1989, 1999). A strict law has no exceptions. The laws of “special” sciences (i.e., sciences other than fundamental physics) are often considered to have exceptions and therefore to be non-strict. Such non-strict laws are said to apply only “other things being equal” or *ceteris paribus*. See Kistler (1999b and 2006d, Chapter 3, 2006b).

responsible informs us that, apart from the fall, the main efficacious property that causes the glass to break is a property of the glass itself.

To express the meaning of a dispositional statement correctly, a conditional statement must include a clause such as “generally” or “in ordinary circumstances.” However, it might seem that the presence of such a clause makes the statement tautological. The statement “if C , then, in ordinary circumstances, M ” (where C represents a test condition and M the corresponding manifestation of the disposition) seems to be equivalent to the tautological statement “if C , then M or not M .”¹⁹ There are several hypotheses concerning the “protective” clause that avoid the consequence that any statement containing such a clause is tautological. According to an important proposition (Mumford 1998, 87 ff.), the attribution of disposition D to x is equivalent to the conditional $\langle C, M \rangle$ relativized to *ideal conditions* I :

(*) If I , then (if Cx , then Mx),

where I represents the ideal conditions, and both conditionals contained in (*) have subjunctive force (Mumford 1998, 88).²⁰ The appeal to ideal conditions raises the problem that the context determines what counts as ideal. Take an object that is not fragile, for example a bouncing ball.²¹ What counts as ideal depends on the context. Therefore, according to (*), a ball is fragile if there are conditions (which count as ideal in certain situations) such that, if the ball is hit under such conditions, then it will break. Let us take the context of research into the loss of elasticity at extremely low temperatures. Given that the temperature of liquid nitrogen is a context that can be counted as ideal for research on the properties of materials at very low temperatures,

19 Several authors (Schiffer 1987; Keil 2000) have expressed doubts about the existence of the referent of such *ceteris paribus* generalizations. According to Martin (1994, 6), for example, the inclusion of a *ceteris paribus* factor in the conditional that serves as analysans makes the counterfactual analysis of the attribution of a disposition trivial. See Lipton (1999); Schrenk (2006). Kistler (2006b) analyzes the role of *ceteris paribus* clauses in taking account of the existence of exceptions to the laws of nature.

20 Bird (1998, 234) suggests analyzing the attribution of a disposition with a counterfactual conditional relativized to “normal conditions,” but by this he means what I call here “ideal conditions” (i.e., conditions that are ideal in *relation to a context* of attribution of the disposition).

21 Malzkorn (2000, 459) uses the example of a red rose. The example is not well chosen, because the presupposition that a rose is not a fragile object can be challenged. It is better to use an object that is clearly not fragile.

the ball is brittle according to criterion (*) (see Prior 1985, 5–10; Malzkorn 2000, 459). The problem is that brittleness is attributed to the ball as such, not to the ball in this specific situation. But, intuitively, the ball becomes brittle only under very specific conditions. The fact of mentioning ideal conditions, as in (*), turns out to have the effect of dissociating the disposition from its “normal” effect. (I will come back to the concept of normality in a moment.)

Moreover, if the conditional relativized to ideal conditions is intended to define the *meaning* of the dispositional predicate, then the predicate has as many meanings as there are ideal conditions appropriate to different contexts (see Malzkorn 2000, 459). Most objects would then be fragile in one sense and not fragile in another.

Another strategy is to include the reference to “normal conditions” in the stimulus-manifestation conditional (Spohn 1997; Malzkorn 2000, 457, 459), on the assumption that what counts as normal does not vary according to context in a given world: normal conditions are conditions that occur statistically most of the time.²² The problem posed by the reference to ideal conditions does not, therefore, arise for the reference to normal conditions: the temperature of liquid nitrogen is not a (statistically) normal condition in relation to the circumstances of the majority of fragility attributions. In this terminology, it is true *a priori* that, “if *x* is immersed in water and the conditions are normal, then *x* dissolves if and only if *x* is soluble in water,”²³ where “normal” has the statistical meaning of “usually, most of the time” (Spohn 1997, 336, 337).²⁴

Indeed, it seems to be plausible that we would judge that conditions are not normal when a water-soluble object does not dissolve in water.²⁵ However,

22 This distinguishes normal conditions from ideal conditions. We can conceive of the initial conditions as being determined by the context in which the disposition is attributed. It can be said (see Spohn 1997) that the concept of normality also has an indexical component, where the index is the whole world and not the particular situation of the utterance; there is only one normal situation in a given world for each stimulus-response relation characteristic of a disposition.

23 “Wenn *x* in Wasser gegeben wird und Normalbedingungen vorliegen, so löst sich *x* genau dann auf, wenn *x* wasserlöslich ist.”

24 “gewöhnlich, meistens.”

25 I propose to leave aside the following difficulty: what would we say about the conditions of application of the predicate “soluble in water” in a possible world (or an exotic region of the universe of the actual world) where almost all water is saturated with salt? Under normal circumstances in that world (or region), salt crystals do not dissolve when immersed in water. Nevertheless, we would judge that even in such situations salt remains soluble. This means that the reference

this is only plausible in the case of certain paradigmatic dispositions. Molnar (1999, 7) is right to deny that the attribution of a disposition analytically implies a statistical generalization according to which a disposition manifests itself more often than it is masked, on the ground that it “violates the ontological independence of dispositions with respect to their manifestations, by excluding as impossible dispositions that never manifest,” and wrongly places “*a priori* constraints on the ratio of responses to stimuli.” It can sometimes be justified to postulate a theoretical property rarely manifested. As I will explain in a moment, the analysis of dispositions in terms of normal conditions is still acceptable for common-sense dispositional predicates, but it is not generally acceptable for scientific predicates.

Various authors (Martin 1994, 5–6; Lewis 1997, 157–58; Molnar 1999, 7) have objected that the analysis of dispositional predicates in terms of manifestations produced under normal conditions is as trivial as a *ceteris paribus* law: having the disposition *D* is to do *M* in situations *S* *ceteris paribus*. In other words, an object has disposition *D* if and only if it does *M* when exposed to *S*, unless it does not. This objection is justified in the case of theoretical properties but not in the case of the semantic analysis of a common-sense predicate: in this case, the statement is not supposed to be nomological, and the reference to normal conditions is not equivalent to a *ceteris paribus* clause. “Normal conditions” are the most frequent conditions in the statistical sense.

3. Dispositional and Theoretical Properties

In order to explain the exceptional behaviour of an object that does not manifest one of its dispositions in a test situation, one can refer to other properties, which might belong to the object itself or to the circumstances. In the clause expressing the dependence of the characteristic manifestation on the test conditions, it is essential to mention the “ordinary circumstances” relevant

of the expression “normal conditions” is evaluated referentially and not attributively. According to the attributive mode of evaluation, salt is not soluble in the exotic world in question because solubility is attributed according to the conditions that are normal in the world (or context) where the proposition is evaluated. Conversely, the referential mode of evaluation makes it possible to interpret the meaning of the expression “normal conditions” as what is normal in the context of the utterance and, more specifically, in the immediate environment of the linguistic community. In this interpretation, salt is soluble even if, in the context of evaluation, it is statistically normal for salt not to dissolve in water, as long as it is statistically normal in the context of utterance (i.e., in the actual world, in our immediate environment) for salt to dissolve. See Spohn (1997).

to the case under consideration, insofar as each test situation has an indeterminate number of other properties that can interfere with the manifestation of the disposition.

The scientific conception of properties seeks to get rid of such *ceteris paribus* clauses. In particular, we might look for a scientific explanation of why a disposition *has not* manifested itself in a particular test situation, and in this case the scientific explanation itself must not contain a *ceteris paribus* clause. Let us take the example of a body falling close to the surface of the Earth. If I drop an object supported by nothing else, then it has the disposition to fall a distance of $s = gt^2/2$ in t seconds. However, because of the presence of “antidotes” such as air friction, the disposition will not manifest itself in this way. The discovery of the various antidotes present in a concrete situation explains behaviour that deviates from the direct manifestation of the disposition. This often requires scientific knowledge of properties not directly observable. Ideally, when all of the factors determining the process have been identified, it is possible to explain the behaviour manifested without the need for a *ceteris paribus* clause. This clause expresses our partial ignorance of the circumstances.

Once the scientific description of the situation has been completed, it becomes possible to conceive of dispositional properties as *powers* that necessarily determine their effects.²⁶ But these effects are not necessarily manifested because they themselves might be powers. For a massive object falling near the surface of the Earth, the scientific conception of the situation makes it possible to substitute for the disposition of the body of mass m to fall $gt^2/2$ metres in t seconds, the force mg that produces a tendency to accelerate with g . Let us call force and acceleration *constraints* or *powers* related according to laws of nature. The force mg determines a power of accelerating with g by virtue of Newton’s law, better known by the equation $F = ma$. This tendency to accelerate, although a necessary consequence of the force, does not necessarily manifest itself directly. What is manifested is the result of the superposition (or interaction) of all of the tendencies related to motion. Air friction is another power present in the situation, which imposes on the body another tendency to accelerate in the opposite direction to the first.

26 I will use the term “power” for properties identified by some science: in other words, for natural properties. A dispositional property can be a power in this sense or a property expressed by a predicate in ordinary language, such as “fragile.”

We must briefly consider an important objection to the thesis that theoretical properties are powers linked by laws to other properties that, also being powers, do not necessarily manifest themselves directly.²⁷ Let us say that the law of free fall, considered as a hypothesis, predicts that a body falls $gt^2/2$ metres in t seconds but that observation shows us that the distance of the fall is actually less. My thesis then seems to suggest that this is enough to justify the postulate of a power to fall $gt^2/2$ metres — a power that does not manifest itself directly — rather than taking the observation to refute the hypothetical law of free fall. However, if the disagreement between theoretical prediction and observation was sufficient in itself to justify the postulate of such a power, then it seems that we would justify a general strategy of immunization that would make it possible to justify even the phlogiston theory of combustion.²⁸ Since observation contradicts the prediction of the phlogiston theory that the residue of combustion has less mass than the body before combustion, my thesis seems to justify the postulate of a tendency, or power, of combustible bodies to become lighter during combustion, a power not directly manifested, however, by a measurable loss of weight. However, we are no longer open to this objection once we impose on the postulate of powers the conditions usually required for the postulates of theoretical entities: the postulate of a power that does not manifest itself directly is scientifically legitimate only insofar as it is possible to give — in each situation in which it does not manifest itself — an independent explanation of the fact that it does not manifest itself.²⁹ It is legitimate only if it is possible to explain the discrepancy between postulated power and manifestation by the interference of factors whose presence can be detected independently. This means that the Popperian criteria that a hypothesis must satisfy in order to have empirical content and not be ad hoc apply to the hypothesis that explains the discrepancy, as much as to any other scientific hypothesis. The hypothesis of the power of combustible bodies to lose mass during combustion is not legitimate because the only way to reconcile it with the observed fact that the mass of bodies *increases*

27 This objection is analyzed by Lipton (1999) and Schrenk (2006).

28 According to the alchemists, during combustion, combustible substances release a noble substance contained within them called “phlogiston.” Ash is the residue that remains once the phlogiston is gone.

29 Pietroski and Rey (1995) show that it is necessary and sufficient to impose such a requirement in order to save *ceteris paribus* laws (i.e., laws that do not apply in all circumstances) from vacuity.

during combustion is to make another postulate that cannot be justified independently: the ad hoc postulate that their mass increases because they give off a substance, phlogiston, whose mass has a negative value. Yet postulating that a body that falls near the surface of the Earth has the power to fall $gt^2/2$ metres in t seconds is legitimate insofar as, in each concrete situation that is the subject of empirical investigation and in which another distance is measured, it is possible to find independent reasons for postulating the existence of interfering factors (which are also powers) — such as air friction — whose superposition on the initial power explains the distance actually observed.

The main conclusion that I propose to draw from this analysis is that the fact of substituting for the disposition to fall $gt^2/2$ metres in t seconds, a force that in turn produces a tendency to accelerate, corresponds to a change of conception of the same property. The first conception of the property involves a dispositional predicate whose meaning is linked to the manifestation; this gives rise to the suspicion of analyticity. Conversely, the second conception of the same property using scientific predicates justifies the idea that it is a real and causally efficacious property. Lawful links between two properties are never known a priori; in other words, laws of nature are discovered a posteriori. Such links are therefore not analytical, which removes any suspicion that properties conceived in this way are “dormitive virtues.” Science makes it possible to substitute a categorical conception of a property for its dispositional conception.

The picture that emerges is as follows: the distinction between the dispositional conception of a property and its scientific conception can be based on the following criteria. When we attribute a disposition to an object, we attribute to it a property that exerts a constraint on the evolution of the object, which satisfies three conditions.

First, the dispositional predicate expresses only one of the properties of the object and the situation in which it is found. The attribution of a dispositional predicate is adequate insofar as we *ignore* at least some of the other properties. A fragile object has a property that imposes on it the constraint of breaking when it falls on a hard surface, but properties that we do not know about can impose other constraints on it that act against this first constraint, so as to prevent it from breaking after it falls. In contrast, insofar as the attribution of the property is part of a complete specification of the situation in scientific terms — implying that the outcome is perfectly determined — it is no longer an attribution of a disposition. In a situation in which we know

that its tendency to break is counterbalanced by an installation that absorbs the shock, we would not say that the same vase, in this situation, is fragile, insofar as we take account of the whole situation.³⁰ The hypothesis that some of the other properties of the situation must be unknown for it to be appropriate to attribute a dispositional predicate helps to explain why it is impossible to specify explicitly the “ordinary conditions” under which the disposition manifests itself in a test situation. No such restriction is imposed on a scientific conception of properties. The attribution of a property according to its scientific conception can occur in principle within the framework of a *complete* description of the situation.

Second, the attribution of a dispositional predicate implies the truth of a counterfactual conditional that necessarily contains a *ceteris paribus* clause, whereas the attribution of a scientifically conceived power implies a strict counterfactual conditional without a *ceteris paribus* clause.³¹

Third, we think of a property as dispositional insofar as we think of it as establishing the dependence (*ceteris paribus*) of a manifestation on a test situation, both of which are specified *by observable terms*. Falling and breaking are observable conditions, as are being dropped and falling *s* metres in *t*

30 It is true, however, that the vase itself, independently of the circumstances, remains fragile: it has the capacity to break in other circumstances. Are the sticks of uranium U-235 in a nuclear reactor capable of exploding? Under normal conditions, the boron rods inserted between the uranium rods moderate the chain reaction by absorbing neutrons. The explosion occurs only when the boron rods are removed. Independently of this difference, the uranium rods can be said to have the capacity to cause an explosion. In the presence of the boron rods, the dispositional property is not manifested by an explosion, but when these rods are removed it becomes efficacious and causes an explosion. The fact that its efficacy depends on the context does not show that it is not efficacious; it shows only that its presence is not a sufficient condition for the explosion. Bird explains that “the combination of a [uranium] pile and boron rods . . . does have a disposition to chain-react when the rods are outside the pile, but loses this disposition when they are in the pile. . . . The reactor as a whole . . . i.e., including the fail-safe mechanism, as long as the mechanism is effective[,] has no disposition to explode at all” (1998, 229–30). The apparent contradiction between this analysis and mine rests on a difference in the choice of object to which the disposition is attributed. The nuclear pile, excluding the boron rods, has the disposition to explode; however, the object composed of both the pile and the boron rods does not.

31 In quantum physics, there are fundamental probabilistic laws; however, these laws make possible predictions of probabilities that are *deterministic* in the sense that these predictions do not depend on partially unknown circumstances, as is the case with predictions based on *ceteris paribus* generalizations, in particular on attributions of dispositions.

seconds.³² Conversely, the identities of scientifically conceived properties is determined by laws that do not necessarily involve observable properties.³³

The position outlined here provides an important corrective to Quine's thesis that a disposition is "a partially discerned physical property that will be more fully identified, we hope, as science progresses" (1971, 13) as well as to Armstrong's view that "dispositions . . . are primitive *theoretical concepts*" (1973, 420). My analysis shows that the dispositional conception of a property can *coexist* with its scientific conception. Each obeys its own logic and serves its specific purposes. The distinction between the dispositional and the categorical is epistemic in nature and does not introduce a difference between efficacious and inefficacious properties. Insofar as it is possible to conceive of a property scientifically (i.e., on the basis of the laws of nature that apply to it), it is legitimate to consider it as efficacious, even if it can also be conceived in a dispositional way. The fact that a disposition does not always manifest itself in test situations is explained by the fact that it is not the only property of the situation. Moreover, the fact that such a property is not sufficient in itself to produce a certain effect is no reason to deny that it is causally efficacious. This is also true of clearly efficacious factors, such as the quantity of movement *M* of the billiard ball mentioned above, causally responsible for the fact that the struck ball has *M* after the impact, only because the impact is elastic. The uncertainty about the manifestation, expressed in the *ceteris paribus* clause of the conditional linking the test situation to the manifestation, has its origin in the partial ignorance of the circumstances; this is a necessary condition for the attribution of a disposition. Neither the fact that a property is not in

32 The manifestation of certain dispositions, which we might call "spontaneous," does not depend on any particular test situation. Radioactive substances have the disposition to disintegrate, even though no observable factor triggers the manifestation of this disposition. To have a belief is to have the disposition to act as if that belief were true. No external, observable factor is needed to trigger an action that manifests the belief: I can express it by saying a sentence without being prompted by any external stimulus.

33 Theoretical properties have second-order relational properties by virtue of the laws of which they are terms. If a copper cable has the conductivity σ , then this conductivity constrains other properties of the same object by virtue of the laws in which it appears: for example, it constrains the current density and the electric field to be in the ratio $J/E = \sigma$, by virtue of the law $J = \sigma E$. If object *o* has mass *m*, and there is another mass *m'* nearby, then the property of *o* having mass *m* places a constraint on *o*'s motion, imposing on it the force $F = Gmm'/r^2$, by virtue of the law of gravitation. The complete set of properties instantiated by the body determines, together with the properties of the environment with which it interacts, its evolution and its causal interactions. For a more elaborate defence of this thesis, see Kistler (2002a).

and of itself sufficient to produce an effect, nor the fact that we do not know whether this effect occurs in a situation that we know only in part, constitutes a reason to deny that it is causally efficacious.

According to the conception suggested here, a property that common sense attributes to objects as a dispositional property can then be scientifically construed as a *power*. The disposition of the opium smoker no longer to feel pain, even in the presence of normally painful stimuli, can be explained in scientific terms: this consists of providing a reductive explanation of analgesia, or insensitivity to pain, a macroscopic dispositional state of the organism, in terms of interactions between certain parts of the organism. In this explanation, the interaction between the morphine molecule and opioid receptors in the superficial part of the dorsal horn of the spinal cord plays a key role. In fact, this area of the body is a strategic zone in the neurological pain circuit, for this is “where the connection is established between the nociceptive fibres and the neurons that transmit the information to the brain” (Besson 1992, 92). The properties of morphine interact with the properties of the body, in this case the opioid receptors in the dorsal horn of the spinal cord, to produce a constraint exerted on the body and thus to produce analgesia. This interaction, and the consequent existence of the tendency to induce analgesia, obey a strict (albeit statistical) law according to which the levogyric enantiomer of morphine binds with a fixed probability to the different opioid receptors. Without exception, the presence of morphine in this area of the body *always* provokes a tendency to induce analgesia. The power of morphine to produce this tendency is always efficacious. However, the analgesic tendency of morphine, the result of an interaction between the properties of morphine and the properties of the body, can be thwarted by another interaction, between morphine and an “antidote,” in medical terms, a morphine antagonist, for example naloxone. This molecule prevents the analgesic tendency from producing an observable effect, by binding to opioid receptors, thereby preventing morphine from attaching to them. In the presence of such an antagonist, the tendency of the body that has absorbed morphine not to feel pain any longer is not accomplished.

One attributes the dispositional property of being insensitive to pain to an opium smoker on the mere fact that she has taken opium (and on the fact that she has a human body) *but ignores all of the other properties that her body might possess*. This bracketing of the other properties of the individual to whom a given dispositional property is attributed is at the root of the fact that

the dispositional property manifests itself only under ordinary conditions. It explains the indispensability of reference to such normal conditions when making explicit the link between the possession of the dispositional property and its manifestation in test situations. The opium smoker has the disposition to fall asleep. This does not necessarily mean that she will fall asleep, because an antidote can counteract the disposition. But if she does fall asleep, what is the causally responsible property? It might be the dispositional property even if it could have been present without causing the manifestation (it is not sufficient for this manifestation). In other words, designating dormitive virtue as the causally efficacious property is a non-specific way of referring to the causally responsible property.

Something similar happens when we refer to the cause of some event *e* by saying “the cause of *e*.” Assuming for the moment that there is only one (complete) cause, the cause of *e* exists, and the expression “the cause of *e*” refers to it. The fact that it can be referred to in this non-specific way does not show that there is no cause of *e*. It exists, and in principle it is possible to identify it more explicitly. But this might require scientific knowledge. In the case of opium, we find that the causally efficacious properties in a case in which the ingestion of opium has caused a person to fall asleep are those chemical properties of morphine whose interaction with the organism produces the tendency to fall asleep. However, we must not confuse the thesis of the existence of causally efficacious properties with the functionalist thesis that “it is the causal basis which is doing the work” (Bird 1998, 233). The disposition is not a property distinct from its causal basis (the former being causally inert, whereas the latter is efficacious). To attribute a disposition to a complex object is to attribute to it (or to its parts) efficacious properties, without being able to identify them precisely. There is only one efficacious property, but there are two ways of attributing it.

The generic statement about what usually happens to opium smokers (and fragile glasses that fall) expresses an analytical link between the possession of the disposition and falling asleep under normal circumstances. Yet the particular causal judgment that such and such a smoker fell asleep because she took opium is not analytical because the link between the possession of the disposition and the manifestation in a test situation is not analytical. “Mrs. X smoked opium at *t*” does not allow us to deduce a priori that “Mrs. X falls asleep at $t + \Delta t$.” However, it might be true that “Mrs. X fell asleep at $t + \Delta t$ because she smoked opium at *t*,” where the “because” has a causal meaning,

in the sense that the judgment affirms not only the existence of a causal relationship between two events but also the responsibility of the fact of having smoked opium for the fact of falling asleep. Why is the generic statement analytical but not the particular judgment? This difference can be explained by the fact that the truth conditions of statements expressing causal responsibility involve properties conceived of in a scientific way. The property causally responsible for falling asleep is a property of the nervous system, which in turn is determined by the chemical properties of the opium absorbed by the body alongside those properties of the nervous system.³⁴ When we consider its efficacy, we conceive of this property as a power (i.e., as a scientific property) and no longer in a dispositional manner. Causal responsibility is based on the existence of a nomological link between the causally responsible property and falling asleep. The judgment of causal responsibility inherits its a posteriori character from the a posteriori nature of the nomological link. The air of triviality of the explanation of falling asleep following the absorption of opium — by its disposition to induce sleep — disappears as soon as we conceive of this explanation as the outline of a scientific explanation, supposed to indicate the causally responsible fact and the causally efficacious property.

One way of expressing the thesis that a given property can be conceived of both dispositionally and categorically is to say that the dispositional/categorical distinction applies to *predicates* designating properties, or to concepts, but not to the *properties* themselves.³⁵ The opposite hypothesis can be refuted

34 From a scientific point of view, it is possible to aim for the discovery of the “complete cause” in a given particular case (i.e., the conjunction of all of the properties that interact with the tendency to fall asleep). But even knowledge of the complete cause in a given case does not justify the assertion of strict regularity, because it is impossible to list explicitly all of the factors *absent* in that case that might have interfered. Joseph (1980) points out that the traditional *ceteris paribus* clause would be better called *ceteris absentibus*. Without mention of these absent factors, the presence of all of the factors of the complete cause in some situation does not guarantee that the same effect will occur.

35 Alston was one of the first to challenge “the assumption that the dispositional and ‘occurrent’ (‘episodic’) interpretations are incompatible” (1971, 359). The thesis that the dispositional/categorical distinction applies to predicates rather than properties has been defended by Shoemaker (1980), Mumford (1998), and Mellor (2000). “I think that the term ‘dispositional’ is best employed as a predicate of predicates, not of properties” (Shoemaker 1980, 211). “Dispositionality is a feature not of properties but of predicates, namely of those whose application conditions can be stated in reduction sentences. . . . Properties in our sense . . . need not in themselves be either dispositional or categorical; those that exist can just be” (Mellor 2000, 767–68). Lowe distinguishes between “‘occurrent’ predication” and “‘dispositional’ predication” (2001a, 11). However, his view is

in the following way. Suppose that the dispositional/categorical distinction applies to properties themselves, independently of the predicates that we use to refer to them. All natural properties are components of laws of nature. It is by virtue of such laws that the objects possessing natural properties also have other specific natural properties. This is also true of properties that we do not intuitively regard as dispositions, such as the property of a gas to have a certain temperature T or the property of a stone to have a certain mass. According to the ideal gas law, all (ideal) gases that have temperature T also have, in volume V , pressure $p = nRT/V$ (where R represents a constant factor and n indicates the quantity in moles of gas molecules contained in the sample). Now the existence of this law provides us with a way to conceive of properties as dispositional: it gives its possessor the disposition to have another property linked to it by the law. Temperature is a dispositional property insofar as it gives the gases that possess it the disposition to have pressure p when they occupy volume V . Similarly, the fact of having a certain mass gives a stone — thanks to the law of gravitational attraction — the disposition to move toward other massive bodies and, in particular, to fall when close to the Earth's surface. Therefore, the hypothesis that dispositionality is a property of properties, and not a property of predicates or of our concepts of properties, leads to the result that *all* natural properties — that is, all properties that appear in laws of nature — are dispositional. But this is clearly incompatible with our intuitive understanding of the concept of disposition according to which not all properties are dispositional.

The Popperian thesis that all properties are dispositional seems to oppose this intuition and thus to undermine my argument.³⁶ However, it can be interpreted in a way that is compatible with my thesis that the dispositional/

incompatible with mine: according to Lowe, dispositional predication ascribes a universal property to an object via a kind of object of which it is an instance, whereas occurrent predication ascribes an instance of a property to the object. This distinction cannot account for the difference between the dispositional and the scientific attribution of a property, insofar as it does not involve the semantic link between the disposition and its manifestation characteristic of dispositional predicates. Lowe conceives of the distinction in purely ontological terms; however, ontologically, the same property is involved in both kinds of attribution: the instance that is the object of an "occurrent predication" is an instance of the same universal property that is the object of a "dispositional predication."

36 See Popper (1957). This thesis has also been defended or at least suggested by Harré and Madden (1975), Thompson (1988), Cartwright (1989), Blackburn (1990), and Harré (1997). Goodman (1983) puts forward the more moderate thesis that there are many more dispositional predicates than appear at first sight.

categorical distinction concerns our *concepts* of properties rather than the properties themselves. We have just seen that there is a way of conceiving of any natural property dispositionally. If *P* is any natural property linked by a causal law to another property *R*, then knowledge of this law enables us to conceive of *P* as “the disposition to cause *R*.” In this interpretation, Popper’s thesis loses the counterintuitive character that we usually attribute to it when we interpret it to mean that all properties are dispositional and, consequently, that no properties are categorical.³⁷ As long as the distinction is conceived of as relating to concepts or predicates, there is nothing to prevent the same property from being conceived of alternatively as a dispositional property and a categorical property.³⁸

A promising way of conceiving the categorical/dispositional distinction at the level of predicates was suggested by Shoemaker (1980).³⁹ A predicate *D* is dispositional if and only if its attribution entails *analytically* — that is,

37 There is a formidable objection to this interpretation of the thesis, variants of which have been put forward by Holt (1976), Robinson (1982), Blackburn (1990), Armstrong (1999), and others. However, this objection that the thesis that all properties are dispositional makes us “lose the substance of the world” (Holt 1976, 23) does not apply to the interpretation suggested here.

38 Here are two other ways of reconciling the fact that most properties can be thought of dispositionally with the paradoxical appearance of the thesis that all properties are dispositional. First, according to Martin (1996) and Heil (2004), every property has a “dual nature”: that is, it “endows its possessor with both a particular disposition or ‘causal power’ and a particular quality” (Heil 2004, 197). However, rather than providing a solution, this is simply a way of posing the problem of understanding how these two apparently incompatible “aspects” can nevertheless coexist. Second, to avoid the conclusion that all properties are dispositional, while considering that the categorical/dispositional distinction applies to the properties themselves, Jackson introduces a distinction between properties bound *essentially* to a certain manifestation in certain circumstances and others thus bound only *contingently*. “What makes a property a disposition is that it itself is *essentially* linked to the production of certain results in certain circumstances” (Jackson 1998, 101). However, insofar as the link between a natural property and its manifestation in characteristic circumstances is based on a law, it is difficult to justify this distinction. It presupposes that there is, among the laws in which a property appears, a first set of laws essential to the property and a second set of laws that apply to it only contingently. The property could exist even if the laws in the second set did not exist, whereas it could not exist without the laws in the first set. The distinction between two sets of laws, in terms of the modal force with which they determine the identity of the property, would require an independent justification. In Kistler (2002a), I give arguments in favour of the opposite thesis, according to which all of the laws in which a property appears are essential to it.

39 Shoemaker illustrates his analysis with the example of the predicate “is made of copper,” which is “not dispositional in this sense. There are causal powers associated with being made of copper — for example, being an electrical conductor. But presumably this association is not incorporated into the meaning of the term ‘copper’” (1980, 210). The distinction that I offer here is not the same as Mumford’s (1998), insofar as I define it in terms of the a priori/a posteriori distinction, whereas

by virtue of the meaning of the predicate alone — a counterfactual linking a test situation to a characteristic manifestation. The statement “this vase is fragile” implies analytically that, if the vase were to fall under ordinary circumstances onto a hard surface, then it would break. Conversely, the statement “this vase is made of fine clay” implies the same counterfactual but not analytically. In this case, the implication is based not on the mere meaning of the predicate “to be made of fine clay” but on laws known only a posteriori. The laws in which a natural property participates guarantee the existence of such counterfactuals, but their knowledge is not always part of the meaning of the predicates with which we refer to these properties. This difference is the basis for the distinction between dispositional predicates and categorical predicates. The attribution of a dispositional predicate implies the counterfactual that links a test situation to a manifestation analytically and therefore a priori, whereas this implication is a posteriori in the case of categorical predicates.

4. The Epiphenomenal Trilemma of Macroscopic Dispositions

The reality of *macroscopic* dispositional properties is often questioned for reasons to do with their relationships with underlying microproperties. The concept of causal basis plays a key role in such arguments. All dispositions have manifestations. The causal basis of a disposition is what causes its manifestations. From this conception, it follows that all dispositions have causal bases since something must cause their manifestations. Insofar as they are efficacious, the constituent properties of such a basis are categorical properties. However, in the case of macroscopic dispositional properties, there are several ways of conceiving of the relationship between a disposition and its causal basis that could lead one to deny that the disposition has causal powers of its own.

First, according to the “functionalist” conception of dispositions (Prior, Pargetter, and Jackson 1982), a disposition is a second-order property. However, only first-order properties can be causally efficacious. There are two reasons for thinking that dispositions are not first-order properties: one

Mumford sometimes characterizes it by saying (like Jackson 1998) that categorical properties are *contingently* linked to their nomological consequences.

disposition can have several different bases, and a disposition has its base (or bases) only contingently (one disposition could have other bases than it actually has).

Second, according to an important concept of reduction (Causey 1977), the discovery of the reduction of a macroscopic property to microscopic properties is the discovery of an identity. Insofar as a dispositional property is identical to its categorical reduction basis, it has no proper causal efficacy beyond that of its basis (Armstrong 1973).

Third, the concept of functional reduction offered by Kim (1998) brings together elements of the first two conceptions. According to this third conception, to attribute a disposition to an object is to attribute a second-order *predicate* to it: the object has a property that plays the role of causing the manifestation (under ordinary circumstances) under test conditions. The predicate specifying the role is second order, insofar as the reference to a property that plays the role is equivalent to an existential quantification over first-order properties. Only the property that plays the role is causally efficacious; the disposition that corresponds to the role is not. However, according to Kim's conception, the property playing the role is necessarily microscopic, even when the disposition is attributed to a macroscopic object.

None of these conceptions accepts that macroscopic properties have their own causal efficacy. This constitutes a dilemma, more precisely a trilemma, insofar as there is apparently no other possibility and none of these possibilities seems to be compatible with the common-sense intuition that our cognitive properties are at the causal origins of our actions, without being identical to any microscopic property of our brain.⁴⁰ I call it the "epiphenomenalist" trilemma because all of the alternatives deny that macroscopic dispositional properties have their own causal powers. Insofar as they have identities of their own, they are epiphenomenal. The first horn of the trilemma consists of considering dispositions as inefficacious, and the second and third horns

40 The question of whether this intuition is correct is controversial of course. It is the subject of a now classic debate between Wittgenstein (1958), who contests the coherence of an entity (a "mental representation") whose content justifies an action and at the same time is causally responsible for that action, and Davidson (1963), who argues contrarily that it is necessary for our conception of ourselves as agents who exercise causal power over our own actions to suppose that our reasons for acting are simultaneously the causes of our actions. The intuition that I am talking about is compatible with Davidson's position but not with Wittgenstein's. See Kistler (2006c).

consider them to be efficacious only insofar as they are identical to their microscopic categorical bases.

However, the trilemma can be avoided by conceiving of macroscopic dispositions as efficacious properties not identical to their microscopic bases, if two premises are accepted:

- (1) the dispositional/categorical distinction applies to predicates, not to properties, and
- (2) the categorical basis is not necessarily the reduction basis.

Rejecting these two theses leads to the first horn represented by functionalism, and accepting (1) but not (2) leads to the last two horns of the epiphenomenalist trilemma, represented by Armstrong's and Kim's conceptions of dispositions.

Armstrong agrees with thesis (1) that dispositionality and categoricity are two ways that one may conceive of properties, in themselves neither dispositional nor categorical. However, he denies that there are macroscopic dispositional properties distinct from the microscopic properties to which they are eventually reducible. Armstrong takes the example of an occurrent fragile state of a piece of glass. This state can be causally efficacious when it contributes to making the glass break when it falls. When we do not know the causally efficacious properties that are intrinsic properties of the glass, we refer to them with a definite description, in terms of their typical effects. The predicate *is fragile* is defined by typical effects that occur in ordinary circumstances. However, we are dealing here with only two ways of referring to a single state, one direct (but inaccessible to us because of our ignorance of the intrinsic nature of the property), the other indirect and referring to its causes and effects. Two ways of referring to a state do not transform it into two states or two properties. This difference is the result of "a verbal distinction between the disposition and the state. (A verbal distinction that cuts no ontological ice.)" (Armstrong 1973, 419). According to Armstrong, disposition is a concept that corresponds to a certain functional way of referring to properties or states rather than to a particular kind of property or state. "Dispositions . . . are marked off from (many) other states by the way they are *identified*" (419).

So far, Armstrong's view is compatible with my thesis (1). The controversial step in his reasoning is the following. Armstrong considers that the only way to make sense of the idea that the same property can be conceived

of, either dispositionally or categorically, is to suppose that this property is actually (identical to) its microscopic basis of reduction, which he calls the “categorical basis.” However, Armstrong gives no justification for the implicit premise that only a microscopic property can be categorical and efficacious.⁴¹ As he puts it, “what then is the disposition, the brittleness? It is the ‘categorical base,’ the microstructure, but it is this property of the object picked out not *via* its intrinsic nature, but rather *via* its causal role in bringing about the manifestation” (1996, 39).⁴² In the case of brittleness, it is a property of the chemical bond between the molecules composing the glass. In the case of the disposition to transmit hereditary characteristics, it is the microscopic properties of DNA molecules.

A good model for the identity of brittleness with a certain microstructure of the brittle thing is the identity of genes with (sections of) DNA molecules. Genes are, by definition, those entities which play the primary causal role in the transmission and reproduction of hereditary characteristics. . . . In fact sections of DNA play that role. So genes are (identical with) sections of DNA. (Armstrong 1996, 39).⁴³

41 This premise is often accepted without argument. Mackie characterizes his own “realist view” of dispositions by saying that “there will always be an occurrent ground” and immediately moving on to assert that this occurrent ground is necessarily different from the dispositional property itself. “This ground will not in itself be specifically dispositional” (1977, 365), his example being the categorical microproperties underlying the macroscopic disposition of the solubility of sugar in water. “In crystalline sugar the feature causally relevant to its solubility in water will be something about the bonds between the molecules in the crystal structure” (365).

42 Armstrong starts from Quine’s thesis that, by the use of a dispositional predicate, “we can refer to a hypothetical state or mechanism that we do not yet understand” (Quine 1971, 10), a use that can be replaced by a direct way of referring to it as soon as science has discovered the intrinsic nature of this state. A disposition, according to Quine, is “a partially discerned physical property that will be more fully identified, we hope, as science progresses” (13). See Armstrong (1968, 86; 1997, 73).

43 See also Armstrong (1968, 90). He encounters a difficulty because, on the one hand, he maintains that the *truth-making* relation (between a proposition and a state of affairs) is necessary, so that, if having a certain molecular structure makes the attribution of the disposition of being fragile true, then it is necessary that all things that have this molecular structure be fragile. On the other hand, he holds that laws are contingent and that the relationship between having the molecular structure and breaking after falling depends on laws. Later Armstrong (1997) adopts a different position, according to which what makes the attribution of fragility true are both molecular structure and laws.

In the case of dispositional mental properties, the underlying properties are microscopic properties of the brain.⁴⁴ Armstrong offers no reason to think that the categorical basis of a disposition is necessarily microscopic. However, the debate in which he develops his theory suggests a hypothesis about the origin of this thesis. In the passage preceding the introduction of his thesis on dispositions, Armstrong criticizes Ryle (1949) and Price (1953) for two mistakes. The first is their rejection — via a priori reasoning — of the search for a microscopic basis that would allow the reduction of a given macroscopic dispositional property, in particular a mental property. The second is the verificationist mistake of refusing to accept the existence of theoretical properties whose identity conditions are independent of any particular verification procedure.

Armstrong's reasoning would be valid if these two mistakes were only one mistake. If that was the case, then it would be natural to think that a single manoeuvre is necessary and sufficient to avoid the mistake; however, the only way to avoid the two mistakes in one step is to postulate a theoretical property underlying the disposition that at the same time is the microscopic property that provides the basis for its reduction. The identification of the disposition with a microscopic theoretical property avoids the verificationist mistake since it is a theoretical property whose identity is independent of any particular verification procedure, and it avoids the mistake of a priori denying the possibility of a microreduction.

However, there is no reason to believe that Ryle and Price committed a single mistake. To avoid the mistake of verificationism, it is necessary and sufficient to postulate a categorically occurring theoretical property whose identity is not reduced to a pair <test condition, manifestation> but might contribute in different and complex ways to different causal processes. Now there is nothing to prevent the property thus postulated from being a *macroscopic* property belonging to the same object as the disposition: the person — and not some of her neurons or neuronal circuits — in the case of mental properties and the body — and not some section of its DNA molecules — in

44 Armstrong (1968, 76–77) develops the analogy between these two identifications with regard to their contingency. However, Armstrong (1997, 73) explains that this contingency arises only from the contingency of the laws of nature that cause DNA, by virtue of its properties, to play the role of genes and that cause the brain, by virtue of its properties, to play the roles that characterize mental states.

the case of the ability to transmit hereditary characteristics. Therefore, it is conceivable to remedy verificationism, without at the same time remedying the other mistake, which consists of rejecting the possibility of microreduction. This second mistake can be avoided by a second step independent of the first step. Microreduction of a macroproperty consists of the discovery of a nomological explanation of the existence of the macroproperty of an object, based on the microproperties of its parts and their interactions by virtue of laws. Molecular biology makes it possible to explain, on the basis of the microscopic components of the human body and their many complex interactions, how organisms can pass on some of their hereditary characteristics to their offspring. However, this reduction, assuming that it is complete, does not justify the identification of the dispositional property of having the capacity to transmit hereditary characteristics to any particular microscopic property. In particular, this capacity might not be identical with any microscopic property of (sections of) DNA molecules.⁴⁵

Once we have distinguished the two steps that separate the dispositional conception of a macroproperty from the discovery of the microscopic basis for its reduction, it becomes clear that the expressions “causal basis” and “categorical basis” are used in two fundamentally different senses: according to their first meaning, they designate the categorical property underlying a disposition causally responsible for its manifestations, a property that might well be macroscopic (i.e., it might belong to the same object as the disposition rather than to its parts). Their second meaning is strongly suggested by the term “base”: when a microreduction of the macroscopic property underlying the disposition has been discovered, what is commonly referred to as the “basis of reduction” is the set of microscopic properties of the parts of the object that determine the macroscopic property. Armstrong’s mistake is in

45 See Kitcher (1984); Rosenberg (1985); Morange (1998). Armstrong is well aware that identifying a gene with a segment of DNA is an oversimplification; however, he thinks that this does not threaten the coherence of his position: “The statement ‘The gene is the DNA molecule’ is not a very exact one from the biological point of view. But it will prove to be a useful example in the development of the argument, and it is accurate enough for our purposes here” (1968, 77). It seems to me, however, that what is at stake here is not a matter of neglecting some details: it is a fundamental mistake to take a microscopic property of a part of the organism as the causal basis of the organism’s disposition to transmit its hereditary traits. The causal basis of hereditary transmission consists of a complex mechanism of which DNA is only one part. The property of possessing this mechanism can be attributed only to the organism as a whole and not to one of its microscopic parts, be it DNA.

confusing these two meanings of “basis” (or “base”) and in admitting without justification that the categorical basis in the first sense of the term must necessarily be the basis in the second sense of microreduction base.

Here is a reason to think that there are at least some categorical bases that are not reduction bases. Let us suppose that the hierarchy of levels of composition of macroscopic objects is not infinite but contains a level of absolutely “atomic” objects and properties no longer microreducible because the objects belonging to this level have no parts. In this case, the chain of microreductions stops with the discovery of this fundamental level. A property *M* belonging to this absolutely fundamental level gives causal powers, at least indirectly, to its possessors; otherwise, there would be no reason to postulate its existence. The powers that *M* gives to its possessors have a categorical basis: the properties of the object causally responsible for the manifestations of those powers. Now, given that *M* has no reduction basis, this categorical basis can consist only of *M* itself or of other properties belonging to the level of *M*.

My thesis that dispositionally conceived properties can also be categorically conceived suggests a simple solution to the “problem of the missing reduction base” raised by Molnar (1999, 8). Molnar shows the implausibility of three attempted solutions to this problem, created by the difficulty to accept both of the following two theses. Every disposition has a categorical basis, in the sense of a microreduction basis, and there are fundamental particles that have absolutely no structure. The three rejected attempts to reconcile the two are the following. (1) The causal basis of particles without internal structure consists of global properties of the universe.⁴⁶ (2) It is speculated that an infinite hierarchy of levels of structure is hidden beneath the level that appears to us as absolutely fundamental. (3) The fundamental properties of absolutely simple particles are not dispositional. After rejecting these three propositions, Molnar concludes that, “when it comes to the fundamental micro-entities, no suitable properties exist that could serve as a causal base for their dispositions” (17). Similarly, Mumford concludes that, in the case of a fundamental property for which there is no microreduction, “we have . . . just the one mode of characterising it available to us, the dispositional” (1998, 169).

This conclusion is paradoxical insofar as it implies that the manifestations of the powers provided by fundamental properties have no cause. My

46 Harré (1986, 295) has proposed the idea of such an “ultra-grounding.”

distinction concerning the two meanings of the term “basis” offers a way of avoiding this: in the absence of a microreduction basis, the way to avoid this conclusion is to suppose that the dispositional property of a fundamental particle is itself the categorical basis causally responsible for its manifestations.⁴⁷

Let us see how my two theses (the dispositional/categorical distinction applies to predicates and not to properties, and the categorical basis is not necessarily the reduction basis) make it possible to avoid the conclusion of the so-called functionalist conception of dispositions according to which macroscopic dispositional properties are epiphenomenal (Prior, Pargetter, and Jackson 1982), where causal efficacy is reserved for microscopic bases.

According to Prior, Pargetter, and Jackson, if a dispositional property is designated by a second-order macroscopic predicate, then its categorical basis is a first-order microscopic property. Prior, Pargetter, and Jackson put forward two reasons to justify the “distinctness thesis” (1982, 253), according to which the causal basis is neither dispositional nor macroscopic. The first reason is that a disposition typically has several bases. This prevents, by virtue of the transitivity of identity, the identification of each of them with the dispositional property. The second reason is that, even in the case of dispositions that have only one causal basis, the disposition has its basis only contingently, whereas the identity of a dispositional property with its basis should be necessary, given that the corresponding predicates are rigid designators (Kripke 1972). However, the conjunction of the distinctness thesis and the thesis that the causal basis causes the manifestations of the dispositional property implies that the disposition itself is causally inert. If the basis causes the manifestations, along with the triggering situation, and if the disposition is distinct from the basis, then, if generalized overdetermination is excluded, the dispositional property itself is causally inert.⁴⁸

47 Hypothetical dispositions for which there is no microreduction are often called “ungrounded dispositions” (see Mumford 1998, 167; Molnar 1999). However, in the sense of “basis,” where this expression designates the property of the possessor of the disposition causally responsible for its manifestations, it is clear that every disposition necessarily has a basis. Therefore, to say that a disposition has no basis can only mean that it cannot be reduced and therefore has no *reduction basis*.

48 Systematic but accidental overdetermination is implausible. It is implausible that every effect has several complete causes that act in parallel but independently of each other. However, it is not implausible that there can be two sets of properties instantiated at the same place and time, both sufficient for the same effect, that *are not independent* insofar as one set of properties nomologically determines the other. See Chapter 5.

The functionalist view makes two mistakes.⁴⁹ It is correct that a predicate that defines a property dispositionally (or functionally) is a second-order predicate, insofar as it contains an existential quantification over the properties that play the role. It is also correct that, insofar as a property is causally efficacious, it can be conceived of with a first-order concept. Yet it is incorrect that the existence of two ways of conceiving of a property entails the existence of two properties and to infer from the fact that the efficacious property is expressed by a first-order predicate to the fact that the property is microscopic.

The distinction between the first and second orders that concerns predicates and concepts is independent of the distinction between the macroscopic and the microscopic, which concerns properties (see Kim 1997b, 1998). Given that functionalists neglect these two distinctions, they arrive at the following three mistaken conclusions: (1) the “causal basis” is necessarily microscopic, (2) dispositional properties — rather than the predicates that express them — are of second order, and (3) therefore they lack causal efficacy.⁵⁰

5. The Example of Colour Representation

The perception of colours by the human visual system can serve as an illustration of the argument developed above. In psychology and psychophysics, colour representations are conceived of as macroscopic dispositional properties of persons: they give them the disposition to make similarity and discriminability judgments.⁵¹ To explain these judgments, which are observable data, we can postulate the existence of a mental or cognitive space specific to colour representation. Such a postulate goes hand in hand with the construction of a theory that describes unobservable entities in such a way as to be able to explain a certain number of observable facts and empirical regularities. Shepard (1962) showed that similarity judgments⁵² contain sufficient constraints to de-

49 I found the same mistakes in the a priori reduction of Jackson and Chalmers (see Chapter 2). See Kistler (2004b, 2005d).

50 Armstrong avoids the mistake of inferring from a duality of conceptions to the existence of two properties, but he makes the functionalists' mistake of thinking that efficacious first-order properties are necessarily microscopic. See Block (1990); Armstrong (1996).

51 Two colours are discriminable if a normal subject can distinguish them systematically under ordinary conditions.

52 See Clark (1993). Shepard uses only the order of similarity between the pairs of stimuli presented to the subjects, as it appears in the subjective judgments of subjects, without using quantitative estimates made by the subjects of the apparent distances between the stimuli. In

termine,⁵³ for any domain of perceptual qualities, (1) the minimum number of dimensions that the cognitive space must have in order to represent the stimulus domain in question, and (2) the location, in the cognitive space, of each represented stimulus (i.e., the coordinates of the representations of the different stimuli in the cognitive space). The algorithm developed by Shepard enables him to construct “maps” of a number of cognitive spaces corresponding to different stimulus domains: the “structure of proximity” by which a subject represents, among other things, the different facial expressions of other members of his species (Shepard 1962), colours (Shepard 1962, 1965), the consonants of his mother tongue (Shepard 1974), musical intervals (Shepard 1974), and familiar animals (Shepard 1974).

In the case of colours, the first result obtained by the algorithm is that two is the minimum number of dimensions that the cognitive space containing the colour representations visible to the human visual system must have (leaving aside the dimension of luminosity). Any assumption of a simpler cognitive structure would be incompatible with the experimental data. It is impossible to account for judgments of similarity between (perceptions of) colours on the basis of a cognitive space of representation that has only one dimension: on the basis of judgments of similarity between red and yellow, yellow and green, green and blue, blue and violet, we could attempt to situate the representations of these colours within a single dimension in the order of the rainbow. However, this one-dimensional representation would not account for the perceptual similarity between red and violet. If the representation of colours were structured in one dimension in the order of the rainbow,

addition to direct judgments of similarity, Shepard uses data obtained by more indirect methods that make it possible to judge the proximity of stimulus representations in cognitive space. In particular, these methods use the frequency with which subjects confuse different stimuli, the delay required to discriminate between two stimuli, or (for small children and animals) the size of the orientation reflex when the first stimulus is replaced by the second.

53 Mathematically, Shepard’s algorithm uses two *a priori* constraints. First, it assumes that the function relating apparent similarity to proximity in the representation space is *monotonic*. The monotonicity of the function guarantees that, if colours *A* and *B* are judged to be more similar than colours *C* and *D*, then the distance, in cognitive space, between representations *R(A)* and *R(B)* is less than the distance between representations *R(C)* and *R(D)*, and conversely apparent similarity depends, in the same systematic way, on the distances between representations. In particular, the representations of the stimuli judged to be the most similar must be separated by the shortest distance. Second, cognitive space has the smallest dimension that allows us to construct a monotonic and unique function linking apparent similarities to distances between representations in cognitive space.

then red and violet would have to be the most dissimilar colours, whereas in reality they are more similar to each other than each is to green or yellow, for example. Shepard's second result is that there is a unique topological structure or "map" of represented colours related by a monotonic function to similarity judgments. In Figure 3.1, the representations of the different visible colours are located on a circle.

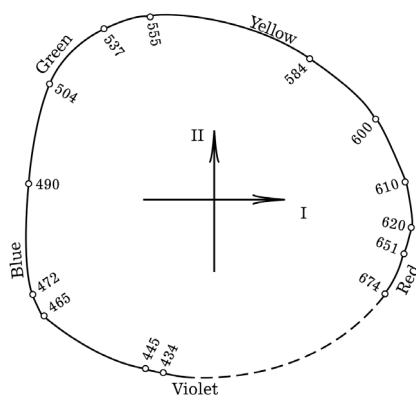


Figure 3.1 Representations of some colours in cognitive space. The wavelength of the colour stimuli is indicated in nm (nanometres). Adapted from Shepard (1962, 236).

Insofar as colour representations are conceived of as intermediaries between stimuli and similarity judgments, they are indeed dispositional properties. However, once we have freed ourselves from the verificationist prohibition that prevented Ryle from conceiving of representations as entities independent of any particular manifestation, we can consider colour representations as theoretical entities that make it possible to produce causal explanations of similarity judgments. As theoretical entities not directly observable but postulated in order to explain observable phenomena, they belong to the same category of entities as protons and neutrons, whose existence makes it possible to construct causal explanations of phenomena observed after the interactions of particles produced in a particle accelerator.

The hypothesis of the existence of colour representations and of the structuring of these representations in a cognitive space is independent of the discovery that these representations and this space can be *reduced* to neurophysiological entities. Similarly, the legitimacy of the postulate of the existence

of protons and neutrons is not conditioned by their possible microreduction, an issue independent of their existence. The neurophysiological reduction of colour representation is the subject of intense research, which suggests the existence of a complex mechanism involving several areas of the cortex, in particular area V1 of the visual cortex and the inferior temporal cortex (Conway et al. 2010). Such a reduction has already been achieved in the case of a number of other cognitive spaces, corresponding to the representation of certain perceptual domains in certain animals: the neural structure used by the barn owl (*Tyto alba*) to represent the location of a sound source has been identified in the upper layer of the optic roof of this animal's brain (see Gallistel 1990, 478 ff.); neuroscientists have also succeeded in discovering the neural structure located in the auditory cortex of the bat used to represent the position and speed of an object using echolocation (see Gallistel 1990, 492 ff.). In each case, the subjective sensation — which causes the action or judgment — results from the simultaneous activation of a large number of neurons located in the area corresponding to the cognitive map of the relevant perceptual domain. According to one hypothesis, the representation produces its effects through a mechanism equivalent to the vector calculation of the average activation, performed on all of the neurons in the relevant area (see Gallistel 1990, 489, 515; Churchland and Sejnowski 1992, 233–37).

The lesson that I propose to draw from this brief examination of some of the results of psychological and neurophysiological research on the representation of colours is that it is coherent to conceive of the categorical basis of the psychological property that produces the manifestations of the representation of colours as a theoretical macroscopic property. It belongs to the person rather than to its microscopic parts, such as its neurons. It is an independent issue whether a microscopic (i.e., neuronal) basis can be found that provides a reductive explanation of this macroscopic psychological property.

6. Dispositional Properties with Multiple Manifestations

An important reason for considering that there are powers (i.e., real properties that make dispositional statements true) is that a natural property generally makes true a whole set of attributions of dispositions.⁵⁴ This is often

54 The reasoning set out in this section is developed in Kistler (2012, 2020).

expressed by saying that many dispositional properties are “multi-track” (i.e., they can manifest themselves in several ways).⁵⁵

Let us take the example of an electric charge. The fact that an object x has the elementary electric charge q makes true the attribution of several dispositions to this object:

1. The disposition of x to undergo a force $\vec{F} = q\vec{E}$ if x is in the electric field $\vec{E}$.
2. X 's disposition to attract a second object carrying a charge q^* at distance r with a force of $F = k_e q q^* / r^2$ (Coulomb force), where k_e is a constant.
3. The disposition of x to undergo a force $\vec{F} = q\vec{v} \times \vec{B}$ (Lorentz force) if x moves with speed $\vec{v}$ in a magnetic field $\vec{B}$.
4. The disposition of x to carry a magnetic moment $\vec{\mu} = 1/2 q \vec{r} \times \vec{v}$ if x is rotating with speed $\vec{v}$ around a circle of radius $\vec{r}$.

These four dispositions are not identical: it is not the same thing for the object x to have the disposition to undergo a force $\vec{F} = q\vec{E}$ (manifestation M_1), if x is in an electric field $\vec{E}$ (test condition T_1), to have the disposition to exert the force $F = k_e q q^* / r^2$ (manifestation M_2) on a second object located at distance r and carrying an electric charge q^* of the opposite sign (test condition T_2), and to have the disposition to undergo the force $\vec{F} = q\vec{v} \times \vec{B}$ (manifestation M_3), if x moves with speed $\vec{v}$ in a magnetic field $\vec{B}$ (test condition T_3).

The fact that these dispositions are different might seem to be paradoxical, insofar as they are all dispositions of bearing the elementary electric charge, a single property. The paradox can be avoided by distinguishing these dispositions from the underlying natural property that I have called a “power.” The postulate of such an underlying natural property is a way of accounting for

55 Ryle envisages the possibility of dispositions that possess an infinite number of possible manifestations. “The higher-grade dispositions of people . . . are, in general, not single-track dispositions, but dispositions the exercises of which are indefinitely-heterogeneous” (1949, 32). See also Mellor (2000, 760).

the fact that the dispositions mentioned are indissociable: nothing has one of these dispositions, or part of them, without having them all.

What is the relationship between the property of being electrically charged and the various dispositions D_i that this property gives to a charged object? The property of being charged cannot be identical to all of these dispositions D_i , insofar as the D_i are not identical to each other. Nor can it be identical to one of them to the exclusion of the others, insofar as it is not more closely linked to one of the D_i than to the others.⁵⁶

The concepts of natural property and power are metaphysical, whereas the concept of disposition is semantic. The postulate of a natural property that is part of the truth-maker of disposition attributions makes it possible to explain in simple terms why the different dispositions of electric charge are indissociable: the natural property constitutes a common element of the truth-makers of attributions of these different dispositions.

As we have seen above, if an object x has a disposition D_i to manifest M_i , then x has a “causal basis” of D_i , which consists of the set B_i of all the intrinsic properties of x that contribute causally, together with the test condition S_i and background conditions, to bring about M_i . If an object has several dispositions, then each one, in general, has a different causal basis. However, when several dispositions are inseparable, in the sense that their attribution

56 Menzies (1988) offers another argument against identifying a dispositional macroproperty with the underlying microproperty. He uses an example borrowed from David Lewis, to try to show that the electrical conductivity and thermal conductivity of a metal are two dispositions based on the same set of microproperties, namely the properties of the metal’s “free” electrons (i.e., electrons not chemically bound to individual atoms). Given the transitivity of identity, these dispositions cannot be identical with their common reduction base without being identical to each other, which they are not. But, on closer inspection, the reduction bases of these two dispositions are not exactly the same. In the reduction model offered by Drude in 1900, the electrical conductivity σ and the thermal conductivity κ are determined by *different* properties of the free electrons: the electrical conductivity σ is determined by the microscopic properties n (the number of free electrons per cubic centimetre), e (the unit of electric charge), τ (the relaxation time or mean free time of the free electrons: i.e., the mean interval between two collisions), and m (the mass of an electron), according to the formula $\sigma = ne^2\tau/m$ (Ashcroft and Mermin 1976, 7), whereas the thermal conductivity κ is determined by n , τ , m , and T (temperature), according to the formula $\kappa = 3n\tau k_B^2 T/2m$ (Ashcroft and Mermin 1976, 23), where k_B represents the Boltzmann constant. Block is therefore right when he notes (in correspondence with Jackson) “that cases where different dispositions seem to have the same basis, and, more generally, cases where different functional roles appear to be occupied by the same state, turn out, on examination, to involve subtly different bases and states” (Jackson 1998, 92n103). However, this case is compatible with my thesis that different properties of the microscopic parts of the metal determine different macroproperties of the metal.

to a given object always has the same truth value, we can assume that these dispositions share a common causal basis.

In the example of the dispositions associated with an electric charge, the postulate of the property of being electrically charged makes it possible to dissolve the apparent paradox of “multi-track” dispositions. The fact of possessing this property, or this power, necessarily gives the object all of the dispositions associated with it. If there are single-track dispositions, then they are a special case. However, it is unlikely that such dispositions exist. The property that would contribute to the truth-maker of the attribution of a “single-track” disposition would be a natural property not linked by laws of nature to any other properties.

The postulate of the existence of a natural property that acts as a truth-maker for attributions of disposition is fallible and subject to evaluation according to the usual criteria for the evaluation of scientific theories. There are two reasons for postulating a theoretical property: the fact that this postulate constitutes the best unifying explanation of a set of phenomena and the fact that it is fruitful for suggesting new empirical hypotheses.

One of the reasons for postulating the existence of electric charge is that it is the best unifying explanation of the fact that the above-mentioned dispositions are inseparable. The fact that this property constitutes a common truth-maker for the attribution of all these dispositions explains why every object that has one of them also has all of the others.

It is important in this context to bear in mind the distinction between the causal basis and the reduction basis. My argument provides no reason to think that the causal basis of a disposition, defined in terms of test condition and macroscopic manifestation, is microscopic.

At first glance, it might seem that multiply manifested dispositions are a superficial phenomenon that should not play any role in metaphysics. According to Bird, “we do not need to posit fundamental multi-track dispositions” (2007, 24). The reason is that it is always possible to analyze such dispositions in terms of single-track dispositions. Bird presents two reasons in favour of this thesis. The first reason is that (T1) all multi-track dispositions (which he calls “impure”) are conjunctions of single-track dispositions (which he calls “pure”). According to (T1), it is equivalent to attribute to an object an impure disposition and to attribute to it a conjunction of pure dispositions. We have already developed a reason for contesting this equivalence: a theoretical power such as an electric charge is not equivalent to a conjunction

of dispositions to which the charge gives rise (see Carnap 1936–37, 444–45; Mumford 1998, 41).

First, powers such as electric charge provide unifying explanations of sets of dispositions. If the possession of some electric charge were equivalent to the conjunction of the dispositions to which it gives rise, then the fact that the dispositions in this set are inseparable would be a brute fact. The postulate of an underlying power makes it possible to offer a metaphysical explanation of that fact.

Second, the idea that a power is the truth-maker of an inseparable set of dispositions accounts for the possibility of scientific discoveries. It might happen that, once the power has been postulated, it is discovered that there is in fact a larger set of inseparable dispositions of which the previously known set constitutes a subset. Let us say that electric charge was associated at some point with the dispositions (1), (2), and (3) mentioned above, before it was discovered that the set of dispositions associated with charge contained a fourth element (4). This discovery shows that it would have been wrong to consider the property of being charged as equivalent to the conjunction of the first three dispositions. It is characteristic of natural properties that it is always possible to discover new dispositions to which their possession gives rise.

The second reason for which Bird contests the fundamental status of impure dispositions is that (T2) “all impure dispositions are non-fundamental” (2007, 22), which means for Bird that they are microreducible. According to his reasoning, dispositions with multiple manifestations are reducible in terms of microscopic properties that he assumes to be necessarily “pure.” In other words, they are single-track. However, as we have seen, (1) the existence of the causal basis of a disposition is independent of the issue of its microreducibility, and (2), even if a given causal basis is microreducible, there is no reason to suppose that the reduction basis is not itself a property that gives rise to many dispositions.

The reasons for postulating a natural property underlying a set of inseparable dispositions are stronger in the case of mental properties, insofar as dispositional properties such as speaking French or being shy give rise to a much larger variety of manifestations than electric charge.

My objection to Bird's thesis takes up a well-known argument against operationalism.⁵⁷ If, as is commonly the case with theoretical predicates in science, there are several operations that can serve as criteria for the application of the predicate, then one cannot identify the meaning of a theoretical predicate with an operation that determines its application conditions. It is generally acknowledged that the operationalist position is refuted by the fact that it leads to the incoherent result that the *different* operations used as criteria for the application of a theoretical concept are nevertheless, by virtue of the transitivity of their identities with the meaning of the predicate, *identical* to each other. Now the operations that serve as criteria for the application of theoretical predicates take the form of conditionals: for an object x that conducts heat and electricity, " x has a temperature of 20°C " can be justified not only by the dispositional conditional "If we put x in thermal contact with a mercury thermometer, then the thermometer will indicate 20°C ," but also by the conditional "if we measure the resistance of x , then we will find $R = A \cdot 20^{\circ}\text{C}$ " (where the proportionality factor A between resistance and temperature is assumed to be known). To avoid having absurdly to identify these different operations, we must consider that temperature is a property whose identity does not coincide with any of its application criteria. It is plausible that the list of criteria is open ended in general, so that the satisfaction of any one criterion is not by itself necessary or sufficient for the application of the concept. It is a good reason, but it is fallible; measurement operations can fail (or succeed for the wrong reasons). If the thermometer malfunctions, then the result of the measurement will not coincide with the real temperature, or it will coincide with it only by a fortunate coincidence.⁵⁸ Such concepts, while

57 See, for example, Hempel (1966). Armstrong calls Ryle's conception the "operationalist account of dispositions" (1968, 86).

58 It can also be argued (Carnap 1936–37; Stegmüller 1983, 162 ff.; Hempel 1965b) that reduction statements cannot be analytical because, when there are different reduction statements for the same disposition, their conjunction has synthetic consequences: what makes the compass needle turn also attracts iron filings. Since the reasons for being analytical are the same for all reduction statements, none is analytical. From this, we can draw the conclusion that dispositional predicates cannot be reduced analytically to observational predicates and that they designate irreducible theoretical properties. In a similar way, Mellor (1974, 175) replies to the objection of the apparent triviality of an explanation by a dispositional property that it would be valid only if that property (e.g., fragility) had as its only criterion of application the manifestation that it is supposed to explain. Dispositional properties are subject to the general criterion that is "to characterize as physically real only things that can be identified in ways other than, and independently of, the procedures

linked to conditional application criteria, cannot be equated to any one of these criteria or to their conjunction or disjunction.

Ryle is undoubtedly right to criticize “the addicts of the superstition that all true indicative sentences either describe existents or report occurrences” (1949, 108). However, we have found reasons to think that judgments that attribute a multi-track disposition can have the descriptive function that Ryle contests and that the dispositional properties thus attributed are occurrent properties. We have also seen that this puts us in a position to understand the complex and fallible link between these properties and the conditionals that serve as criteria for their attribution.

7. Conclusion

I have tried to show in this chapter that macroscopic properties such as my present intention to write the word *disposition* can be causally efficacious in bringing about their manifestations, although they can also be conceived of as dispositional properties. The defence of this thesis involves arguing in favour of the hypothesis that the categorical/dispositional distinction applies primarily to predicates and to the concepts expressed by those predicates and only indirectly to the properties designated by those predicates. If this is correct, then a dispositional predicate and a categorical predicate can designate the same property. We have seen that this conception allows us to refute a number of traditional objections against the efficacy of dispositional properties and that it allows us to escape what I have called “the epiphenomenal trilemma” with respect to macroscopic dispositional properties. According to some important and currently debated accounts, these properties are either epiphenomenal and therefore causally inert or efficacious only by being identical to microscopic properties that also constitute their reduction basis. I have shown that it is coherent and plausible to consider that a macroscopic dispositional property itself can be causally responsible for its manifestations and that the same property can be conceived of in principle in a categorical way. Whether such a property is reducible is a matter independent of the issue of its causal efficacy; however, the discovery of a reduction does not by itself

used to define those things” (Nagel 1961, 147). “If we take the, perhaps infinite, set of possible sorts of manifestation or expression of a belief that *p*, the only unifying factor we can discover in the set is that they might all spring from, be manifestations or expressions of, the one belief” (Armstrong 1973, 421).

warrant an identification of the reduced property with the reducing property. To acknowledge the causal efficacy of macroproperties does not lead to an unacceptable overdetermination of their effects. The microproperties in the reduction base cause those effects only indirectly by determining the macroscopic property. We can therefore accept the intuition that my act of writing the word *disposition* has been caused by my decision to do so. That decision is a macroscopic mental property not identical to any microscopic property of my brain.