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CHAPTER I

INTRODUCTION

Whether or not one subscribes to anti-Reductionism,[1] it must be admitted that special-science domains at least appear autonomous. Consider that a scientist might observe the neurological activity of a person pondering the previous evening's events. The neuroscientist sees a vast network of firing neurons and synapses, while the subject experiences mental images and a mild euphoria associated with an enjoyable dinner at a fine Italian restaurant. Yet, both the scientist and the subject observe properties related to the same object, *viz.,* the subject's brain. One set of properties has to do with cells and neurons; the other set has to do with emotions and memories. So, properties associated with a single object can indeed appear to exist in distinct domains.

In fact, the scientific enterprise itself is divided into specialties defined by domains' putative boundaries. Neurobiologists, for example, focus on how the brain operates, while psychologists concern themselves with the mental life, how one experiences these inner workings. Sociologists discover patterns of behavior across members of a group, and economists look for patterns of behavior across financial transactions; all the while, physicists study the universe's most fundamental objects and properties.

As Paul Oppenheim and Hilary Putnam have pointed out, however, special-science domains seem to stand in a hierarchy of dependency relations that extends from the macro-level to the micro-level (Oppenheim and Putnam 1958, 9-11). Again, neurobiology and psychology provide a pointed example. Consider that one can visualize the face of a best friend. Such recall is experienced at the macro-level; when visualizations are pulled from memory, the distinct neurons involved are not noticed. According to neurobiologists, however, firing neurons are crucial to recall. Sensory input moves from nerve endings to the brain, where that information is encoded, processed, and stored at the micro-level. This micro-level neurological encoding just is the physical basis of

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[1]'Reductionism' with a capital 'R' will be used to denote the broad project of reductionism as distinct from the varieties of reductionism I shall discuss below.

recollection. So, memory is apparently *experienced* at the macro-level but is the *result* of micro-level processes. Consider other examples: The domain of sociological inquiry seems dependent upon the domain of psychology, for the psychological properties of members within the observed group appear to determine observed sociological patterns; the properties of a chemical solution seem dependent upon the properties of the solution's constituent molecules; and so on. Domains therefore apparently link together in a chain of dependency relations that at bottom ends with physics.

Oppenheim and Putnam went further, however, arguing that most (if not all) special-science predicates denote kinds and properties that in fact fall within the physical domain but which are simply described in a different way (Oppenheim and Putnam 1958, 5). They believed that by following a certain set of interpretive steps, psychological theories, for example, could be expressed as biological theories; that is, psychology could be "reduced" to biology. The Reductionist/anti-Reductionist debate, which provides the context for this thesis, centers upon whether such a project can ever be successful.

In this chapter, I shall present both sides of the debate in rather broad strokes. In the first section, I present an important distinction within Reductionism that is often overlooked, *viz.,* the distinction between kinds and predicates of kinds. The second section opens with a discussion of the so-called multiple realization (MR) argument, which is taken by and large to have devastated reductionist hopes. To lay my cards on the table, I believe for reasons given in the next three chapters that the situation is not quite so dire. This chapter's final section will serve as an introduction to the remainder of the thesis.

Varieties of Reductionism

A logical positivist doctrine, Reductionism accorded with twentieth century phenomenalism, which claimed that the objects of science are nothing over and above their sense impressions; and sense impressions were characterized as observation statements (Carnap 1934; Neurath, 1959; Schlick 1959). Reductionism itself therefore began as a project to unify all of science under a set of statements reducible to the set of observation statements. With the fall of phenomenalism, however, a distinction was drawn between observable objects and their sense impressions, and so 'Reductionism' came to refer to the doctrine according to which all the theories of science can be unified under a single "lower-level" theory, *viz.,* physics (Fodor 1991, 429). Since the objects comprising scientific domains are now viewed as ontologically independent of sense impressions, theoretical statements are now thought to describe objects that occupy various domains. So, shifting from one reductive base (observation statements) to another (physics) introduced a new level of complexity.

Although the distinction between ontology and the language used to describe ontological objects is acknowledged, formal language issues continue to affect post-positivistic philosophy. Consider that if a true and exhaustive[2] theory about a scientific domain *B* can be reduced to a true *A*-domain theory, then *B*-domain objects must be ontologically identical to certain *A*-domain objects. Reducing the *B*-domain theory to the *A*-domain theory is said to have occurred, however, only when all the *B*-theoretic terms are interchangeable with *A*-theoretic terms and when all *B*-domain laws are proved derivable from *A*-domain laws. Part of the reductionist's task therefore focuses on issues surrounding *linguistic* units in order to show *ontological* identity.

Linguistic issues (or more precisely, conceptual issues represented linguistically) have blurred the distinction between two varieties of reductionism. Consider first the following predicates:

(1.1) *x* is a Peregrine falcon

(1.2) *x* is biologically fit

While (1.1) and (1.2) are both predicates, (1.1) is an example of a kind-predicate. Using (1.2) theoretically requires it to be predicated of a kind rather than a particular; so call (1.2), when used theoretically, a 'predicate-of-kinds'. While law-statements typically consist in logical operators, kind-predicates, and theoretical terms used to predicate properties of kinds, I use the term 'predicate-of-kinds' to include both theoretical law-

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[2]By 'true and exhaustive' I mean after any necessary corrections have been made to the upper-level theory so that all of the statements in the theory are true and the set of statements is maximal.

predicates and special-science predicates which might not appear in laws. So, while predicates-of-kinds are, aptly enough, predicated of kinds, kind-predicates are typically predicated of particulars: Mort is a Peregrine falcon, and Peregrine falcons, I am told, are at the top of their food chain.

To further distinguish the two predicate types, notice that everything falling within the extension of (1.1) might do so necessarily: if Mort is a Peregrine falcon, then presumably he could not have been otherwise. But surely it is not true that everything–whether a particular or a kind–falling within the extension of (1.2) does so necessarily. Not every particular Peregrine falcon is fit, even though the kind, Peregrine falcon, might be; and the kind, Peregrine falcon, is presumably not fit necessarily, for the environment might change. Therefore, although (1.1) and (1.2) both express biological predicates, the predicates they express are of two types. I shall refer to the collection of special-science kind-predicates and predicates-of-kinds as 'special predicates'.

The distinction between special predicate types leads to two forms of reductionism. For, reducing higher-level kind-predicates to lower-level kind-predicates is methodologically different from reducing higher-level predicates-of-kinds to lower-level predicates-of-kinds. On the one hand, kind-predicates, as stated above, are predicated of particulars. So, reducing all higher-level kind-predicates to the set of lower-level kind-predicates entails identity between each member within the extension of the higher-level kind-predicate and some member within the extension of the lower-level kind-predicate. Call reductionism that shows identity of objects across domains 'kind-reductionism'.

On the other hand, predicates-of-kinds denote putative properties, and therefore reduction of higher-level predicates-of-kinds to lower-level predicates-of-kinds entails showing that the higher-level properties are identical to certain lower-level properties. Unlike two objects, *a* and *b*, that can be shown to be identical although they fall within the extension of distinct kind-predicates, one cannot empirically show that two properties are identical. Rather, it must be demonstrated that the necessary and sufficient conditions for a higher-level property are identical to the necessary and sufficient conditions for a lower-level property. I shall call showing the identity of predicates-of-kinds across domains 'property-reductionism'.

A second way formal language aspects of scientific descriptions adversely affect Reductionism is, I submit, through the use of theoretical statements (universal statements including law-statements; theoretical statements that are non-lawful, I shall call 'mere-theoretical' statements). For, theoretical statements typically employ both kind-predicates and predicates-of-kinds. Take for example the following two statements, the first of which is a putative law-statement and the second of which is a mere-theoretical statement:

(1.3) For all *x*, if *x* is an emerald, then *x* is green.

(1.4) If *x* is a Peregrine Falcon, then *x* is biologically fit.[3]

The antecedents consist in kind-predicates, and the consequents consist in predicates-of-kinds. I believe that this conjoining of kind–predicates and predicates-of-kinds, which is crucial to the task of scientific description, further blurs the distinction between the two types of reductionism. Once these two types of reductionism are differentiated, it can be seen that each requires a different methodology.

Two methods of reduction have been put forward, one by Oppenheim and Putnam (Oppenheim and Putnam 1958, 3-36) and another by Ernest Nagel (Nagel 1961, 336-397). On the one hand, Oppenheim and Putnam include within their list of the necessary and sufficient conditions for reduction the notion of explanation. Nagel, on the other hand, includes, rather than an explanation requirement, showing that the law-statements of the higher-level science can be derived from the lower-level law-statements. Now, my concern throughout this thesis is not so much with the derivation of law-statements, but with the reduction of special predicates to lower-level predicates. Since there are two types of special predicates, I shall distinguish between two methods of reduction. What I shall call 'kind-reduction' is for reducing kind-predicates, and 'predicate-reduction' is for

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[3]Some have argued that statements such as (1.4) can be transformed into laws by binding the variables with a universal quantifier and adding to the consequent terms such as 'likely' and 'probably' (I take it Sober [1999] has something like this in mind). I am dubious of such a tactic, but I shall not take a formal stance here.

reducing predicates-of-kinds. Oppenheim and Putnam's method of reduction is similar to my kind-reduction; Nagel, going further, includes the reduction of theoretical predicates, which is similar to part of what is included in predicate-reduction. Neither go far enough, however, for, as I argue below, both kind-reductionism and a complete predicate-reductionism are necessary to the reductionist enterprise as a whole. I turn first to Oppenheim and Putnam's form of Reductionism.

Kind-Reductionism

According to Oppenheim and Putnam, in "Unity of Science as a Working Hypothesis," there are three necessary and sufficient conditions for reduction to take place (1958, 5):

(1.5) A theory T_2 is reduced to a theory T_1 iff:

(1.5a) The vocabulary of T_2 is not a subset of the vocabulary of T_1
(1.5b) All observations explained by T_2 are also explained by T_1
(1.5c) T_1 is at least as well systematized as T_2

So, suppose that two particular branches of science (hereafter, two "special sciences" [from Fodor (1991)]) *S* and *P* consist in sets of theories:

(1.6) $S = \{T_{s1}, T_{s2}, T_{s3}\}$

(1.7) $P = \{T_{p1}, T_{p2}, T_{p3}, T_{p4}, T_{p5}\}$

In order to reduce *S* to *P*, the conditions (1.5a), (1.5b), and (1.5c) must all be met, and each of T_{s1}, T_{s2}, and T_{s3} must be reduced to one of T_{p1}, T_{p2}, T_{p3}, T_{p4}, or T_{p5}.

Now, Oppenheim and Putnam present the object of the scientific enterprise as consisting in a hierarchy of domains (1958, 9):

6.........Social Groups
5.........(Multi-cellular) living things
4.........Cells
3.........Molecules
2.........Atoms
1.........Elementary particles

The reductionist hope was that each domain above the domain of elementary particles is reducible to the domain just below it. So, while the domain of living things might not be directly reducible to elementary particles, it is reducible to cells, which are then reducible to molecules, and so on down to elementary particles (Oppenheim and Putnam 1958, 7).

It should be noted that although Oppenheim and Putnam are interested in reducing one special science to another, their list of necessary and sufficient conditions for reduction to take place includes no mention of deriving higher-level law-statements from lower-level law-statements. Rather, their reductive methodology, called "micro-reduction," includes only reducing kinds (Oppenheim and Putnam 1958, 6). Again, since micro-reductionism focuses on kind-terms falling within distinct universes of discourse (Oppenheim and Putnam 1958, 6-8), micro-reductionism is similar in method (although different in theory[4]) to what I mean by 'kind-reductionism'. For each special science x, there is a universe of discourse U_x that is peculiar to it. Psychology talks of beliefs and desires; physics speaks of waves and particles. The "part-whole" relation between objects in, say, U_S and the objects in U_P allows U_S to be micro-reduced to U_P. Since a block of wood, for example, consists in nothing over and above the individual particles in which it consists, 'this square block of wood' can be micro-reduced to 'this stable aggregate of particles', or so the story goes.[5] Thus, exemplifying the first variety of reductionism, Oppenheim and Putnam attempted to reduce one special science to another by appealing to the part-whole relations between lower-level and higher-level kinds.

Predicate-Reductionism

In 1961, Earnest Nagel argued that if all of the following conditions are met:

(1.8) $V_S = \{v_S : v_S \text{ is a theoretical term in a theory } T_S\}$

(1.9) $V_P = \{v_P : v_P \text{ is a theoretical term in a theory } T_P\}$

(1.10) $V_S \neq V_P$

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[4]The theoretical difference has to do with the scope of the results. Oppenheim and Putnam claim that micro-reductionism is necessary and sufficient for Reductionism to occur (Oppenheim and Putnam 1958, 6); I take it that it is necessary but insufficient, as is discussed below.

[5]See footnote 7.

(1.11) Each v_S can be defined in terms of the members of V_P via bridge laws

(1.12) The laws in T_S can be derived from the laws of T_P

then the laws of T_S are reducible to the laws of T_P (Nagel 1961). Suppose, for example, that the following is a law of psychology: 'if *x* is in pain, then *x* will intend to recoil from the perceived pain source,' which can be expressed thus:

(1.13) $Px \Rightarrow Rx$

where '⇒' indicates a causal relation. Take first the psychological property of being in pain, which, for simplicity, I shall assume consists in C-fibers firing. According to Nagel, the predicate '*x* is in pain' (P*x*) is reducible to the neurological predicate '*x*'s C-fibers are firing' (C*x*). For, if pain is nothing more than C-fibers firing, then the following bridge law holds:

(1.14) $Px \leftrightarrow Cx$

Second, the predicate '*x* intends to recoil from the perceived pain source' (R*x*) is presumably identical to certain other neurological activity (N*x*). Thus, the following bridge law also holds:

(1.15) $Rx \leftrightarrow Nx$

Since each of the psychological predicates in (1.13) are reducible to neurological predicates, (1.13) itself is reducible to (1.16):

(1.16) $Cx \Rightarrow Nx$

So, to generalize, a special-science law,

(1.17) $Px \Rightarrow Qx$

is reducible to a lower-level law,

(1.18) $Ax \Rightarrow Bx$

by way of reducing each predicate in the special-science law to a predicate in a lower-level law. And such reduction can occur provided the following biconditionals hold:

(1.19) $Px \leftrightarrow Ax$

(1.20) $Qx \leftrightarrow Bx$

One theory, T_S, is putatively reducible to another, T_P, in virtue of *both* defining all of T_S's theoretical vocabulary in terms of T_P's theoretical vocabulary and deriving all of T_S's law-statements from T_P's law-statements (Nagel 1961).

So, on the one hand, Oppenheim and Putnam's micro-reductionism was an attempt to reduce special sciences to physics by means of reducing special kind-predicates to physical kind-predicates. On the other hand, Nagel's reductionist project included reducing special science terms to physical terms by means of bridge laws and then deriving higher-level laws from lower-level laws.

So, which type of reduction must be successful if the reductionist project is to succeed? I submit that both projects are necessary, but neither goes far enough. For, as mentioned above, some predicates are attributed to special kinds but do not show up in laws. I include these under the rubric of predicates-of-kinds. So, I shall argue, both kind-reductionism and predicate-reductionism must take place.

Now, perhaps *prima facie* predicates-of-kinds are simply members of sets that form the necessary and sufficient conditions for kind-predication. For example,

(1.21) *x* is an emerald iff (*x* is green & *x* a molecular structure *m* & ....)

In such cases, kind-predicates would simply be the names of clusters of predicates-of-kinds.[6] But mere-theoretical statements show that this is demonstrably false: being fit is a biological predicate that is neither necessary nor sufficient for being a Peregrine falcon, but is indeed predicable of the kind. Furthermore, a lower-level predicate-of-kinds can be (and often is) predicated of a special-science kind: falcons have mass and velocity. That there are predicates-of-kinds that are truly predicable of, but are neither necessary nor sufficient for, a kind-predicate is sufficient to show that kind-predicates and predicates-of-kinds are distinct. And non-reducible kind-predicates and non-reducible predicates-of-kinds are each alone sufficient to show distinctness of scientific domains. Therefore, both

[6]There are, I believe, cases in which kind-predicates are indeed simply the names of clusters that include predicates-of-kinds. In fact, non-causal statements such as (1.3) are both true and lawful in virtue of such a relation between a kind-predicate and a predicate-of-kinds. I shall have more to say about this issue in the third chapter.

kind-reductionism and predicate-reductionism must occur if Reductionism is to succeed. I shall address kind-reductionism and predicate-reductionism in the third chapter.

Since Oppenheim and Putnam and Nagel presented their respective methods of reduction, criticisms of each type have mounted rapidly. Moreover, these criticisms have had far reaching influence. I turn next to two critical positions.

Anti-reductionism

The central complaint against Reductionism stems from the putative failure of a one-to-one correspondence relation occurring between the kinds within upper-level sciences and the kinds found within lower-level sciences. This complaint has become known, for reasons soon to be apparent, as the multiple realization (MR) argument. First, the MR argument was originally put forward in 1967 by Putnam in order to argue against identifying mental states with physical states (Putnam 1967). In 1975, Putnam used the MR argument to attack the possibility of micro-reductionism (and thus if successful it would undermine kind-reductionism; 1975, 295-7). As described above, micro-reduction relies on the part-whole relation between a lower-level kind and the corresponding higher-level kind.

Putnam expresses his argument in terms of macro-level to micro-level reduction (Putnam 1975, 295-7).[7] Consider that a macro-level square peg is comprised of micro-level particles. Notice, however, that an infinite number of micro-level arrangements of particles can realize a macro-level square peg (Putnam 1958, 296). The failure of a one-to-one correspondence relation between the macro-level and micro-level kinds results, Putnam argues, in differing degrees of explanatory value with regard to why the square peg does not go in a round hole (1975, 296-7). Science is the in the business of explanation, and an essential aspect of scientific explanation is the positing of laws. It is a law of geometry that the area of a one-inch by one-inch square is larger than the area of a

[7]That Putnam puts his argument in terms of macro-level to micro-level reduction seems odd, for there can be both macro and micro levels within a single domain. But that the MR relation between macro and micro levels parallels the MR relation between higher and lower kinds allows Putnam's description to be instructive.

circle whose diameter is one inch. It is not a law that some arrangement *a* of micro-level particles keeps the aggregate from passing through a specified spatial area, for laws are supposed to be universal statements. Since the macro-level description of both the peg and the hole is an instantiation of a geometric law, but the micro-arrangement of particles seems non-lawful, the better explanation is at the macro-level, according Putnam.

Thus, since the macro-level properties that figure into scientific laws are multiply realizable by micro-level properties that do not figure into laws, macro-level to micro-level reduction cannot occur. For the same reason, micro-reduction (and thus kind-reduction) cannot occur: arrangements of elementary particles do not distinguish between macro-level kinds like tigers and falcons.

Second, Jerry Fodor (1974) has argued that since special-science properties are multiply realizable by lower-level properties, MR undermines the possibility of reducing via bridge laws upper-level laws to lower-level laws. Consider again the psychological predicate '*x* is in pain'. Presumably, Syd the octopus and Natasha the lifeguard can both experience pain, but Natasha is the only one with the firing C-fibers. So, pain must be realized in Syd in some way other than firing C-fibers. A biconditional connecting a higher-level predicate to a lower-level predicate therefore requires the latter to be expressed disjunctively:

(1.22) $\mathrm{P}x \leftrightarrow \mathrm{A}_1x \vee \mathrm{A}_2x \vee \mathrm{A}_3x \vee \ldots \vee \mathrm{A}_nx$

where '$\mathrm{P}x$' means *x* is in pain, 'A_1x' means *x*'s C-fibers are firing, 'A_2x' denotes some other pain realization occurring in *x*, and so on, and where *n* might go to infinity. Fodor then argues that the right side of the biconditional does not denote a genuine property, for genuine properties are neither disjunctive nor open-ended. So, while Oppenheim and Putnam and Nagel presented micro-reduction and bridge laws, respectively, as reductive means, Putnam and Fodor use the MR argument against micro-reduction and bridge laws, respectively, to show that Reductionism is a failed enterprise.

Argument Overview

Having introduced the notion of Reductionism and the MR argument, I shall spend the rest of this thesis arguing not that Reductionism is true (although I believe there are good reasons for accepting it), but that nonreducibility owes much to a misconception of kind-predicates and predicates-of-kinds. The structure of this thesis is as follows. In the next chapter, I discuss Jaegwon Kim's argument against the notion of special kinds and Ned Block's naturalistic response to Kim. Block's version of anti-Reductionism seems the most compelling, and so far, I have seen little response to it from the Reductionist side of the debate. The third chapter consists in a taxonomy of special predicates. I argue that kind-predicates and predicates-of-kinds consist in clusters of genuine and non-genuine, or mere-Cambridge, predicates. In the fourth chapter, I appeal to cognitive science in order to argue that special predicates reflect an advantageous way of comprehending the world. That is, the human brain is predisposed to categorize observations a certain way. Special predicates simply reflect this categorization, although this categorization is not actually *in the world* (except perhaps at the level of physics).[8] By successfully exposing special predicates for what they are, I will remove one more obstacle from the unification of science under the domain of physics. Before turning to Kim's and Block's respective arguments a few words about assumptions are in order.

Fulcrum of Disagreement

In *Law's Empire*, Ronald Dworkin points out that argumentation requires initial agreement (Dworkin 1986, 45-6). If, for example, two legal theorists cannot agree upon the proper usage of the term 'law', then an argument about what the law requires cannot begin. Worse, if each theorist assumes incorrectly that 'law' is being used in the same way by both, any putative agreement is meaningless. Ills incurred by failing to agree upon the meanings of important terms result from what Dworkin calls the 'semantic sting' (Dworkin 1986, 46). The "fulcrum of disagreement" (FD) is the set of claims upon which each interlocutor must agree before an argument can take place (Endicott 2001, 39).

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[8]See the Epilogue for a discussion of physical kinds.

FD$_1$: Physicalism

One element within the FD between Reductionists and anti-Reductionists is the doctrine of physicalism. There are, however, at least three ways 'physicalism' can be understood. First, 'physicalism' can denote a version of so-called scientism. According to scientism, scientists are the paragons of epistemic virtue, and thus those engaged epistemic pursuits should emulate scientists' behavior (or at least their behavior in the laboratory during working hours). Thus, in this scientistic sense, physicalism amounts to nothing more than emulating the activities in which present day physicists engage. In its second sense, 'physicalism' denotes the belief that, should physics ever be completed, it could in principle give an exhaustive explanation of the world. This claim is a primary point of contention between Reductionists, who find the doctrine compelling, and anti-Reductionists, who reject it (cf. Kim 1998, 8). Therefore, the doctrine of physicalism thus construed cannot be an element of the FD. Third, 'physicalism' can be used to refer to an ontological commitment, according to which there is nothing in the universe over and above physical substance. Upon the doctrine of physicalism in this third sense the majority of philosophers agree, and moreover it provides at least some of the fulcrum of disagreement in the Reductionist/anti-Reductionist debate. I assume that physicalism in this third sense is roughly correct.[9]

FD$_2$: Substance Monism

Now, identifying the FD will put the interlocutors in a better position to discover the precise point of disagreement. Take for example a rough and ready version of a Reductionist argument:

(FD$_1$) Physicalism is true

(1.23) Physicalism entails monism

(1.24) Monism entails Reductionism

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[9]'Roughly' indicates a rejection of existential claims about soul substance. By contrast, my assumptions do not extend to a rejection of certain theological claims, which in any case are beyond the scope of this thesis.

Therefore,

(1.25) Reductionism is true

In order for the anti-Reductionist to deny (1.25), she must argue against either (1.23) or (1.24); (FD_1) is not available to her.

Moreover, whichever premise is attacked will indicate which statements might be added to the FD, further focusing the argument. Most present day anti-Reductionists, for example, will complain that (1.23) is ambiguous. For, as stated above, while few deny that physicalism entails substance monism, many anti-Reductionists claim that physicalism is consistent with property dualism (Bickle 1998, 6-14). Although the latter claim is contentious, the former can be added to the FD:

(FD_2) Physicalism entails substance monism

and (1.23) and (1.24) in the Reductionist argument can be replaced with (1.26) and (1.27), respectively, yielding:

(FD_1) Physicalism is true

(1.26) Physicalism entails property monism

(1.27) Property monism entails reductionism

Therefore,

(1.25) Reductionism is true

In the next chapter, various nuances in the positions held within the Reductionist/anti-Reductionist debate will be further clarified. For now, it is sufficient to note that (1.26) is a main point of contention within the debate. For, Reductionists argue that property dualism entails a rejection of physicalism; anti-Reductionists, of course, deny this.

<u>FD_3: Causal Processes</u>

Throughout this thesis, and particularly in chapter three, causation plays an important role, although the particular theory of causation will bear little upon the discussion. A third element of the FD, however, is the claim that causation is essentially physical. Jaegwon Kim calls this the causal closure principle, which can be stated thus (Kim 1998, 40):

(FD_3) For any physical event *e*, *e*'s ancestral causal chain never crosses the boundary between the physical and the non-physical

Since the Conserved Quantities (CQ) theory of causation put forward by Phil Dowe is essentially physical, I shall assume for the purposes of the first four chapters that CQ causation is correct.[10] With these assumptions in hand and the FD partially defined, I turn now to Kim's response to anti-Reductionism and Block's response to Kim.

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[10]For a discussion of physical causation, see the Epilogue.

CHAPTER II

DISSOLUTION-MENT

In the last chapter, I differentiated between two varieties of reductionism, *viz.,* kind-reductionism and property-reductionism, and I argued that both are necessary to the success of Reductionism. Unfortunately, however, the distinction between these two types of reductionism has often been overlooked. One reason is that kinds and properties, when expressed as elements of a theory, are often denoted with predicates: kind-predicates denote kinds, and predicates-of-kinds generally denote theoretical properties. Now, in chapter four I will argue that these forms of linguistic representation reflect the particularly advantageous way human cognizers comprehend the world. In fact, the scientific enterprise itself, I believe, is a direct of extension of this manner of comprehension, and for this reason, science too has shown itself quite useful. Regardless, however, how humans typically understand the world and how the world actually is must be kept distinct if there is any hope of arriving at an accurate depiction of the world's ontology.

In the first chapter, I also introduced the debate between the anti-reductionists and the reductionists. The present chapter therefore describes the point at which my thesis enters the discussion. To give an overview, blurring between kind-reductionism and property-reductionism has occurred by both reductionists and anti-reductionists alike. In the first section of the present chapter, I describe how shifting to a functionalist account of the special sciences has blurred the line even more, and I mention implications for functionalism entailed by the argument in which this thesis consists. In the second section, I discuss what I call a 'trilemma' put forward by Jaegwon Kim against the anti-reductionist position (Kim 1992). Since Kim's argument focuses on the issue of multiple realization itself, it need not be construed as being specific to either kind-predicate or predicate-of-kinds issues.[11] Ned Block, in his "Anti-Reductionism Slaps Back" (1997),

[11]Therefore, the distinction between kind-reductionism and property-reductionism will not become particularly important until the end of this chapter.

responds to Kim's trilemma; the third section consists in an discussion of Block's response. Finally, in the last section of this chapter I briefly describe how the reductionist might respond to Block, and the remainder of this thesis is a development of that response. I turn now to an issue of functionalism.

Functionalist Realizability

As stated just above, reductionists have typically blurred the distinction between kind- and property-reductionism. Through the lens of functionalism, Reductionism becomes even more blurred. For, in a functionalist account, theoretical predicates–whether denoting kinds or properties–are defined in terms of causal relations. A kind k_1 is distinct from a kind k_2 in virtue of the causal relations that k_1 enters into and that k_2 does not. Similarly, what makes a property distinctive is the set of causal relations it can enter into.[12] Within functionalism, kinds are thus viewed as a proper subset of properties. In fact, Kim takes kinds to be just projectible properties (1992, 12). I will have more to say about this later.

I mention that functionalism views kinds as properties for two reasons. The first is to avoid terminological confusion *vis-à-vis* the previous chapter. In functional-speak 'kinds' and 'properties' (and their cognates) are used somewhat interchangeably, for kinds and properties are assumed to have similar features. For example, the term 'predicate' is often used to refer to a linguistic element that can denote either a kind or a property. My shifting to functionalist-speak in this chapter should not be too jarring, however, for the discussion is really concerned more with the multiple realization (MR) argument itself.

Second, I believe that the blurring between kinds and properties in functionalism is a symptom of blurring the distinction between metaphysics and epistemology. By making this distinction more explicit, functionalism's importance will be prove to be different than originally believed: functionalism is not so much an accurate metaphysical doctrine, but an indication of how the human brain successfully operates in the world. Functionalism is the skeletal structure of *a posteriori* reasoning. Although, I will not explicitly develop this

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[12]I am assuming only a nomological modality.

thought beyond just mentioning it, I believe it is worth considering. So, I turn now to Kim's argument against multiple realization.

Kim's MR Trilemma

I begin with the fulcrum of disagreement between the reductionist and the anti-reductionist. As stated in the previous chapter, but more formally here:

(BL) A special science T_S can be reduced to another science T_P only if there exists a bridge law that connects the kinds in the domain of T_S to the kinds in the domain of T_P

The term 'connects' denotes a correlation between kinds (Kim 1992, 10) that can be expressed thus (Kim 1992, 4-5):[13]

(CT) For each *x* that is an *S*-kind at time *t*, there is a structure-type *T* and a unique *P*-kind such that *x* is a system of structure-type *T* and is a *P*-kind; and for all systems of type *T*, *S*-kinds are nomologically coextensive with *P*-kinds

First, '*X*-kind' simply denotes a kind in *X*, where *X* is instantiated with the name of a special science. Second, 'nomologically coextensive' means that, as a matter of law, any system instantiates an *S*-kind at *t* iff that system instantiates a *P*-kind at *t* (Kim 1992, 4). In short, (CT) effectively restricts nomological coextension between *S*-kinds and *P*-kinds to systems that have a certain type of structure.[14]

Fodor argues that biconditionals between higher-level and lower-level kinds entail that lower-level kinds are disjunctive:

(2.1) $S \leftrightarrow P_1 \vee P_2 \vee P_3 \vee \ldots P_n$

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[13]I have changed the variables for the sake of consistency.

[14]Suppose that *S*-kinds are mental kinds and *P*-kinds are neurological kinds. Without the restriction, there can be no distinction between the brain states that give rise to human pain and to octopus pain; and furthermore if there is a physically possible creature who cannot feel pain, then it must be impossible for that creature's brain to occupy that state (Putnam 1980, 228; cited in Kim 1992, 4-5). But there is no single brain state that realizes pain across all species, and thus nomological coextension needs to be restricted to (at least) species or structure-types.

where *n* might go to infinity. (2.1) is just a formal result, however, and so the anti-reductionist must go further and argue presumably for one of three positions: either that the biconditional does not hold, or that the biconditional does hold, but that it is possible for one side to be a kind and other side not. Now, since kinds are nomological categories, the there are three methods of argument available to the anti-reductionist:

(AR_1) Argue that *S*-kinds are not nomologically coextensive with *P*-kinds

(AR_2) Argue that *P*-kinds are nomologically coextensive with *S*-kinds, and show that while taking *P*-kinds to be non-genuine kinds, *S*-kinds can be genuine

(AR_3) Argue that *P*-kinds are nomologically coextensive with *S*-kinds, and show that while taking *S*-kinds to be genuine kinds, *P*-kinds can be non-genuine

In "Multiple Realization and the Metaphysics of Reduction," Jaegwon Kim puts forward what might be termed a 'trilemma' for the anti-reductionist, and the trilemma Kim puts forward stems directly from these three possible lines of argument. For, none of them lead to an acceptable position for the anti-reductionist.

Take (AR_1) first. Ernest Lepore and Barry Loewer point out that no P_i is necessary for *S*, but each is sufficient (1989, 179). They claim that although the biconditional does not hold, when any P_i is instantiated, the covariation between *S* and *P* is nonetheless accounted for by P_i's sufficiency. Kim counters, however, that it is better to keep the biconditional, but to relativize it to structure types (1992, 7). The reasoning is clear: Causation of a variation regarding an *S*-kind requires that there be *P*-kind covariation. Such covariation within a single type of system entails a biconditional holding between the *S*-kind and the *P*-kind. Each *S*-state (the instantiation of an *S*-kind at a particular time) within a system type must have its "nomologically coextensive *physical* state"[15] if the physical state is to control *S*-variation (Kim 1992, 7). As stated in the introduction, it is part of the FD that each cause and effect relation must be physical. So, in short, arguing for (AR_1) leaves the anti-reductionist without a causal mechanism by which variations in *S*-kinds can occur.

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[15]Emphasis added.

Turning second to (AR_2) and (AR_3), both of these fall by the same sword. Having argued that the biconditional between *S*-kinds and *P*-kinds must be maintained (even though to do so requires relativization to structure types), Kim turns to Fodor's claim that *S*-kinds cannot be reduced to *P*-kinds via (2.1) because *S*-kinds are nomologically coextensive with a disjunction of *P*-kinds, and a disjunction of kinds cannot itself be a kind (Kim 1992, 8-10).

According to Fodor kinds are defined in terms of kind-predicates, which appear in special-science laws and whose variables are bound (Fodor 1991, 432). Thus, it is through appearing in certain special-science laws that kinds are recognized to be relative to particular sciences. Simply not appearing in a law, however, is insufficient to show why disjunctive predicates cannot denote a kind. What makes disjunctive predicates non-kind-predicates is, according to Kim, that they are not projectible (Kim 1992, 12).

For the functionalist, projectibility has to do with similarity between cause and effect relations. It is therefore important to distinguish between heterogeneous and homogeneous disjunctions, for if a property is heterogeneously disjunctive, each disjunct will produce a different effect and thus similarity will fail to hold (Kim 1992, 13). Consider the following two predicates:

(2.2) *x* is either an African emerald or a non-African emerald

(2.3) *x* is either an African emerald or an African tiger

The first predicate, (2.2), although disjunctive, is not heterogeneously disjunctive; it simply denotes the property of being an emerald. Objects that have the property of being an emerald behave similarly. (2.3), however, is heterogeneously disjunctive; not everything falling with the extension of (2.3) behaves similarly. Therefore, while (2.2) putatively denotes a natural kind and is therefore the sort of predicate that can figure in a law, (2.3) is not natural-kind predicate.

So, consider that the psychological property of being in pain seems like a genuine property. But, Kim asks, why not think that being in pain is just like being either an African emerald or an African tiger (Kim 1992, 15)? Or, closer to the point, why not think that being in pain is like being jade, which was long believed to be a geological kind? If jade were a kind, (2.4) would be a geological law:

(2.4) For all *x*, if *x* is jade, then *x* is green.

As it turns out, however, what we have been calling 'jade' can in fact be comprised of either neophite or jadite, two minerals whose micro-structure are heterogeneous. (2.4) thus turns out to be a conjunction of the following two laws:

(2.5) For all *x*, if *x* is jadeite, then *x* is green

(2.6) For all *x*, if *x* is nephrite, then *x* is green

Kim argues that (2.4) is not a law, for being jade is heterogeneously disjunctive:

(2.7) For all *x*, *x* is jade iff *x* is either nephrite or *x* is jadeite

and thus jade is not a kind (Kim 1992, 11-3). To see this, suppose that every single instance of jade that has thus far been observed turns out to be an instance of nephrite. If such were the case, (2.6) would be well-confirmed, and each confirming instance of (2.6) would be a confirming instance of (2.4). Notice, however, that each confirming instance of (2.4) does not establish (2.4) as a law, for it could be that the next mineral one finds is in fact jadeite, which turns out to be, say, yellow. If jadeite is yellow, then (2.4) is not a law, for being jade is not a projectible property. If being jade is not a projectible property, then jade itself is not a kind.

To summarize, if the biconditional does not hold between *S*-kinds and *P*-kinds, then the dependency relation between *S*-kinds and *P*-kinds fails to hold. The result is that *S*-kinds cannot figure into causal relations, for causation is physical, and without the biconditional, *S*-kinds become detached. Therefore, biconditionals must be maintained, but they must also be relativized to structure types. *S*-kinds can, however, be multiply realized within specific structure types. Thus, one is still faced with a biconditional between an *S*-kind and a disjunction of *P*-kinds. The difference here has to do with homogeneity versus heterogeneity. If the disjunctive property that is nomically equivalent to a higher-level property is heterogeneous, then the equivalent higher-level property cannot be projectible, and thus cannot be a kind. If *S*-kinds and disjunctive *P*-kinds are nomologically coextensive and the *S*-kind is a genuine kind, then the disjunctive *P*-kind is too. The disjunction is simply homogeneous. So, the MR argument shows not that higher-level laws are non-reducible to lower-level laws, but that if lower-level disjunctions are not kinds, then that which these disjunctions realize cannot be kinds.

Block's Response

As state above, Kim argues that what makes the property of being either an African emerald or an African tiger non-projectible is the fact that the property is heterogeneously disjunctive. But what makes being an African emerald and a non-African emerald projectible, say, in being green, is that the property is homogeneously disjunctive. Having argued that rejecting the biconditional entails a rejection of the physical causal closure principle, Kim shows that if the thing denoted by one side of the biconditional is a kind, then *both* things whose names are connected by the biconditional are kinds. If, however, one side of the biconditional denotes a non-kind, then both sides denote a non-kind. Furthermore, according to Kim, there is reason to reject the kind-hood of heterogeneous disjunctive properties and thus the kind-hood of whatever is realized by heterogeneously disjunctive properties. Since mental properties are realizable by heterogeneously disjunctive properties, mental properties, or more specifically putative psychological kinds, are in fact not kinds at all. While the practice of psychology is *scientific*, it is not a science.

It is the last claim–that psychological kinds, or even special-science kinds in general, are heterogeneously disjunctive–that Ned Block, in "Anti-Reductionism Slaps Back," finds contentious. Block provides reasons for believing that special-science kinds are not themselves heterogeneously disjunctive: there is no hard and fast line between kinds and non-kinds.

Principles of Homogeneity

According to Block two principles in nature lead to homogeneous disjunctive kinds: the so-called Disney Principle and what might be called the Natural Forces Principle (Block 1997, 120, 121):

(DP) Laws of nature impose constraints on ways of making something that satisfies a certain description [Disney Principle].

(NFP) Natural forces produce similarities [Natural Forces Principle].

Taking the former principle first, in a Disney movie tea cups and candlesticks have the ability to think and talk, but in reality thinking and talking requires more structure than these objects possess (Block 1997, 120). This sort of nomological constraint is described by the so-called "Disney Principle"; moreover, constraints give rise to similarity (Block 1997, 121). So, for example, while thinking might be realized in different ways, the number of ways is constrained by the laws of nature: thinkers must have a structure that is nomologically viable for thinking. And, according to Block, having this requirement imposes across thinkers similarity that works toward making the multiple realizers of special kinds homogeneous.

Now, while the Disney Principle describes a passive constraint in nature that imposes similarity, the Natural Forces Principle describes active mechanisms in nature that produce similarity. Such mechanisms include natural selection, learning, conscious design, and various combinations of these (Block 1997, 121). For example, two neighbors, Sam and Syd, might recognize that shelters should be built in preparation for the coming tornado season. Sam builds a basement, and Syd builds a very sturdy tree house. If a tornado runs across both neighbors's yards, Syd, assuming he survives the ordeal, will learn something about trees and tornados (one generally does not want to be in a tree during a tornado), and he will change the design of his tornado shelter in response to what he has learned. Block rightly points out, however, that the "deep scientific similarities" found within special-science domains cannot be accounted for by the mere Natural Forces Principle (Block 1997, 121-2).

What does account for deep similarity in nature, according to Block, is an interaction between the Disney Principle and the Natural Forces Principle (Block 1997, 122). The idea is that the Disney Principle constrains the possible outcomes produced by natural forces. There are, for example, only so many ways in which a thinker can be constructed. In fact, Block points out, there might be only two such ways, one of which is exemplified by computers and one of which is exemplified by connectionist networks (Block 1997, 122). If a thinker is going to be realized, say, through natural selection, she must be realized in one of these two ways. As another example, natural selection can account for the similarity that organisms who survive are typically able to elude danger. But some organisms fly, others run quickly, and still others are simply too prickly to be eaten; similarity imposed by natural forces occurs only insofar as the mechanisms "do the job" (Block 1997, 122). The Disney Principle, however, accounts for why, say, only certain wing designs allow for flight. In short, the Disney Principle determines the similarity of the deeply scientific sort, and natural forces bring about the mechanisms that exhibit that similarity.

Multiple Realization and Kinds

Next, Block attempts to show that certain projectible properties (*i.e.,* kinds) are multiply realizable. The strategy goes like this: certain properties, D-properties, get their projectibility from being realized through "channeled selection" as described in the last paragraph (Block 1997, 124); and Block attempts to show that these D-properties are multiply realizable. The example Block puts forward is stimulus generalization, a property of perception (Shepard 1994; cited by Block 1997, 124-6). For example, pigeons and humans possess perceptive apparatuses that are very differently realized. Yet, both seem to generalize across perceived stimuli in a similar way. So, although pigeons and humans have distinct perceptual apparatus, a certain form of stimulus generalization is common to both. In fact, this form of stimulus generalization is projectible; other creatures can be expected to generalize similarly. (I will discuss Shepard's article in greater detail in chapter four.) So, it appears that D-properties show that higher-level kinds can be multiply realized by what certainly appear to be heterogeneous disjunctions.

Now, the above example shows three important things about kinds (Block 1997, 128-9). First, whether or not a projectible property or disjunction of properties is a kind is relative to the scientific domain. Being a perceptive apparatus is a psychological kind, but neuro-physiologically, being either a human apparatus or a pigeon apparatus is not a kind.

Or, again, being jade at the macro-level is a kind, but being either jadeite or nephrite at the micro-level is not a kind. Consequently, truly heterogeneous kinds might not exist at all. Two putative heterogeneous kinds at one level might multiply realize a single kind at a higher-level, in which case the former will turn out to be homogeneous relative to the higher-level. Second, and similarly, kind-hood is based on similarity and similarity comes in degrees; therefore, kind-hood comes in degrees. The degree of similarity between instances of a property is relative to the scientific domain. So, while, say, channeled selection might provide similarity at one level, it simultaneously might not provide similarity at a lower-level. Similarity is graded and seems to increase as one goes "higher" up the special sciences.

Block concludes by pointing out that reductionism, according to Kim and Fodor, is based on a notion of kinds that are not relative and graded (Block 1997, 129). If Block is right, then whether or not a particular predicate denotes a kind is domain relative, and thus there is no fact of the matter about it. Whether something is a kind ends up being an issue of mere terminology.

The Dissolution of Special Kinds and Special Properties

Let us take stock of where the discussion has taken us thus far. We began with Jaegwon Kim's presentation of a trilemma for the anti-reductionist. It appears that the anti-reductionist must accept *(a)* that the biconditional connective found within bridge laws does not hold, *(b)* that heterogeneous disjunctions are kinds, or *(c)* that there are no special-science kinds. Denying the biconditional entails a denial of the causal closure principle. Accepting the biconditional entails accepting nomic equivalence between the two sides of the biconditional such that either both sides denote kinds or both sides do not. The result is that either there are no special kinds or special kinds are reducible; and either way, one is left with only a lower-level science, *viz.,* physics.

In response, Ned Block argues that Reductionism is simply a terminological issue. Since the Disney Principle and what I have called the 'Natural Forces Principle' constrain what sorts of kinds can be realized, there are few (if any) truly heterogeneous disjunctive kinds; therefore, whether something is a kind is a question of domain relative gradation. On the one hand, if considering a particular kind *K* from within the domain in which *K* occurs, *K*'s multiply-realizing base, $k_1 \vee k_2 \vee k_3$, is also a kind. But this is not a problem, for the base is homogeneously disjunctive as determined by the two principles mentioned above working together to constrain what sorts of lower-level kinds can realize *K*. If, on the other hand, $K \leftrightarrow k_1 \vee k_2 \vee k_3$ were considered from the lower-level science where k_1, k_2, and k_3 are distinct lower-level kinds, then *K* would appear to be a non-kind, for $k_1 \vee k_2 \vee k_3$ would appear to be heterogeneously disjunctive. So, if reduction amounts to reducing kinds, then there simply is no fact of the matter about whether or not Reductionism is true.

In the introductory paragraph of "Anti-Reductionism Slaps Back", Block states (1997, 107):

> This paper was originally titled "Anti-Reductionism Strikes Back", but in the course of writing the paper, I came to think that the concepts used in the debate would not serve either position very well.

Then, at the close of this same article, Block points out that (1997, 129):

> Once one agrees that the notion of a kind is relative and graded, unless one is prepared to see causation as relative and graded, kinds will be poor candidates for the key to causation.

These two claims are right, but they should be taken further, which will show that Block's conclusion serves the reductionist position better than the anti-reductionist's. True: If kinds are relative and graded, then kind-hood is not causally efficacious. Properties, however, are causally efficacious. So, if kinds are relative and graded, then kinds are not identical to properties. Now, going further, properties seem to be ontological–after all, they do enter into causal relations–but kinds do not enter into causal relations. And thus, there seems to be little reason to think of kinds as things in the world.[16]

I shall also offer another reason to reject the notion of ontological kinds, which has to do with the fact that kinds do not seem to be projectible properties *per se*, but rather they are sets of properties (or more precisely, predicates), some of which are projectible.

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[16]Except, perhaps, at the level of physics. See the Epilogue for a discussion of physical kinds.

Projectibility, however, is an epistemic notion, and I shall argue that once the notion of kinds is seen as being dependent upon the projectibility of properties, kinds (except perhaps at the physical level[17]) will turn out to be simply conceptual apparatuses that help us to grasp the world. Thus, kinds are not things in the world so much as they are the result of the way humans, as thinking physical beings, interact with the world.

In this chapter, I present reasons to think kinds are not ontological entities; in the following chapter, I discuss the notion of properties and their relation to putative kinds; and in the fourth chapter, I describe how the notion kinds stems directly from a selectively advantageous way in which humans, as thinking creatures, interact with the world. Consequently, special science whose autonomy partially rests upon the autonomy of special kinds will prove to be conceptually, but not ontologically, distinct from physics.

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[17]For a discussion of physical kinds, see the Epilogue.

CHAPTER III
SPECIAL PREDICATES

If kinds are not ontological entities, then why do special-science predicates seem to "carve the world at its joints"? This chapter begins an answer to that question with an analysis of special-science predicates (hereafter, 'special predicates') themselves. In the following chapter, I present a naturalistic account of special predicates. Simply put, predication is a selectively advantageous skill that begins prior to consciousness. The Epilogue then provides a sketch of micro-level causation, which, I argue, provides the ontological foundation for special predication. By analyzing special predicates, showing how their constituent predicates are selectively advantageous, and describing the relation between these constituents and micro-level causation, I hope to provide a compelling account of predicates peculiar to the special sciences.

The crux of the argument in the present chapter is this: special predicates are comprised of intricate combinations of genuine and non-genuine, or mere-Cambridge, predicates. Mere-Cambridge predicates' failing to pick out real properties prevents them from being reduced to lower-level predicates. First, since genuineness with regard to properties and predicates is crucial to my project, the first section takes up this very issue. In the second section, the notion of causal powers is considered in light of the previous section's analysis. I will show that causal power-predicates are also mere-Cambridge in form. The final section will be an application of my analysis of predicates to kind-predicates and predicates-of-kinds. It should be noted that since my concerns are broadly scientific, modal issues will be discussed in terms of nomological, rather than, say, metaphysical, necessity and possibility.

Mere-Cambridge-ness

An alternative title for this section could be "The Problem with Predicates." For, the focus will be on the fact that there is a essentially only one way to predicate of an object, but there are many ways for an object to be a way. Let me explain.

There are many ways an object can be. For example, *x* might be five feet four inches tall, or *x* might be five feet six inches tall. And of course there are different determinate predicates to denote these different ways of being:

(3.1) *x* is five feet four inches tall

(3.2) *x* is five feet six inches tall

So, on the one hand, an object can be different ways, and each of these ways is described by means of a particular unary determinate predicate. Call these particular types of predicates 'internal determinate predicates'. By 'internal' I mean something like the property's being exemplified in the same spacetime region as the object of which the property is predicated.

On the other hand, and this is where the problem begins to show itself, there are many ways an object can be a way. For one thing, an object can be a particular way *in virtue of* being, say, a more primary way. For example, an object can be a certain way with regard to height as opposed to being a way with regard to shape. And each way of being a way can be predicated of an object using a determinable predicate:

(3.3) *x* has height

(3.4) *x* has shape

Call predicates like these 'internal determinable predicates'.

Returning to determinate predicates, while some denote internal properties, others denote putative external properties. For example, an individual *x* might be a member of a set in virtue of having certain properties such as maleness and residence,

(3.5) *x* is a member of the set of males in Athens

Or *x* might be some way relative to another object,

(3.6) *x* is taller than Theaetetus

Second, an object can be a way in virtue of some *other* object being a way:

(3.7) *x* is such that Theaetetus is five feet four inches tall

in which case (3.7) is, one might suppose, true of Socrates (or for all objects in the universe of discourse, for that matter) at certain time, t_1. Call predicates of this type 'external determinate predicates'.

Now, the problem with predicates begins with the fact that there are at least three distinct types of predicates: internal determinate predicates, internal determinable predicates, and external determinate predicates, but all three types share one, lowly form:

(3.8) *x* is [or has] *F*

Call this a concern about 'formal ambiguity'.

A second concern is that sentences, regardless of predicate type, have their truth conditions *in the world.* As we all know, commonsense (which I assume is correct) claims that for all statements *P*, *P* is true iff *P* corresponds in the right way to the world. (I trust the reader's intuition as to what the right way is.) So, not only is a single form used to predicate of an object various ways of being and various ways of being a way, a single method of truth-making makes sentences, regardless of predicate type, true.

The third concern arises from a conjunction of the first two. Using a single predicate form regardless of predicate type and the fact that truth conditions are in the world regardless of predicate type conspire, I fear, to make predicates appear genuine when they are not. This concern is the focus of much of the rest of this chapter.

Now, properties, the putative referents of predicates, have long been divided into types, and not too long ago Peter Geach distinguished between properties that give rise to genuine change and those that do not (Geach 1969, 71-2). Now, according to the Cambridge criterion of change,

(3.9) An object *x* has undergone a change...just in case for some predicate *F* and times t_1 and t_2, it is true (false) that *x* is *F* at t_1, but false (true) that *x* is *F* at t_2.[18]

Geach has pointed out, however, that the Cambridge criterion of change seems too weak, for it allows that something in Socrates has changed in virtue of his being outgrown by Theaetetus, although surely no genuine change in Socrates has occurred (Geach 1969, 72). The "properties" denoted by predicates such as

(3.10) *x* is outgrown by Theaetetus

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[18]Adapted from Francescotti (Francescotti 1999, 295).

have been dubbed mere-Cambridge properties, and many have concluded that mere-Cambridge properties themselves are non-genuine. But what does it mean for a property to be non-genuine? It cannot mean that its predicate is vacuous or has no *t*-value. For, surely a majority of people will agree on when (3.10) is true and when it is false of an object, and they will arrive at their agreement by observing the world.

In "Mere Cambridge Properties," Robert Francescotti attempts to determine just where the line of demarcation falls between genuine and mere-Cambridge properties. After considering several possibilities, Francescotti temporarily concludes that a property *F* of an object *x* is genuine iff it is internal to *x*. He defines an internal property thus (Francescotti, 300-1):

> (3.11) *F* is an internal property of an item $x =^{df} x$ has *F*, and *F* is not the sort of property *x* has in virtue of having a relationship to an object *y*, where *x* is distinct from *y*.

Then, Francescotti posits this definition of 'mere-Cambridge property' (Francescotti, 302):

> (3.12) *F* is a mere-Cambridge property of an item $x =^{df} x$ has *F*, and *F* is not an internal property of *x*.

Since, however, some non-wholly internal properties appear genuine, Francescotti expends considerable energy trying to redefine 'mere-Cambridge property' to exclude these (Francescotti, 302-3). Since I am unsure of what a non-genuine property is, I will speak from here on almost exclusively in terms of predicates. Genuine predicates denote genuine properties; mere-Cambridge predicates do not.

The existence of genuine but non-wholly internal predicates, I believe, is an illusion. There is little doubt that the predicate

> (3.13) *x* is growing taller

denotes a property of *x*. Therefore, the question of whether or not

> (3.14) *x* is growing taller than Socrates

is genuine hinges on whether or not a property can be had by one object in virtue of another object being a certain way.

> (3.15) *y* is being outgrown by Theaetetus

however, seems obviously mere-Cambridge. I shall assume *(a)* that when (3.14) is instantiated with 'Theaetetus' and (3.15) with 'Socrates', both correspond to the same situation and *(b)* that ontological change takes place only within Theaetetus. What, then confers genuineness upon (3.14) but not upon (3.15)? Francescotti seems to hold that a predicate denotes a property only if the locus of change with regard to that predicate exists within the object whose name is instantiated in the predicate (Francescotti 1999, 302). By 'locus of change' I mean the spacetime region in which ontological change takes place in virtue of which *x* changes with regard to *F*.[19] Thus, on Francescotti's view (3.13) and (3.14) are both genuine because the denoted putative property's locus of change occurs within objects found in the extension of (3.13) and (3.14) respectively. (3.15), by contrast, is not genuine, for the locus of change occurs outside of the objects in its extension.

The locus of change account points in the right direction, but it seems too weak. Notice that (3.15) is a two-place relational predicate in which the name of the second relatum is fixed. This is important, for while the locus of change with regard to height is internal to whoever's name is instantiated, (3.15) is true of the instantiating object in virtue of both Theaetetus changing in height *and* the instantiating object's height falling within a certain range. But since Theaetetus's name is fixed in the predicate, 'Theaetetus' is part of the predicate. Such fixing precludes Theaetetus from being a locus of change with regard to (3.15). Of course, though, Theaetetus is a (one of two) locus of change for a *relational* predicate comparing the instantiating object's height to that of Theaetetus. The relational predicate, '*y* is being out grown by *x*' and (3.15), however, are utterly different: one is unary and the other is binary. I see no reason to think that a single locus of change has the ability to confer genuineness on a relational predicate.

Now, notice that (3.14) and (3.15) both consist in two place predicates in which the name of one relatum is fixed. The difference between (3.14) and (3.15) has only to do with (3.14)'s being instantiated by the name of an object in which change actually takes place. And this is sufficient to create the illusion that (3.14) denotes a property. For,

[19]Of course, the object need not actually change.

while change takes place in the object whose name is instantiated in (3.14), the change is not the change denoted by (3.14); the change is denoted by (3.13). So, while (3.14) appears to denote a property, it does not, and thus (3.14) and (3.15) are both mere-Cambridge predicates. I thus posit the following definition of a genuine unary predicate:

(3.16) *F* is a genuine predicate of *x* iff
- (3.16a) *F* is truly predicable of *x*
- (3.16b) *x*'s locus of change with regard to *F* is internal to the object whose name instantiates *x*
- (3.16c) the truth of '*x* is [or has] *F*' does not depend on the truth of another predication instance, '*y* is [or has] *G*'

So far, I have only put forward what I think are the necessary and sufficient *criteria* for predicate genuineness. But what is the nature of a mere-Cambridge predicate? What does it mean for a unary predicate to be non-genuine? Basically stated, a mere-Cambridge predicate is a conceptual construct built up out of genuine predicates. That is, there is no real property that a mere-Cambridge predicate denotes, but rather something like a conceptual cluster of genuine predicates. Consider sentence (3.17):

(3.17) Theaetetus is growing taller than Socrates

We possess the mathematical notion of length, or in this case height; we have comparative notions such as greater-than or less-than-or-equal-to; and we understand the notion of change with regard to height. If we know that Theaetetus at t_1 is five feet four and is five feet six at t_2, then we can infer that for *any* object *y* that is five feet four at t_2, Theaetetus has grown taller than it. So, if it turns out that Socrates has the property of being five-four at both t_1 and t_2, then Socrates just happens to possess a height than which Theaetetus is growing taller. Being five-four at both t_1 and t_2 is a property of Socrates, not Theaetetus, and the relation between the two is a property of an ordered pair, <Theaetetus, Socrates>, again not just Theaetetus. Therefore, while (3.17) is true, the predicate (3.14) (used in (3.17)) does not denote an existent property of Theaetetus; it denotes a cluster of existent properties and relations. In the next section, I will argue that putative power-predicates are also merely-Cambridge.

The Corrupting Influence of Power

Causation is crucial to the sciences, whether special or physical. It is my contention, however, that causation is a relation and therefore causal predicates can be put in the form of mere-Cambridge predicates. I shall argue that the notion of a power just is a causal predicate in mere-Cambridge form. Moreover, rephrasing causal predicates in terms of powers leads to mistaken notions of what sorts of properties an object can possess.

History of Power

Before presenting my case, it is important to begin with just what a power is. I will first look at Robert Boyle's discussion, then consider John Locke's and David Hume's before taking up Shoemaker's conception. I begin by looking first at Robert Boyle's consideration of properties in "The Origin of Forms and Qualities According to the Corpuscular Philosophy" (1991, 23-30). The crux of Boyle's discussion is that not everything attributed to an object is a physical property (Boyle 1991, 28); the example Boyle uses is of a lock and key (Boyle 1991, 23-4).[20] First, suppose that there exists a lock and a key, but at a certain time, say t_0, the key can fit inside the lock but cannot open it. Notice, next, that the key and lock are distinct objects possessing nothing over and above their respective shape, size, texture, rigidity, and so on (Boyle 1991, 23-4). Now suppose that at a later time t_1 the lock is retooled such that it can now be opened with the key. Boyle argues that although '*x* is unable to open the lock' is true of the key prior to t_1, the key did not gain a new property, denoted by '*x* is able to open the lock', when the lock was retooled. To say that the key gained a property commits one to the possibility of the key gaining an infinite number of properties, for there can (at least in principle) be an infinite number of locks tooled to fit it, which Boyle believes is clearly unreasonable (Boyle 1991, 24). Thus, not every predicate of an object denotes a property of that object. Rather, what accounts for the key's being able to open the lock at t_1 rather than at

[20] I modify the example slightly for the sake of perspicuity.

t_0 is presumably a *power* intrinsic to the key that allows it to open any lock that is of a certain shape, size, and so on (Boyle 1991, 24).

John Locke also discusses the notion of powers when he differentiates between primary, secondary, and what might be called 'tertiary' properties[21] (Locke 1948, 45-6). Locke presents his division between properties as if a line of causal demarcation runs between primary properties, on the one side, and secondary and tertiary properties on the other. The latter are described in terms of powers. Secondary properties consist in powers possessed by the object and by which certain sensations are caused in observers. Pickles have the ability to produce in humans the sensation of a particular taste and the sensation of a certain color, for example. Like secondary properties, tertiary properties also consist in powers. Tertiary powers, however, are not the powers of sensation but the power of one object to act on another object to affect the latter's powers of sensation. Thus, for Locke not only do objects possess powers, the sorts of powers they possess can be further distinguished.

Finally, Hume recognized that empirical observation comes down to cause and effect relations, but he attempts to do away with the notion of power, and even causation, altogether. As is well known, Hume argued that the notion of causation is simply an inference based upon habitually observing contiguous events, where an event of one kind always precedes an event of another kind (Hume 1977, 16-29). The notion of powers seems even more repugnant to Hume; he simply dismisses powers as non-existent (Hume 1977, 21). Powers are simply properties of objects that are posited in order to account for why one object seems to bring about one effect rather than another. Once causation has been done away with, powers are no longer needed.

I must admit that I am somewhat partial to Hume's take on powers, although dismissing causation seems to put us in certain difficult situations, as is well known. And regardless, since the notion of causation is essential to physics, I shall assume that

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[21]For consistency with the rest of this chapter, I shall use 'properties' where Locke speaks of 'qualities'.

something like causal relations exist in the world.[22] Therefore, it seems that what is needed is an account that recognizes that certain predicates are not genuine, but that also takes causation seriously. I think the account provided by Sydney Shoemaker points in the generally right direction.

Shoemaker's Powers

According to Shoemaker, the notion of causation is needed in order to distinguish between genuine and mere-Cambridge predicates, and the relevant notion of causation is expressed in terms of powers (Shoemaker 1980, 209). There are different sorts of powers, however, that roughly correspond to Locke's notions of primary properties, on the one hand, and secondary and tertiary properties, on the other (Shoemaker 1980, 211). A property (which roughly corresponds to Locke's notion of primary properties) just is the ability to produce a certain effect in certain circumstances, and it is in virtue of having these properties (*i.e.,* abilities) that an object has the powers (roughly equivalent to Locke's secondary and tertiary properties) to affect other objects in the way it does (Shoemaker 1980, 211). Shoemaker thus describes a power as a function from one causal event to its effect (Shoemaker 1980, 211).

This function, however, does not provide a one-to-one correspondence between causal events and their effects (Shoemaker 1980, 211). One type of poison, for example, has a property in virtue of which it affects the heart, while another type has a property in virtue of which it affects the nervous system; however, both have the power to bring about death.[23]

Similarly, there is not a one-to-one function from properties to powers. In fact, a property is a cluster of conditional powers (Shoemaker 1980, 213). A conditional power can be described thus (see Shoemaker 1980, 212-3):

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[22]See the Epilogue for a discussion of causation.

[23]In his (1980), Shoemaker does not put it in these terms, but it is easy enough to see that if powers exist, they might provide the means for multiple realization.

(3.18) *R* is a power conditioned on *x*'s having a set of properties $\mathcal{Q}$ iff *(a)* there is a set $\mathcal{Q}$ of properties that *x* has but which is causally insufficient for *x*'s having *R*, *(b) x* has a property *P* that is not a member of $\mathcal{Q}$, and *(c) if there exists a P such that, if* x *has P* and $\mathcal{Q}$, then *x* has *R*.

For example, a key's having the power to open a lock is conditioned on its having a particular shape and a particular size iff having a certain degree of rigidity is necessary and sufficient to give the key the power to open the lock. A cluster of conditional powers can be described thus: an object has a property *P* iff it has the power R_1 to produce an effect E_1 in a situation (defined as the instantiation of a set of properties) S_1, the power R_2 to produce an effect E_2 in a situation S_2, and so on. Presumably, then, which property an object has just is determined by which conditional powers appear in the clustered set.

Shoemaker admits that his analysis of properties and powers suffers from circularity (Shoemaker 1980, 221-2).[24] Two properties *P* and *Q* are identical iff both *P* and *Q* give rise to the same power *R*; but whether or not *R* is coinstantiated is determined only if *(a)* comparing the cause-events reveals them to be similar and *(b)* comparing effect-events reveals those to be similar. But similarity of events must be described in terms of properties. In short, property identity rests upon identity between the powers they produce, and identity of powers rests upon identity of properties. Shoemaker claims that the circularity between powers and properties is unproblematic, however, for the issue is epistemic (Shoemaker 1980, 222). That is, ontologically, powers and properties coexist in a sort of network, but determining whether two properties are identical is epistemological.

Mere-Cambridge Causation

In what follows, I shall argue that positing powers imports the notion of a causal property mistakenly thought to be possessed by an object. I shall begin with an analysis of power and show that there are no powers *per se* but only internal, physical properties that determine which causal relations an object can enter into. Then, I shall turn to a linguistic analysis of what I call 'power-predicates' and show that they are very similar to mere-

[24]Shoemaker (1980, 221-2) shows a second way in which circularity might afflict his conception of properties, but I think there are ways to deal with it.

Cambridge predicates. The problem with power-predicates is that they seem to ascribe to objects something over and above their properties. I turn first to the issue of powers.

Consider that a particular's physical properties determine the sorts of causal relations that the particular can enter into. For example, a key *k* has the power to unlock a lock *l* in virtue of *k*'s having certain physical properties. Notice, though, that there is an infinite set of possible causal relations. Causal relations are multi-arity properties, and which causal relations are realizable in a particular instance is determined by the physical properties of each member of the *n*-arity ordered set. Put another way, the physical properties of each relata partition the set of all possible causal relations into those relations which can be realizable by the relata and those relations that are not.

Consider, though, that if a causal relation is held fixed, then a particular's physical properties determine which sorts of objects the particular can enter into the relation with. Notice, though, that this is very different from saying that, for example, a key *k* has the power to unlock a particular lock *l*. What this shows is that *k* can unlock any member of a particular set of objects:

(3.19) *k* has the power to unlock any member of a set $\mathscr{L}$ of locks, where,
$\mathscr{L} =^{df} \{l \mid S_2 l \; \& \; {\sim}M_2 l \; \& \; \ldots \; \& \; Z_2 l\}$

where S_2 is '*x* has [such and such] shape', ${\sim}M_2$ is '*x* is not malleable to [such and such] degree', Z_2 is '*x* has [such and such] size' and so on. The key *k* has *R* in virtue of having a particular shape S_1, an unmalleability ${\sim}M_1$, a certain size Z_1 and so on (Shoemaker 1980, 211). And so *k*'s having *R* can be expressed thus:

(3.20) $Rk \leftrightarrow (S_1 k \; \& \; {\sim}M_1 k \; \& \; \ldots \; \& \; Z_1 k)$

Furthermore,

(3.21) $Rk \leftrightarrow \forall l \in \mathscr{L} \, Ukl$

where '*Ukl*' is interpreted as *k* unlocks *l*, and therefore,

(3.22) $(S_1 k \; \& \; {\sim}M_1 k \; \& \; \ldots \; \& \; Z_1 k) \leftrightarrow \forall l \in \mathscr{L} \, Ukl$

Shoemaker takes the material equivalence in (3.22) to mean that causal relations between objects are necessary (Shoemaker 1980, 222). I think this is wrong. It might be necessary that for all objects with a certain set $\mathscr{F}$ of attributes to stand in causal relation *Rxy* to another object which has a different set $\mathscr{G}$ of attributes, but this is just a law of kinematic geometry. When speaking of a particular key, the key just happens to have a particular set of properties, and that set of properties determines which kinds of causal relations that the key can enter into. (3.22) therefore just shows powers to be ontologically identical to having a set of properties. Powers themselves are nothing over and above the set of physical properties possessed by the particular, as Locke suggests.

Now, turning to power-predicates, recall from above that a mere-Cambridge predicate is a predicate that conflates a binary and a unary predicate by fixing the name of one relata. Power-predicates, I submit, are simply mere-Cambridge predicates with one important difference: the conflated binary predicate is causal. Consider first that the following:

(3.23) *x* has the power *R* to unlock *l*

is true of key *k*. Now, compare this power-predicate to the mere-Cambridge predicate (3.15):

(3.15) *y* is being outgrown by Theaetetus

As argued above, mere-Cambridge predicates like (3.15) are actually two place predicates posing as one place predicates, such that when the object whose name is fixed changes, it appears (in some sense) that the object in the extension of the predicate changes. I suggest that (3.23) is similar. When lock *l*, referred to in (3.23), changes, (3.23) is true of things in its extension at one time, then false of them at another, in a way similar to the mere-Cambridge change that occurs *vis-à-vis* (3.15). Only, it appears that the (putative) power possessed by whatever is in the extension of (3.23) has changed too, for it can no longer unlock *l*. Therefore, for the same reasons that (3.15) is mere-Cambridge, power-predicates are mere-Cambridge, although they might appear otherwise.

By revealing power-predicates to be mere-Cambridge predicates treading on causal-relation predicates, we can reduce power predicates to unary physical and binary causal predicates. To say otherwise is to attribute a mere-Cambridge predicate on the order of (3.8) of an object. Predication of this latter sort, as will be discussed in the next section, is what leads to kind-predicates and predicates-of-kinds.

Mere-Cambridge Kinds

What follows is an analysis of special predicates in light of the above discussion of mere-Cambridge-ness. In the first chapter, I made the often blurred distinction between kinds and properties and thus between kind-predicates and predicates-of-kinds. It will be recalled that (1.1) is an example of a biological kind-predicate:

(1.1) *x* is a Peregrine falcon

and (1.2) is an example of a biological predicate-of-kinds:

(1.2) *x* is biologically fit

Since reduction of both kinds and properties is necessary for Reductionism to succeed, the anti-reductionist can use the multiple realization (MR) argument to attack either type of reductionism. It is thus incumbent upon the reductionist to show either than the MR argument itself is flawed or that neither kinds nor properties are multiply realized.

As mentioned in the second chapter, functionalism blurs further the distinction between kinds and properties. Since my concern was with the MR argument itself, the functionalist description of the argument was of little consequence until the end. At the end of the chapter, I argued that kinds and properties are distinct, for kinds are not ontological entities but properties are. Consequently, the distinction between kinds and properties, and thus between kind-predicates and predicates-of-kinds, becomes important again.

Therefore, this last section will consist roughly of two parts. In the first part, assuming that kinds are non-existent entities, I will endeavor to analyze kind-predicates in light of the my analysis of mere-Cambridge predicates. Simply put, kind-predicates are clusters of genuine predicates and power-predicates. I will turn to predicates-of-kinds in the second section, and I will argue that such predicates are also clusters similar to kind-predicates.

Kind-Predicates

There are two issues with regard to distinguishing kind–predicates: on the one hand, one must distinguish between kind-predicates and non-kind-predicates, and, on the other hand, one must distinguish between distinct kind-predicates. There are, furthermore, two ways in which kind-predicates can differ: They can differ across special sciences:

(1.1) *x* is a Peregrine falcon

versus

(3.24) *x* is gold

And they can differ within a special science:

(1.1) *x* is a Peregrine falcon

versus

(3.25) *x* is a Bengal tiger

It will be helpful to approach the issue of kind-predicates from within a particular special science. In this case, I will draw from biology.

The question at hand is, what distinguishes (1.1) from (3.25)? First, the distinction cannot be based on a set of immediately obvious traits, for traits can vary greatly within a kind-predicate extension (Kitts and Kitts 1979, 621). For example, as is well known, swans were long believed to be white by law, until black swans were found in Australia. So, whiteness was not essential to swan-hood after all. Second, reproductive isolation is often thought to distinguish the extension of one biological kind-predicate from another (Kitts and Kitts 1979, 620-1). But reproductive isolation is insufficient to indicate whether Mort is a Peregrine falcon or a Bengal tiger. Something must be added. A third possible way to distinguish (1.1) from (3.25) was stated in the last chapter. Jerry Fodor takes a kind to be the sort of thing whose name appears as a bound predicate in law-statements (Fodor 1991, 432). One's name appearing in a single law-statement, however, is insufficient for kind-predicate-hood: Presumably a property's name can appear in a law-statement and yet the property itself might not define a kind-predicate. In fact, one reason that I have distinguished between kind-predicates and predicates-of-kinds is that although many predicates-of-kinds appear in law statements, they themselves do not necessarily denote a kind. They denote properties of things falling in the extension of kind-predicates. So, for example, it is not a law that every tiger is orange; but 'orange' does appear in law-statements (*e.g.,* under normal conditions, an electromagnetic wavelength of 610 nanometers will appear orange). Perhaps, then, what distinguishes (1.1) from (3.25) is that the names of objects in their respective extensions appear in distinct *clusters* of law-statements. I take this too to be on the right track.

Finally, Jaegwon Kim claims, as mentioned in the last chapter, that the additional condition of projectibility is needed to distinguish kind-predicates from non-kind-predicates (Kim 1992, 12). But will this work in differentiating one kind-predicate from another? I believe so, but it cannot be the projectibility of just any trait. For, considerable variation can occur between two members within the same kind-predicate extension. Rather, with David B. Kitts and David J. Kitts, some particular trait (or set of traits) seems necessary and sufficient for an object to fall within the extension of a kind-predicate (Kitts and Kitts 1979, 614).

The idea that the necessary and sufficient conditions for kind-membership get cashed out in terms of an essential property or set of properties seems to generalize. As Kitt and Kitt put it, "All that glitters is not gold and all that is gold does not glitter"; what makes gold a kind is its having an atomic number of 79–a prime example of an underlying kind-predicate-determining property (1979, 617). But, again, I think the underlying trait is insufficient, although it is probably necessary. For presumably it is not in virtue of having an atomic number of 79 that gold conducts to electricity, but surely it is a law that,

(3.26) For all *x*, if *x* is gold, then *x* conducts to electricity

It seems, then, that one is left with defining kind-predicates in terms of both an underlying set of properties essential to objects falling within the extension of the predicate and the role those properties play in causal laws.

Now, not just any causal relation can determine which objects fall within a particular kind-predicate. Rather, causal relations that distinguish between objects falling within the extension of one kind-predicate versus another must be laws. But for all properties–immediately observable or otherwise–there exists a law-like relation–*ceteris paribus* or not–that the property can enter into. Therefore, there must be a distinction within the general set of causal relations that determines which kind-predicate extension the object falls within.

I submit that a *set* of underlying *physical* properties is essential to a particular object's falling within the extension of a kind-predicate. I agree with Kitt and Kitt that the "search for essences is prompted by theoretical necessity" (1979, 621). And such essences are surely *known* by their causal effects. If one is to maintain the causal closure principle, then the essence for which Kitt and Kitt are searching must be a set of underlying physical properties.[25] I shall call this underlying set of properties a 'Disney Cluster'.

Now, it will be recalled that the Disney Principle is essentially negative, in terms specifically of constraints imposed by the laws of nature on the (nomologically) possible ways that an object can satisfy a particular description (Block 1997, 120). Notice that there are two aspects of the Disney Principle: the nomological and the descriptive. A Disney Cluster is the nomological correlate; it is the set of *properties* necessary in order for the object to satisfy that description. A Disney Cluster is thus the ontological base for kind-predication.

An ontological cluster of properties, however, is not sufficient for kind-predication. Kind-predicates are applied in light of the causal relations that objects can enter into. Causal relations, as noted above, are properties of ordered sets, but kind-predicates are unary. In this way, kind-predicates are very similar to power-predicates. In fact, consider that power-predicates consist in infinitely sized groups of potential-causal predicates. Power-predicates conflate genuine predicates and the causal predicates in whose extension an object falls as determined by the object's physical properties. Finally, kind-predicates are applied in virtue of both applicable power-predicates and generalizations across immediately observable properties. In short, kind-predication is based on clusters of genuine predicates and power-predicates, which in turn are based on the causal relations that an object can enter into in virtue of its Disney Cluster. The cluster of genuine predicates and power-predicates correlates with the descriptive aspect of the Disney Principle.

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[25]It might not be necessary for all the properties in the set to be underlying.

The ontologically necessary and sufficient conditions for applying a kind-predicate to an object comprise a Disney Cluster. A Disney Cluster is the set of underlying physical properties that partitions the set of causal relations into those the object can enter into and those it cannot. Causal predicates, which are determined by the object's Disney Cluster, are implicit in power-predicates. Together, power-predicates and genuine predicates determine which kind-predicate is applicable to the object.

Predicates-of-Kinds

Predicates-of-kinds are, as one might surmise, predicates generally applied to kinds. I will show that predicates-of-kinds are similar to kind-predicates in that often they too consist in clusters of lower-level predicates. The composition of predicates-of-kinds, however, can vary considerably from one predicate to another. Some predicates-of-kinds are simply genuine predicates attributed to objects falling within the extension of kind-predicates:

(3.27) *x* are orange and black striped

is a predicate-of-kinds when it is used of objects falling within the extension of a kind-predicate. For example,

(3.28) Tigers are orange and black striped

as opposed to

(3.29) Those two objects are orange and black striped

Many genuine predicates-of-kinds serve as general indicators of when a kind-predicate should be applied, although they might not stand in a law-like relation to the kind-predicate. Often one is taught from kindergarten that tigers are orange and black striped,

(3.30) If *x* is a tiger, then *x* is orange and black striped

But (3.30) is not a law-like relation, as the white tigers of Bengal have shown.[26]

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[26]This might give one pause for thinking that 'for all *x*, if *x* is a raven, then *x* is black' is a law. It might be an accidental generalization based upon white ravens going extinct prior to recorded history.

Also, it might be mentioned, the generalization made in the other direction does not give a law-statement either, although it too can guide kind-predication:

Some predicates-of-kinds, however, consist in Special Clusters, clusters of lower-level predicates, *viz.,* genuine predicates, mere-Cambridge predicates, and power-predicates. Above, I said that predicates-of-kinds are *generally* applied to objects falling within a kind-predicate's extension, but sometimes predicates-of-kinds are applied to particulars falling within the extension of kind-predicates. What distinguishes a predicate-of-kinds from normal everyday predicates is the condition of either being applied to kind-predicated objects or consisting in Special Clusters. I shall give two examples of predicates-of-kinds that consist in Special Clusters. The first contains within it predicates that appear in law-statements, and the second does not.

Suppose there is a gas *g* which has a pressure *P* and which is in a container *c*. Notice that pressure is not an intrinsic property of the gas. Rather, it is a result of a causal relation between the momentum of each particle in a container and the physical properties of the container itself. Thus, attributing pressure to a gas falls under the rubric of a mere-Cambridge property. If the container changes, does the pressure of the gas change? In some sense, yes, but pressure is only a statistical notion. At the particle level, nothing has changed: particles move at the same velocity, have the same size, etc. Presumably, the gas is nothing over and above the individual particles of which it is comprised; if so, the gas itself has not actually changed. So, pressure, while a pragmatically useful notion (as will be discussed in the next section), is a mere-Cambridge predicate.

The notion of fitness, though not law-like, is similar. Here, it will be helpful first to distinguish between the following two predicates:

(1.2) *x* is biologically fit

(3.32) *x* has an internal degree of fitness ($D^f x$) value of *y*

such that $0 \leq y \leq 1$. Finally, suppose that there is an kind-predicate *Ox*, where objects falling within the extension of *Ox* are often said to be members of the kind *O*.

(3.31) If *x* is an orange and black striped feline-featured beast, then *x* is a tiger

It is not a law-statement, for presumably one can genetically alter a leopard to appear orange and black striped. Since statements like (3.31) are generally true, such features as being orange and black-striped guide the application of a kind-predicates.

First, a word about biological fitness. According to Elliott Sober, the "overall fitness," F, of an organism x can be given by the equation, $F_x = eP(x)$, where e is a measure of an organism's fertility, that is, an organism's expected number of offspring, and $P(x)$ is a measure of its viability, the probability that the organism will in fact reach adulthood (Sober 2001, 309). First, 'expectation' is a technical term that refers to "roughly, the (arithmetic) average number [of offspring] that the individual would have if it got to live its life again and again in identical circumstances" (Sober 2001, 310). Second, an organism's viability is a function of how well the organism can cope in its environment (Sober 2001, 309). If o_1 is expected to have 2.25 offspring and has a probability of .70 of surviving to adulthood, then o_1 has a fitness value of 1.575. "*Fitness*," according to Sober, "*is both an ecological descriptor and a mathematical predictor*." (1.2) requires this understanding of 'fitness'.

Next, I shall turn to what I am calling the 'degree of fitness' ($D^f x$). The $D^f x$ value is a numerical value that represents an organism's viability in virtue of only its phenotypic traits. Since the $D^f x$ value will hold across an infinite number of possible environments, epistemologically determining the $D^f x$ value for an organism a can be done counterfactually. Suppose that $D^f a = .50$ and that there are several environments $\{E_1, E_2, \ldots, E_n\}$ into which a might have been placed. E_1, a paradise of tranquility, has an abundance of fine food and mating opportunities, such that surviving and producing offspring in E_1 requires only that $D^f a \geq .10$; therefore, if a were placed in E_1, then (1.2) would most likely be true of a. E_2, however, is harsh; food is scarce and potential mates are rare and not particularly alluring when they do show up. Since being fit in E_2 requires that $D^f a \geq .90$, if a were placed in E_2, the organism would likely not survive long enough to produce offspring; that is, in such an environment, a would fail to be fit. Finally, if a were placed in E_3 and E_3 requires that $D^f a \geq .40$, then a will likely get a run for its money, but eventually it will reproduce. In short, a's $D^f x$ value arises from a collection of ontological properties internal to a; whether or not a is fit is a function of a complex interaction between a's phenotypic traits and environmental conditions (see Rosenberg

1978, 371); and whether or not *a* is fit can be *discovered* only if *a* produces offspring. So, while *a*'s being biologically fit entails that *a* has some $D^f x$ value, the converse is not true.

What is important to see, then, is that while (1.2) and (3.32) both denote biological predicates-of-kinds that are closely related, they do not both possess among their constituents mere-Cambridge predicates. (1.2) consists in a cluster of genuine predicates and power-predicates in a way quite similar to kind-predicates. The power-predicate in (3.32), however, is a bit easier to determine. Similar to a key, an organism has a particular set of internal properties, and like the key whose properties allow it to open any one of a potential infinite number of locks, the properties in the organism give rise to the organism's ability to survive in a large (perhaps infinite) number of potential environments. But, similar to the key illustration, being able to survive in an infinitely large set of potential environments just is what it means to possess a certain set of internal properties. Therefore, ontologically speaking, the $D^f x$ value is simply a numerical value placed on a cluster of certain internal properties. Epistemologically, the $D^f x$ value allows one to expect the organism either to survive or to fail to survive in a particular environment.

Notice that while no environmental changes affect the $D^f x$ value, the environment can change such that (1.2) is true of an organism *a* at t_1 but false of *a* at t_2. (1.2) is true *only* in virtue of $D^f a$ *and* the particular environment in which *a* finds itself. Therefore, (1.2) possesses mere-Cambridge predicates in its Special Cluster. Changes in the environment alone that make (1.2) false of *a* are mere-Cambridge changes, but they have causal effects. A change in the environment can change whether *a* is likely to survive or not. Therefore, predicates-of-kinds like (1.2) conflate predicates-of-kinds like (3.32) with mere-Cambridge predicates. In the end it appears that predicates-of-kinds rely crucially upon the mere-Cambridge form of causal predication. In the next chapter, I will show why viewing causal relations in mere-Cambridge form is advantageous in our world

Conclusion

As stated in the first chapter, my intent is not so much to show that Reductionism is true, but to give an account of the predicates used in special sciences. In the second chapter of this thesis, I described Ned Block's argument according to which kind-hood is graded and relative to particular special sciences and that kinds are not causally efficacious. Consequently, I concluded, kinds themselves are not ontological entities. In order for the reductionist to be successful, however, he or she must not only reduce kind-predicates, but reduce predicates that seem to denote properties peculiar to special sciences. Therefore, this chapter has consisted in an analysis of both kind-predicates and predicates-of-kinds.

I began with a discussion of mere-Cambridge-ness. Simply put, the form of unary predicates is forced to do considerable work. They must represent both ways of being and ways of being a way, a difficulty which I have termed 'formal ambiguity', and mere-Cambridge-ness gains its traction on the formal ambiguity of predicates. Linguistically, there is no difference between a genuine predicate and a mere-Cambridge predicate. And yet, surely mere-Cambridge predicates are non-genuine. I showed that mere-Cambridge predicates occur when a binary predicate has the name of a single object fixed "creating" a unary predicate. As a result, if the object whose name is fixed changes, then the mere-Cambridge predicate is true at one time of the instantiated object and false of that object at a later time.

With this analysis of mere-Cambridge-ness in hand, I turned to the notion of causal powers. I showed that power-predicates are essentially mere-Cambridge predicates but with a deceptive side. A power-predicate is essentially a relational predicate in which the name of a particular object is fixed in place of one of the variables. The relations that power-predicates employ, however, are causal relations, and it is under the coattails of causation that deception lurks. For, if the object whose name is fixed in the power-predicate changes such that the predicate is true of the instantiated object at one time and false of it at a later time, then the instantiated object seems to have really lost an amount of causally efficacy. Nonetheless, I argued, power-predicates do not denote actual properties of an object, but conflate genuine predicates of an object and the causal relations the object can enter into as a result of having those genuine predicates. Powers themselves are ontologically identical with physical properties.

In the final section of the paper, I took up the notions of kind-predicates and predicates-of-kinds. To put things succinctly, kind-predicates consist in clusters of genuine predicates and power-predicates. The properties that provide the ontological base for power predication, and thus for the application of kind-predicates, I called 'Disney Clusters'. It is in virtue of having certain properties in its Disney Cluster that a power-predicate is applicable to a particular object. Predicates-of-kinds, on the other hand, consist either in genuine predicates applied to objects to which kind-predicates are applied or, somewhat similarly to kind-predicates, in clusters of genuine predicates, mere-Cambridge predicates, and power-predicates. In the following chapter, I will show that it is adaptive to view the world through the lense of kind-predicates and predicates-of-kinds.

CHAPTER IV
NATURAL PREDICATION

If kinds are non-existent, except perhaps at the level of physics, why do special predicates seem to describe the world accurately? The present chapter is an attempt to answer that question. In the last chapter, I argued that special predicates in fact have an ontological base, *viz.,* clusters of physical properties that partition the set of all possible causal relations into relations the object can enter into and those it cannot enter into. The set of physical properties that determines which causal relations an object can enter into and that provide the grounds for kind-predication, I have referred to as a 'Disney Cluster'.[27] So, similarity of Disney Clusters will yield similarity of causal effects, and kind-predicates are applied to an object based upon these causal effects.

Going further, Hume has pointed out however that two objects *a* and *b* can be dissimilar, although they nonetheless have similar causal effects upon an object *c*. For example, the cue ball can cause the eight-ball to move along a certain line AB at a certain velocity *v*. But the eight-ball's moving along AB at *v* does not entail that it was struck by a cue ball, or even a pool ball at all. Likewise, perceived similarity of effects is insufficient to establish that two objects' respective Disney Clusters are similar. It is, however, often *useful* to classify together distinct Disney Clusters if their causal effects are similar within a certain somewhat stable environment. This causal-classification, I believe, is just the sort of thing humans engage in, and the usefulness of this classification in the world gives rise to special predicates. The upshot so far, then, is this: Objects with similar Disney Clusters will fall within the extension of a particular kind-predicate; Disney Clusters guide kind-predication by determining which of certain causal relations an object can enter into; and similarity of causal efficacy is often a useful means for classifying objects in the world,

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[27]As in the last chapter, I shall continue to take modal issues to be in terms of nomological necessity. Therefore, I take it that an internal, physical property's particular partitioning the set of causal relations holds across all nomologically identical worlds; and thus counterfactual relations do not affect the partitioning itself.

although the objects might in fact be dissimilar with regard to their respective Disney Clusters.

I shall show in this chapter that kind-predicates and predicates-of-kinds seem to describe the world accurately for they provide an advantageous means of understanding the world, and this means of understanding begins prior to consciousness. Consequently, the present chapter stands at the nexus, as it were, of cognitive science and special science. But instead of viewing cognitive science as a science falling under the rubric of a special science (which of course it does), I shall look at special science in light of the findings of cognitive science, specifically psychophysics.

The layout of the chapter goes like this: I first look at empirical evidence that seems to indicate that the mind, at the point of perception, categorizes the world in certain selectively advantageous ways. Call this sort of categorization 'categorical perception' (CP). Then, I will argue that categorizing relations (especially causal relations) similarly is also advantageous. It will be important to show how this categorizing of causal relations might occur, and so I will argue that it is an extension of categorizing particulars. Finally, I will argue that categorizing causal relations gives rise to power-predicates and categorizing non-causal relations gives rise to mere-Cambridge predicates. And it will be recalled from the last chapter that power-predicates and mere-Cambridge predicates give rise to the special predicates. So, having given reason in the first two chapters to maintain a minimal physicalist ontology which includes only particulars, physical properties (assumed to be without universals), and causal relations (again, with no universals), this chapter consists in a look at the role the selectively advantageous mind plays in special sciences.

Perceiving Categorically

Central to this chapter is the phenomenon of so-called categorical perception (CP), a process at the point of perception in which objects begin to be sorted into cognitive categories. Since I will be arguing that kind-predication and predication-of-kinds begin with CP, I will turn first to just what CP is.

CP is a phenomenon first observed in psychophysical experiments concerning the perceptions of color and speech sounds (Harnad 1987, 2), in which regions of a continuously varying physical stimulus are discriminated and identified (or labeled). Richard Pastore has provided a list of necessary criteria for CP (Pastore 1987, 32):

(4.1) Distinct labeling categories with sharp boundaries

(4.2) Regions or 'troughs' of chance performance in discriminating stimuli drawn from the same labeling category

(4.3) A discrimination performance peak at the category boundary

(4.4) A close correspondence between the actual discrimination performance and discrimination performance predicted from the labeling results based on the assumption of absolute categories

Consider, for example, that a human subject can visually detect a range of electromagnetic energy, roughly between 400 and 700 nanometers (Bornstein 1987, 287). If a subject is presented with a visual stimulus consisting in an evenly graduated continuum from 400 to 700 nanometers, she will discriminate and label regions, called 'hue categories', of that continuum (Bornstein 1987, 287). When asked to describe the various regions of the continuum using only the words 'red', 'yellow', 'blue', and 'green', there was high agreement between subjects upon where the boundaries between the colors fall (Bornstein 1987, 287).

At the center of the study of the phenomenon of CP are three issues: discrimination, categorization, and universality (Bornstein 287, 289-91). First, discrimination has to do with how much difference between two stimuli are necessary for an observer to notice the distinction. In the case of light, the distinction might be in terms of wavelengths (Bornstein 1987, 288). Call the points of reported discrimination ' '. To determine , a subject might be exposed to two fields of identical colors set side-by-side. While controlling for saturation and brightness, the wavelength of one of the fields is altered until the subject responds that she has noticed a difference between the two fields. When this experiment has been performed with color-normal trichromat adults, there are usually 120 to 150 s across the spectrum (Bornstein 1987, 288). It seems, therefore, that under normal conditions humans can keenly perceive distinctions between color stimuli.

Second, categorization has to do with whether subjects observe "qualitative similarities" when presented with an assortment of stimuli and asked to categorize them (Bornstein 1987, 288). For example, a subject might be presented with a spectral continuum that varies uniformly from one end to the other and asked to apply certain color labels to regions of the continuum, as described above. Near the edges of the individually labeled regions, discrimination between wavelengths is better than discrimination between wavelengths closer to the center of the category regions (Bornstein 1987, 289). Thus, one pair of stimuli will often be judged to be identical and another pair will be judged to be distinct, although the distance within one pair is quantitatively identical to the distance within the other. What makes the difference is how close the pair is to the boundary of a region.

Finally, there is the issue of universalism versus relativism. In his influential book *Language, Thought, and Reality* (1964), Benjamin Whorf argued that language shapes the way observers view the world; since language is a convention, one can view the world only relative to her community. This claim is often referred to as the 'Whorfian hypothesis', and it bears directly upon issues of CP. For, if one's view of the world is constrained by language, then, in the case of color stimuli, for example, should be community-relative. As it turns out, however, such is not the case. When asked to use only 'red', 'yellow', 'blue', and 'green', not only is there is little variation across subjects, there is very little variation across cultures; that is, most subjects agree on the basic colors' boundaries within the spectral continuum (Bornstein 1987, 288-90). What is more, infants and animals that are able to perceive color seem to divide the spectral continuum into hue-categories that are similar to the four-color partitions put forward by adult humans (Bornstein 1987, 290-1). Therefore, it seems that discrimination and categorization both occur somewhere prior to language. In the next section, I will consider perceptual categorization as it relates to higher-order categorization.

CP Universals

As mentioned in the second chapter, Ned Block drew from Roger Shepard's "Perceptual-Cognitive Universals as Reflections of the World" in order to argue that higher-level kinds can be multiply realized by heterogeneous disjunctions (Shepard 1994; cited by Block 1997, 124-6). In the present section, I want to argue that other equally plausible conclusions can be reached using the same data set. Then, in the final section, I will show how this other interpretation shows that kind-predicates and predicates-of-kinds are natural results of a biologically adaptive mind existing in the world.

The crux of Shepard's article is that the mind categorizes the world in advantageous ways, and what makes this means of categorization advantageous is that the principles (C-principles) along which perceptual categorization occurs often mirror the laws of nature. In order to show this, Shepard considers various examples, two of which are of particular importance for the present thesis: apparent motion of an object and apparent membership in a kind. I turn to the former first.

Apparent Motion

The first C-principle having to do with the motion of objects that Shepard puts forward can be summarized thus (Shepard 1994, 4-5):[28]

(4.5) Apparent motion conserves the object in three-dimensional space

The phrase 'apparent motion' is used to refer to an observer's experience of an object in motion, such that the experience is a "direct reflection of the organizing principles of the viewer's brain" despite no physical motion actually being perceived (Shepard 1994, 3). For example, when presented with only two alternating stimuli (see Fig. 4.1a) a subject will typically perceive the pair of stimuli as if they were a single object "rolling" back and forth (Shepard 1994, 4). Similarly, if a subject is presented with only two alternating stimuli (see Fig. 4.1b), she will usually perceive them as if they were two sides of a single

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[28]Shepard presents this principle under two headings (*viz.,* "Apparent Motion Achieves Object Conservation" and "Apparent Motion is Experienced in Three-Dimensional Space"). I believe that integrating them into a single principle, however, does no violence to Shepard's interpretation.

disk that actually "flips over" in three-dimensional space thereby revealing the other side (Shepard 1994, 4-5). Each of these experiments are confirming instances of the C-principle expressed in (4.5). Furthermore, (4.5) mirrors the law of nature that physical objects move in three-dimensional space and typically conserve their shape.

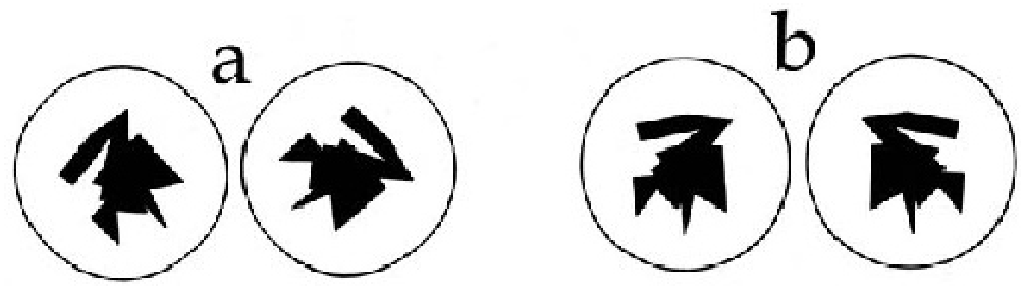

Fig. 4.1. Alternated Shapes. Pairs of alternately presented visual shapes that give rise to two different types of apparent motion: *(a)* a rigid 90 degree rotation in the picture plane, and *(b)* a 180 degree rotation out of the plane and through three-dimensional space (Reproduced from Shepard 1994, 4).

While the first C-principle discussed has to do with conservation aspects of the object itself, the second has to do with the path an object is often expected to traverse (Shepard 1994, 5-9):

(4.6) Apparent motion travels along the simplest path as determined by kinematic geometry

Prima facie, a discrepancy *vis-à-vis* this C-principle occurs between Shepard's conclusion that categorization principles reflect natural laws and what the data reveal. Kinematic geometry is concerned with characterizing geometrically possible motions (without consideration of such things as how much work is required to move the object and the role friction will play) (Shepard 1994, 6). The simplest path as determined by kinematic geometry, however, very often is not the only path an object can take as determined by the principles of Newtonian mechanics. Take for example the object depicted in Fig. 4.2. Apparent rotation around an axis usually favors an axis of geometrical symmetry, although it differs from an equivalent axis of inertia (Shepard 1994, 6).

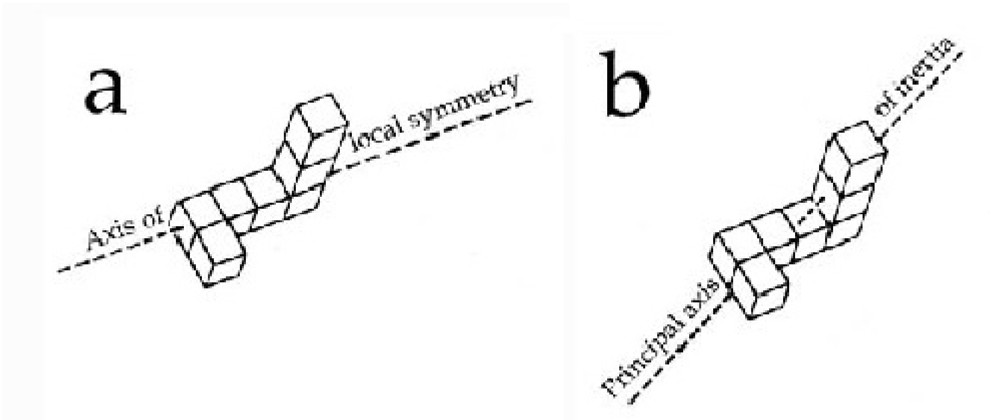

Fig. 4.2. Axes of Geometrical Symmetry. *(a)* favored by apparent motion and *(b)* avoided by apparent motion (Reproduced from Shepard 1987, 6).

In order to account for the discrepancy between (4.5) and Newtonian mechanics, Shepard draws upon two principles. First, by utilizing the abstract principles of kinematic geometry, kinematic calculations can be applied to more objects more quickly (Shepard 1994, 6). Second, there is Chales's Theorem according to which:

> any two positions of an asymmetric shape in three-dimensional Euclidean space determine a unique corresponding axis through that space such that the object can be rigidly transported from either position to the other by a combination of a linear translation along that axis and a simple rotation about that same axis–that is, by the helical motion called a *screw displacement* [italics, his].

Thus, by means of screw displacement, a rigid object can be moved and rotated along a single axis to another predetermined asymmetrical position. Together, then, by employing kinematic geometric principles and Chales's theorem, the human mind is able to calculate the motion necessary to move a multitude of rigid objects. Again, since the majority of objects that bear upon survival are rigid and since being able to manipulate rigid objects allows for adaptability, it seems clear that despite their differing with Newtonian mechanics, C-principles are highly advantageous.

<u>Apparent Kinds</u>

The second of Shepard's examples in which I am interested is the representation of an object's kind (Shepard 1994, 22 - 6). What is particularly striking about perceiving kinds is perceiving two objects as both distinct and members of the same kind. As Shepard points out, perceiving two objects as being members of the same kind stems not from a failure to discriminate between two objects but to generalize from one object to another based on presumed consequences (Shepard 1994, 22). For example, if a subject experiences a certain desirable consequence as a result of interacting with an object, then the subject will likely infer that interactions with objects of the same kind will also yield desirable consequences (Shepard 1994, 23).

So, along what axes of comparison does kind-generalization, as it were, occur? Shepard describes it as a comparison of functions along a continuous region of representational space (Shepard 1994, 23-6). If two objects *a* and *b* are of the same kind (*i.e.,* have the same expected consequences), then between the two points representing *a* and *b* there is a continuous region such that if *a* were somehow transformed into *b*, there would be no point at which *a* was not a member of the kind in question (Shepard 1994, 23). Drawing from previous experimental data in which CP had been tested for colors, Shepard shows how both humans and pigeons generalize *vis-à-vis* representational space (see Fig. 4.3). As the distance between two points increases, there is an exponential decrease in generalization (Shepard 1994, 23-4). Therefore, Shepard concludes, generalization of kinds is based on the potential for certain consequences; the closer the consequences in representational space, the more likely they are to be members of the same kind (Shepard 1994, 26).

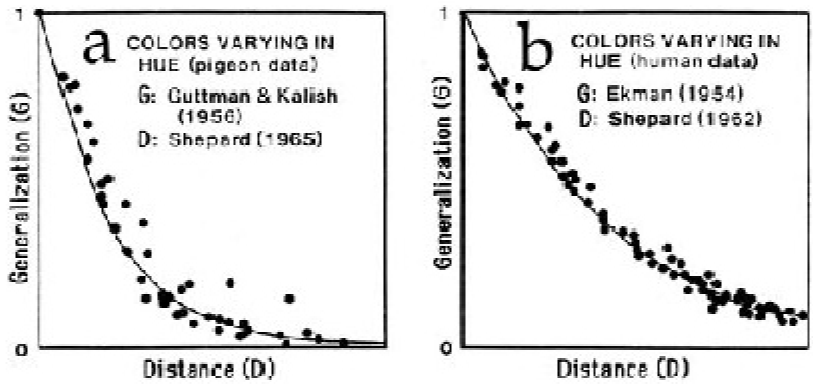

Fig. 4.3. Generalization Gradients. Generalization gradients for spectral hues obtained by applying multidimensional scaling to human and animal data: *(a)* based on the solutions obtain by R. N. Shepard (1965) for the pigeon generalization data collected by Guttman and Kalish (1956), and *(b)* based on the solution obtained by R. N. Shepard (1962) for the human similarity data collected by Ekman (1954) (Reproduced from Shepard 1987, 23).

Natural Predicates

It will be helpful to recap what has been shown thus far. First, I discussed the psychophysical study of categorical perception, in which despite being given a continuously varying stimulus, a subject will discriminate regions within the continuum and will categorize particular instances within the continuum in terms of these regions. In the first section, I considered Bornstein's work regarding CP in terms of color perception. When subjects are exposed to a spectral continuum and asked to label regions within the continuum with the words 'green', 'yellow', 'red', and 'blue' they will do so with high agreement both in terms of which regions receive which colors and where the borders of the regions are located. Furthermore, the ability to discern differences in wavelengths is keener for wavelengths near the borders of regions rather than near the center of the region. Finally, where the borders of spectral regions appear to fall is not language or culture specific, but seems to be universal and thus is perhaps a result of evolutionary processes in the world.

In the second section, I turned to Shepard's work in which objects known to be two-dimensional appear to be three-dimensional when considered in terms of motion, and other objects are categorized into kinds based upon consequences of interacting with them. Whether in terms of apparent motion or categorizing by kinds, it appears that these processes, like the spectral CP phenomenon, are the result of evolutionary development.

In this final section, I shall apply the findings of CP theory to the notion special predicates, and I will argue that Shepard's findings do not necessarily support Ned Block's assertion that kinds can be multiply realized by heterogeneous disjunctions. Rather, I shall argue, Shepard's findings only show that it is advantageous to think of objects as being members of kinds.

A couple of remarks concerning Shepard's article will be a useful starting point. It should first be pointed out that Shepard does not offer the results of his study as support of the existence of kinds. Rather, he simply assumes their existence and expands the criteria of kind-hood to include both natural kinds and what he terms "basic kinds" which includes bowls and chairs for humans and burrows and nests for animals (Shepard 1994, 22). Consequently, whatever conclusions Block draws from Shepard's data Block must either admit that chairs and nests are kinds or he must demarcate between natural kinds and basic kinds on grounds other than projectibility.[29] I do not know if the inclusion of basic kinds and natural kinds is particularly worrisome for Block, but it seems to suggest that his criteria for kind-hood might be too weak.

Second, Shepard claims that kind-predication is "more fundamental and ubiquitous" than recognizing colors and spatial distances (Shepard 1994, 22). Indeed, viewing colors and spatial distances are insufficient to recognize whether or not something falls within the extension of a kind-predicate. It seems, however, that it might be necessary. For, consider that the only alternative basis for kind-predication Shepard provides is the consequences an object has for the observer (Shepard 1994, 22). If Shepard were right about this, then kind-predication would require the observer to suffer

[29]The line dividing natural kinds and basic kinds must be based on something other than projectibility, for '*x* is a nest' seems just as projectible as '*x* is a tiger'.

the consequences of each object *before* she could apply a kind-predicate to it, in which case kind-predication would have died off with the first generation of kind-predicating organisms. Therefore, it seems that applying a kind-predicate to a particular object requires the use of generalizing across features, even if in some instances of kind-predicable objects are not similar with regard to those features. And thus I suggest that kind-predication is not more fundamental than color discrimination and apparent motion.[30]

Kind-predicates and predicates-of-kinds seem to describe the world accurately for two reasons: these predicates provide an advantageous means of understanding the world, and this means of understanding begins prior to consciousness. Notice first that the phenomenon of spectral CP shows that given a wide array of stimuli, cognizers naturally categorize that stimuli at the point of perception. It seems perfectly plausible that such categorization is important for the survival of animals. As argued above, whether or not a kind-predicate applies to an object is likely determined to some degree by features such as color. But without categorization, recognizing colors would be too large a task to be useful. A means of categorizing colors quickly is important if colors are to be selectively advantageous. Now, metaphysically speaking colors might or might not be genuine properties of objects. But notice that whether colors are in the objects or, with Locke, simply the way observers experience some structural property of the object is irrelevant to questions of selection and adaptation. Similarly, the selective role of colors does not bear upon whether colors have ontology. What is important is that observers are able to quickly determine which color-predicates are applicable in various instances.[31] That this color-categorization occurs prior to conscious awareness and is selectively advantageous gives the (again, useful) illusion that colors are in the world and even perhaps that they exist in clustered spectral regions.

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[30]I shall say more about this below.

[31]It should perhaps be mentioned that by ‘color-predicate’ I do not mean that the observer must possess a language, but only that an observer can discriminate between and recognize colors across instances. The same will be true for most such physical predicates.

Second, consider the issue of apparent motion. As Shepard has argued, it is likely advantageous to view moving objects as rigid entities. Therefore, even when presented with stimuli that merely seems similar to rigid movement, observers "fill in" the missing data and thus perceive apparent motion. Again, though, one's being appeared to with rigid motion, even if doing so is selectively advantageous, does not indicate that that motion is actually occurring in the world. I of course do not deny that motion occurs in the world, but it is often useful to behave as if motion is occurring when it is in fact merely apparent.

Third, the use of kinetic geometry rather than Newtonian mechanics is another pointed example. It is selectively advantageous to be able to calculate quickly the trajectory that an object expected to move might take and to be able to make such calculations for a wide array of objects. Although one might expect such calculations to match Newtonian mechanics, they are closer to the calculations in kinematic geometry. Again, that viewing the world in terms of kinematic geometry is selectively advantageous does not mean the world itself operates by the laws of kinematic geometry. In fact, we know that it is more inclusive.

Finally, consider the issue of kind-predicates and predicates-of-kinds. Kind-predicates and predicates-of-kinds consist in clusters of genuine, physical predicates and mere-Cambridge predicates.[32] It will therefore be important to discuss how the use of each of these types of predicates aids in survival.

Consider first the issue of physical predicates. The difficulty with physical predicates is that many organisms can fail to share any number of a set of physical properties and yet fall within the extension of the same kind-predicate. As mentioned above, Shepard has taken this to mean that kind-predicates are more fundamental than physical predicates with regard to classification. Empirical evidence suggests otherwise: one is able to determine quickly whether or not an object falls within the extension of a certain kind-predicate without having to experience the consequences of interacting with it. That is, by observing only a few characteristics that are not peculiar to an object can

[32]By 'physical predicate', I mean predicates that pick out physical properties that are internal to the object.

one determine which kind-predicate is applicable. What seems peculiar to objects within a specific kind-predicate extension is the *set* of physical predicates that are applicable to it. Again, though, Shepard's worry arises. Many objects falling within the same kind-predicate extension do not have the same set of physical predicates. It therefore seems like the following must be the case: sets of physical properties *guide* kind-predication. What makes a particular instance of kind-predication correct is the causal relations the object can enter into as determined by its Disney Cluster. Finally, what likely allows the use of a kind-predicate in a particular instance in which the object is very atypical is having an explanatory story to accompany kind-predication. Through experience, one learns that objects that fall in the extension of a particular kind-predicate can suffer certain changes. Moreover, what sorts of changes a certain kind-predicable object can suffer is also learned. So, even if one is presented with an object that is quite distinct from members falling within the extension of a kind-predicate, by observing a set of physical properties and having experience to draw from, one can often accurately attribute a kind-predicate to an object atypical in appearance.

Second, as I argued in the last chapter, and as Shepard implies, kind-predicates are essentially relational (Shepard 1994, 22). For, whether or not an object falls in the extension of a kind-predicate is largely determined by which causal relations one believes that the object can enter into. Since kind-predicates are unary and causal predicates are binary, I argued in the last chapter that kind-predicates are comprised partially of power-predicates. Recall that mere-Cambridge predicates consist in a relational predicate in which one relatum is fixed. What makes power-predicates a distinct form of mere-Cambridge predicates is that the binary relation in which power-predicates consist is a causal predicate. So, put another way, power-predicates are causal predicates in mere-Cambridge form. Therefore, I concluded in the last chapter, kind-predicates consist in clusters of genuine predicates and power-predicates. I shall now discuss why, based upon CP and Shepard's findings, power-predication and thus kind-predication and even predication-of-kinds is selectively advantageous, although kind-predicates and predicates-of-kinds are not genuine. Before discussing kind-predicates and predicates-of-kinds themselves, it will be useful to discuss the utility of mere-Cambridge predicates in general.

It is a truism that in order for a predicate to be generally useful, the world must be a certain way; it need not be exactly as the predicate seems to indicate, but it must be pretty close. If mere-Cambridge properties are relational predicates in which the name of one relatum is fixed, and if such predicates are to be useful, then the relatum whose name is fixed must be relatively stable. Otherwise, it would be of no value to fix its name.

The next thing to notice is that by fixing the name of one of the relata, calculating the developing relation between the two relata becomes much more manageable. This is easy to see by drawing an analogy to a multi-variable mathematical statement. By holding more variables constant, the other values become easier to determine. In an environment, which "variable" is held constant will depend upon the circumstances in which the organism finds itself, but generally the fixed variable will be instantiated with the name of whichever relatum is perceived to be the more stable at the time. Now, attempting to fix the more stable relatum's name will possibly require switching back and forth between which relatum gets fixed. So, the idea, then, is this: by fixing the name of the more stable relatum in the appropriate relational predicate (as determined by the circumstances), an organism can make quick calculations regarding the other relatum; by switching between which relatum is fixed, the organism can quickly make calculations as circumstances develop. Therefore, the ability to refer using mere-Cambridge predicates is shown to be quite advantageous. Since causal relations are likely the most selectively significant relations, then power-predicates–mere-Cambridge predicates in which the relation is causal–will be among the most useful predicates available.

Mere-Cambridge Predication in the Special Sciences

As human observers, scientists have various means of detecting and thus classifying objects. Moreover, they are consciously aware of the classifications. What human observers in general are not aware of is why these classifications are made. I submit that as indicated by CP and Shepard's findings, classifications are made prior to consciousness, and certain classifications are made because they are selectively advantageous. Kind-predicates and predicates-of-kinds directly result from this advantageous method of classification.

Consider first kind-predicates. As discussed in the last chapter, whether or not an object falls within the extension of a kind-predicate depends upon the sorts of causal relations the object can enter into. Which kind-determining causal relations can be instantiated, however, is a function of the Disney Cluster and the physical properties of another object. Shepard's findings show that humans naturally classify objects according to kind-relevant causal relations. Since, as mentioned above, being able to categorize quickly objects by their causal relations is advantageous, it is often desirable to view objects in terms of causal predicates in which one relatum is fixed. Since, furthermore, such categorization is advantageous in our environment and occurs prior to consciousness, power-predication can appear to accurately represent the world. By clustering power-predicates and Disney Clusters, kind-predicates become very useful.

Turning to predicates-of-kinds, consider the two examples mentioned in the last chapter. First, what makes a gas *g* have a certain pressure *P* is not merely the physical properties of the particles that comprise it, but also the container in which it is held. By holding the name of the container as a fixed relatum in a causal predicate, one can quickly refer to *g* as having a certain pressure *P*, perhaps thereby avoiding disaster, without having to detail the relation between the gas and the container. Similarly, one might remark that *g* has the power to cause a large explosion if the pressure exceeds a certain point *r*. Again, such talk is most useful if the properties of the container remain fixed.

The second example, being biologically fit, is similar to the pressure predicate. Whether or not an organism is biologically fit is, as was argued in the last chapter, determined by the relation between phenotypic traits of an organism and the environment in which the organism finds itself. To speak of an organism as being simply biologically fit is to apply to the organism a mere-Cambridge property. As long as the environment is not expected to change greatly, however, then it is often useful to speak of an organism as being fit, *simpliciter*.

The moral of the present chapter is this: As CP and Shepard's findings indicate, there are times when it is more advantageous to perceive the world in a certain way, although the perception is not, all told, accurate. Something similar, I have attempted to show, occurs in the case of special predicates. Although kind-predicates and predicates-of-kinds consist in mere-Cambridge predicates, they are useful because of the stability of Disney Clusters and the stability of our environment. This stability is what allows one to apply special predicates to objects of observation.

Conclusion

The purpose of this thesis has not been to argue that Reductionism is true, but to show that kind-predicates and predicates-of-kinds are reducible, and that special predication stems from selectively advantageous ways of conceiving of the world. In the first chapter I introduced the notion of Reductionism and argued that if Reductionism is to succeed, then kind-reductionism and predicate-reductionism must both succeed too. In the second chapter, I presented the point at which my thesis enters the discussion in terms of Ned Block's response to Jaegwon Kim's reductionist argument. Basically, I agreed with Block's conclusion that kinds are essentially an issue of terminology, but I think he does not take his conclusion far enough. If whether or not kind-predicates are applicable in a certain instance is a matter of terminology, then it seems that kinds themselves are not ontological categories in the world.

In the third chapter, I presented a taxonomy of both kind-predicates and predicates-of-kinds. Both types of predicates, I argued, consist in clusters of physical predicates, power-predicates, and mere-Cambridge predicates. I showed that mere-Cambridge predicates are non-genuine (*i.e.,* they do not pick out genuine properties) for they are composites of first-order predicates and relational predicates. In short, mere-Cambridge predicates are relational predicates that appear to be first-order predicates, and therefore do not denote a genuine property. I showed also that power-predicates are mere-Cambridge predicates in which the contained relational predicate is causal. For the same reasons that other mere-Cambridge predicates are non-genuine predicates, power-predicates are non-genuine, too.

If kind-predicates and predicates-of-kinds are non-genuine, then why does it seem that they accurately describe the world? I took up this question in the present chapter. Simply put, what makes these types of predicates useful are the facts that their application depends upon Disney Clusters, clusters of physical properties by which objects are categorized into the extensions of special predicates, and that the environment is relatively stable. Because it is selectively advantageous to be able to categorize objects and to perform calculations quickly, mere-Cambridge predicates are often useful. So, I presented findings according to which, cognizers in general categorize the world in certain ways prior to consciousness. As it turns out, the findings of cognitive scientists, specifically in the areas of categorical perception, seem to provide strong reasons to think that kind-predicates and predicates-of-kinds, although non-genuine, provide an particularly adaptive and selectively acquired lens through which the world is viewed. The sciences that make use of these predicates, then, work not so much because they accurately describe the world, but because they describe the world in ways that are useful to humanity.

CHAPTER V

EPILOGUE: PROCESSES AND PREDICATION

What determines whether an object falls within the extension of a kind-predicate is the set of causal relations it can enter into. Similarity of possible causal relations determines similarity of kind-predication. Furthermore, one kind-predicate is distinguished from another by *dis*similarity of possible causal relations. Now, as mentioned in a previous chapter, Ned Block states at the close of "Anti-Reductionism Slaps Back" that since kind-hood is relative and graded, kinds are not the "key to causation" (Block 1997, 129). Indeed, Block is probably right. But causation might be the key to kinds. In what follows, I explore this possibility in light of a particular process theory of causation, and then I sketch a metaphysical picture based on my conclusions and propose a direction for further empirical research.

The layout of the present chapter goes as follows. In the first section, I introduce the notion of causal processes by looking first at Wesley Salmon's causal process theory (Salmon 1998) and then at some difficulties Salmon's theory faces. I turn in the second section to Phil Dowe's CQ theory (Dowe 2000). Although CQ theory is able to account for difficulties faced by Salmon's theory, it faces challenges of its own (Schaffer 2003). To avoid these challenges, I propose in the third section what I call 'micro-quantities theory' ('MQ theory'). Since kind-predication is guided by causation, MQ theory presumably can tell us something about kind-predicates and genuine kinds, should such things exist. I conclude in the final section that kinds do exist, but only at the micro level. I turn now to Salmon's theory of causal processes.

Salmon's Causal Processes

In his "Causality: Production and Propagation," Wesley Salmon argues that processes rather than events should be taken as the basic kind of causal relata (Salmon 1998, 285-301). Roughly put, causal processes are objects and waves that persist through time (Salmon 1998, 286). In order to differentiate between genuine causal processes and pseudo-processes, Salmon introduces the notion of a mark (Salmon 1998, 197). A mark is a modification in a process, such that if it is made at point *A* and continues to a second point *B* without either interruption or additional intervention, then and only then is the process said to transmit the mark (Salmon 1998, 197). Only those processes that are capable of transmitting a mark are causal; all others are pseudo-processes (Salmon 1998, 287). Salmon provides the following example: Suppose that a spotlight hangs in the center of a large round room with white walls such that when the lamp is flipped on a white beam of light travels from the lamp and forms a round spot on the wall. That the light traveling from the lamp to the wall is a causal process can be shown by the introduction of a piece of red cellophane to the light beam at some point between the lamp and the wall. The cellophane creates a mark by modifying the color of the light at the point at which the cellophane is introduced; and after that point, the light remains red without interruption and without the aid of additional intervention and thus the spot on the wall is now red.

The spot itself, though, is an example of a pseudo-process. Suppose that the spotlight suspended in the middle of the round room is rotated so that the spot of light runs along the wall. Furthermore, suppose that the red cellophane is held stationary about halfway between the lamp and the wall, so that as the spotlight is rotated, its beam will at some point pass through the red cellophane. Thus, as the spot travels along the wall, it remains white until it moves behind the red cellophane, at which point the spot becomes red. Once the spot moves out from behind the cellophane, however, it loses its modification and becomes white again. The spot's inability to maintain its redness after moving out from behind the cellophane indicates that the spot is a pseudo-process. Had the spot been a causal-process, then it would have remained red after it moved out from behind the cellophane. Now, even if the person holding the red cellophane were to wait until the spot on the wall became red and then run alongside the spot thereby keeping it red, the spot on the wall would fail to be a causal process. For, the modification is maintained only by continuous intervention. So, a process is causal iff it is capable of transmitting a mark from one point to the next without continued intervention.[33]

Phil Dowe objects, however, that some pseudo-processes are not excluded by the mark criterion. The most compelling counterexample Dowe puts forward is one in which the pseudo-process of a car's shadow seems to meet the mark criterion sufficient to call it a causal process (Dowe 2000, 74-9). Suppose that a car is parked such that its shadow is cast upon a nearby standing fence (Dowe 2000, 79). If the fence were to fall over, then the shadow would be modified by a single interaction (the fence's falling), and the shadow would maintain this modification. Surely, though a shadow is not itself a causal process. In order to obviate this sort of counterexample, Salmon adds a counterfactual criterion, according to which a causal-process would have remained unaltered *ceteris paribus* had the marking interaction not occurred, but a pseudo-process would not have so remained (see Dowe 2000, 79). Rightly enough, though, Dowe responds that the shadow would have remained unaltered had the fence not fallen and furthermore was altered only in virtue of the fence's falling. Salmon's theory of mark transmission, it thus seems, fails to rule out such counterexamples (Dowe 2000, 79).

In the following section, I shall discuss Dowe's conserved quantity theory. First, I will offer a brief overview of the theory and show how it handles Dowe's own shadow objection to Salmon's mark criterion. Then, I will discuss two objections that have been raised by Jonathan Schaffer against Dowe's theory. Finally, I posit a modification to the conserved quantity theory that will allow it to deal with these objections.

Conserved Quantities Theory

In order to circumvent the difficulty faced by Salmon's causal theory, Dowe puts forward a process theory based upon the notion of conserved quantities. Dowe describes the conserved quantity (CQ) theory as consisting in the following two statements (Dowe 2000, 90):

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[33]Importantly, a process needs only to be capable of transmitting a mark in order to qualify as a causal process; it need not actually transmit mark.

CQ1: A *causal process* is a world line of an object that possesses a conserved quantity.

CQ2: A *causal interaction* is an intersection of world lines that involves exchange of a conserved quantity.

To explicate the first a bit, a world line is the history of an object as it is represented on a Minkowski diagram, and so a process itself is a spacetime "worm," *i.e.,* an object in four-dimensional spacetime (Dowe 2000, 90-1). Dowe includes within the extension of '*x* is an object' the objects of science (*e.g.*, particles, waves, and fields of force) and commonsense (*e.g.*, chairs, people, and spots; Dowe 2000, 91). Importantly, a spacewise gerrymandered thing counts as an object, but a timewise gerrymandered thing does not (Dowe 2000, 91). Consider for example, that the referent of '*x* is the President of the United States' is something that can be partially described thus (cf. Dowe 2000, 100):

for $t_{30\text{ Apr }1789} \leq t < t_{4\text{ Mar }1797}$	x is George Washington
for $t_{4\text{ Mar }1797} \leq t < t_{4\text{ Mar }1801}$	x is John Adams
for $t_{4\text{ Mar }1801} \leq t < t_{4\text{ Mar }1809}$	x is Thomas Jefferson

The variable '*x*' denotes a timewise gerrymandered thing that consists in a conserved quantity, but which fails to be an object in the CQ theory. *A*, however, is a spacewise gerrymandered and thus counts as an object:

$A =^{\text{df}}$ {George W. Bush, Miles Davis's trumpet, Manny the cat}

I argue below that the allowance of spacewise gerrymandered objects creates unnecessary difficulties.

Turning to the notion of a causal interaction, according to Dowe, an intersection occurs between two or more processes that "overlap" in spacetime (Dowe 2000, 91). Furthermore, by 'exchange' Dowe means the occurrence of a change in the value of the conserved quantity within at least one process, such that the change takes place at the point at which the world lines putatively overlap (Dowe 2000, 92). Finally, by 'conserved quantity' Dowe means any quantity, such as mass-energy and charge, that is subject to a conservation law, and Dowe maintains that at present the best guide to what these laws are is scientific theory (Dowe 2000, 91). So, on the CQ theory, causation is what occurs when the world lines of at least two objects interact such that a conserved quantity of at least one object changes at the point of the interaction.

Dowe then is able to avoid the objection he raises against Salmon's conception of causation. For, regardless of whether the shadow would have remained unaltered had the fence not fallen, the shadow itself does not consist in a conserved quantity; it "consists" in the absence of a quantity.

Jonathan Schaffer, however, raises two important objections against Dowe's theory: the so-called disconnection and mis-connection objections (Schaffer 2003). The disconnection objection points out that causation is often attributed to instances in which there is no direct connection between the cause and the effect and thus no single process connects two events. Consider the following example, given by Schaffer (Shaffer 2003). Pam, a devious young woman, desires to smash a neighbor's window with a brick. Instead of throwing it, however, she builds a catapult capable of launching the brick. After wheeling the catapult to the proper location, Pam cocks the catapult's arm, places a brick in the basket at the end of the arm, and then she raises the catapult's catch, thereby allowing the arm to swing free and the brick to be tossed. Pam's aim is perfect, and the brick shatters the glass.

In describing this scenario, one typically would say that the brick's shattering the glass was caused by Pam's releasing the catch mechanism on the catapult; after all, had Pam not raised the catch, then the window would presumably have remained intact. Consider, though, that there is a causal flow (a sequence of causal processes and causal interactions) that extends from Pam's raising the catch and the catch going up; however, the catch's going up is where the causal flow seems to stop. That is, what seems to have caused the window to break was the brick; what caused the brick to break the window was the brick's being launched by the catapult; and what caused the launch to take place was the *absence* of the catch. Thus, the flow from Pam to the window is disconnected.

According to Schaffer, the most plausible reply to the disconnection objection is to deny that the putative counterexample presents a case of genuine causation (Schaffer 2003). This reply entails denying that all commonsense attributions of causation are correct, for again commonsense tells us that Pam's having released the catch is what caused the brick to break the window. To put my cards on the table, I think the rejection of the scenario as a genuine case of causation is the right move to make, but for reasons given in the next section.

The mis-connection objection shows that not all conserved quantities involved in causal interactions are causally related to an end result. This objection, which Schaffer also expresses via a counterexample, seems more difficult for the CQ theorist (Schaffer 2003). Suppose that instead of catapulting a brick through her neighbor's window, Pam simply throws it. Shortly after Pam releases the brick, Tom, who is standing nearby, throws purple paint at the brick while it is in mid-flight. Like Pam's aim, Tom's is exact, and thus the paint strikes the brick, and the brick then smashes the window. In this case, there is a causal flow that extends from Tom to the broken window, but it seems inappropriate to say that Tom had a causal role in the window's being broken. Thus, while the paint is a genuine process extending from Tom to the window, it is not causal.

Schaffer describes two possible replies. The first is to admit that there are instances of causation that seem counterintuitive, although these instances are so negligible that they can be safely discarded (Schaffer 2003). So, in terms of the above counterexample, Tom in fact did play a causal role, albeit a minor one, in the breaking of the window. The second reply, according to Schaffer, is to recognize that multiple processes are often involved shaping a particular instance of causation (Schaffer 2003). I shall consider each of these possible replies in the next section.

Micro-Quantities Theory

Both the mis-connection and disconnection objections can be avoided by simply limiting what one is willing to count as an object. Since Dowe allows both objects in the ontology of science and the objects of commonsense to count, there are two directions the limitation can go: either eliminate commonsense objects by reducing them to the objects within the ontology of science or get rid of the objects of scientific ontology altogether. The former, which eventually results in what I shall call 'micro-quantities' ('MQ') theory, is the better route and can be achieved by viewing macro-level objects as *derivatives of* micro-level objects that are "bonded" together.

Consider that there are two ways to describe the scenario in which Pam throws her brick through the window and Tom throws purple paint on the brick as it is in mid-flight. According to commonsense, the brick and the paint comprise two distinct objects. Both objects have conserved quantities, and both of those quantities interact with the window. Consider furthermore that had Tom failed to throw paint, but Pam threw the brick (and the brick keeps the same trajectory across scenarios), the brick presumably would have broken the window. If, on the other hand, no bricks were thrown, but Tom simply threw purple paint at the window, then the window would not have broken. So, commonsensically, what breaks the window is only one object, *viz.,* a paint-splattered brick, and therefore taking paint to be a nominal cause of the window's breaking seems worse than merely counterintuitive. We have very good reasons to think that flying paint (except perhaps in controlled laboratory settings) does not break windows: paint thrown by a human simply does not have the requisite mass and velocity to accomplish the task.

The force of the misconnection counterexample derives from this seeming (mathematical) incongruity: commonsense tells us that there are two causal processes leading up to the broken window, but only one process was involved in the window's breaking. The difficulty, I think, is that commonsense is rarely rigorous enough to describe what is going on. According to the commonsense description, an object (a handful of paint) at one time *becomes* a property (denoted, '*x* is paint-splattered') at a later time. The paint-splattered brick is just the sort of spatially-gerrymandered object that Dowe seems to allow. This is not a terrible thing, for if push comes to shove the commonsense view can reply to the question, What is the causal role played by the paint? Answer: it caused the brick and (assuming the paint has not dried by the time the brick reaches the window) the bits of glass to be purple. So, the ontology of commonsense is fine for an everyday heuristic. It is not, however, fine-grained enough capture the nuances of causation in the world. So, one would do well to avoid commonsense ontology.

For this reason the MQ theorist rules out any gerrymandered objects whatsoever. Furthermore, non-gerrymandered (spacewise or timewise) object-hood should be viewed as existing in degrees, for macro-level objects are derived from aggregates of the micro-level objects found within the ontology of science (specifically particles, waves, and fields of the force should they prove to have quantity). 'Aggregate' should be understood roughly in the sense in which physics and chemistry speaks of particles "bonding." So, for example, a macro-level square peg counts as an object (though derivative), because it consists of a set of particles bonded together at the micro-level; similarly a drop of water counts as a macro-level (and thus derivative) object. Two adjacent but unattached bricks, however, are not bonded at the macro-level and thus do not together form a single object, derivative or otherwise.

Two felicitous things follow from this move. The first is a measurement issue: if macro-level objects are understood as aggregates of micro-level objects, macro-level quantities will be seen as having been "built up" from micro-level quantities. This is beneficial, for exchanges of conserved quantities can be described in greater detail.

Second, if macro-level objects are seen as aggregates of micro-level objects, the processes of conserved quantities can be "followed" with a greater degree of accuracy to their points of interaction with other processes. Such fine-grained descriptions of processes allow the MQ theorist to avoid criticisms arising from what might be called macro-level "fission" and "fusion" cases of causation. A fission case exists when a single macro-level object is the common cause of, say, two effects. By admitting only micro-level particles, one need only to specify which particles interacted with which other particles to bring about the two macro-level effects. That is, by homing in on the micro-level process, one can follow the conserved micro-quantities to their points of interaction and can thus give a more accurate description of causal occurrences.

A macro-level fusion case occurs when three or more macro-level processes converge, but only two macro-level processes seem at the macro level to have causally interacted. The paint and the brick case is an example of a macro-level fusion case. The paint-splattered brick is comprised of two previous aggregates of particles that at some later point come to comprise a single aggregate of particles. Since macro-level objects are derivative, this forms no problem. So, in this way, by admitting only micro-level objects as the primary objects, the MQ theorist avoids the mis-connection objection.

Finally, the disconnection objection, as exemplified by the catapult, can also be avoided by appealing to micro-level processes. At the micro-level it is quite obvious that there are multiple causal processes interacting with the catch standing at the nexus. First, a causal interaction occurs between Pam and the catch when Pam uses the catch to lock the catapult's arm in place just before the launch.[34] Second, the catch's holding the catapult's arm in place before the launch is both *(a)* a causal interaction between the catch and the catapult's arm and *(b)* a background *condition* for the causal interaction between the catapult's arm and the brick. Finally, the catapult's arm interacts with the brick, and then the brick interacts with the window. Background conditions allow for the possibility of other causal interactions, and it is here that the break occurs in the causal flow from Pam to the window. A causal interaction occurs only between Pam's fingers and the catch, and a distinct causal flow runs from the catch, to the arm of the catapult, to the brick, and then to the window. So, Pam's connection to the broken window is only indirect; she merely establishes the background conditions for the causal interactions between the catapult's arm and the brick, and the brick and the window. This is most easily seen by considering the various causal sequences of processes and interactions at the micro level.

So, by limiting objects to only the micro-level objects in the ontology of science, causation can be cashed out in terms of micro-level processes, which accords with Schaffer's second proposed response. By taking causation to consist in micro-level processes, the roles multiple micro-processes have in an instances of causation become obvious. Now, I consider the notion of kinds and kind-predicates in light of MQ theory.

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[34]For simplicity of description, I shall set aside Pam's interaction with the catapult's arm and will focus only on Pam's interaction with the catch.

Conserving Kinds

So far, I have argued for a specific causal process theory. First, I presented Wesley Salmon's notion of causation as a process which is capable of transmitting a "mark." Phil Dowe, however, has put forward several counterexamples to Salmon's concept, one of which proves quite difficult for Salmon's theory. Therefore, I took up Dowe's theory according to which causation is an interaction between two causal processes in which an exchange of quantities occurs. Schaffer, however, has presented two counterexamples to Dowe's CQ theory. In the last section above, I proposed a means for coping with Schaffer's criticisms. The solution is to take as genuine objects (and thus as causal processes) only those objects (processes) that occur at the micro level; macro-level objects (processes) are therefore seen as derivative. This move, which results in what I call the 'MQ theory' of causation, avoids Schaffer's criticisms and reveals something important about the universe: if MQ theory is right, then it shows that causation occurs only at the micro level.

Now, it has been assumed throughout this thesis that whether or not an object falls within the extension of a kind-predicate is determined largely by the causal relations it can enter into. In fact, it is not just any causal relations, but certain relations as determined by the Disney Cluster of an object. Therefore, kind-predication is guided by causation. So, if MQ theory is right, it might have something to say about kind-predication. In fact, I think it does.

Before discussing the notion of kinds and kind-predicates, however, it will be useful to clarify further the notions of objects and object-hood which is at play in MQ theory. Given the argument in the last section, micro-level particles are basic ontological entities, for these are the objects whose processes enter into causal interactions. I take it, therefore, that Locke is in a sense right to say that an object x at t_1 is the same as an object y at t_2 iff "no addition or subtraction of matter" occurs to the object (Locke 1948, 163). Only, I would go one step further: in order for an object to retain its identity through time, it must be nomologically impossible for the object to add or lose parts. Consequently, the only non-derivative objects there are, are micro-level particles which can have such properties as positive or negative charge, spin, and so on.

As stated somewhat loosely in the last sections, derivative objects consist in aggregates of these particles. The Ship of Theseus, for example, is thus a derivative object. Once a single plank (or a single particle, for that matter) has been removed, the aggregate of particles ceases to be the same, and the derivative object is therefore different. Supposing that the plank-replacing activity occurred on the sea and that a crew sailing on a different ship behind the Ship of Theseus collected all of the lumber, nails, etc. and put it all back together in the same arrangement as before, then (assuming also that no particles were lost while each board floated on the waters) the original aggregate of particles would have been restored, and thus the original derivative object would have existed with the second crew. The intuition that the first ship retains the label 'Ship of Theseus' despite every bit of its wood having been replaced arises largely from the fact that humans operate at the macro level and thus expect the world to, as well. If MQ theory is right, however, causation occurs at the micro level and thus what determines whether two macro-level objects are identical is the identity of the micro-level particles that comprise them.

A consequence of MQ theory is that macro-level kind-predicates are attributed to derivative objects, *viz.,* macro-level objects consisting in aggregates of particles. In fact, I take it that a macro-level object consists ontologically in *nothing more* than its micro-level constituents, for I do not know what sorts of things could be added to an aggregate of micro-level particles to make it a macro-level object. I thus take it that emergentism is false; the properties of wholes are nothing more than the properties of the micro-level parts and their relations to each other. So, what distinguishes the micro level from the macro level seems to be mere macro-level observation. Furthermore, observers at the macro level are incapable of perceiving differences at the micro level between, say, two objects without the aid of scientific instruments. But if those two objects are different at the micro level and objects in general are *ontologically* nothing over and above their micro-level constituents, then their macro-level similarities are *merely apparent.* So, insisting that two objects are both members of the same kind because they appear at the macro level to be similar and then claiming that macro-level kinds are nonreducible is logically akin to saying that chairs, cars, and tennis balls belong to a kind which is nonreducible. Of course it is nonreducible, the constituents have nothing to do with each other.

Now, of course the reader will cry foul, for kind-predications are not made merely on the basis of macro-level similarity. Rather, they are made on the basis of a similarity of how objects partition the set of causal relations. Chairs, cars, and tennis balls are not even close to partitioning the set of causal relations in the same way. My perhaps radical, but (it is hoped) eventually plausible claim is this: neither are two tigers.

Consider this: First, again, macro-level objects, presumably, are ontologically nothing over and above their micro-level constituents. Second, kind-predicates, as mentioned above, are applied in light of the causal relations an object can enter into. In fact, two objects are given the same kind-predicate iff they partition the set of causal relations similarly. Third, also as shown above, causation itself seems best explicated in terms of processes at the micro-level. Since causal relations occur at the micro level and similarity of causal relations must therefore occur the micro level, kind-hood, if it is a genuine feature of the world, also must exist at the micro level.

So, drawing from MQ theory and the explication of object-hood given above, the genuine kinds of the universe are plausibly the fundamental processes of the universe, *viz.,* particles with similar internal properties and waves with similar functions (and perhaps fields of force if they turn out to possess quantities). On this view, then, two particles with negative charge fall within the same kind, two waves with the same function fall within the same kind, and so on. All else is built up from and thus are derivatives of these kinds.

The pertinent question is this: Can the relatively few number of kinds in the universe account for the deep scientific similarity that seems to divide derived objects into the extensions of respective special-science kind-predicates? Perhaps so. If the number of protons in an atomic aggregate is two less than the number of electrons, the aggregate as a whole will be (derivatively) negatively charged. Given that two atoms are exactly similar with regard to quantities of protons, neutrons, and electrons, the two atoms will behave quite (though perhaps not exactly) similarly. As an initial speculation, however, I think the limited number of genuine kinds is insufficient to account for the similarities observed in the special sciences. What else is needed is the notion of statistical significance. As one works one's way up through the hierarchy of special sciences, raw similarity becomes more obscured. Statistical methods must be employed to bring out any underlying similarities.

Regardless, MQ theory is able to account for causation in a way that avoids the difficulties faced by Salmon's mark theory and Dowe's CQ theory by reducing object-hood to the micro-level. Furthermore, since causation guides kind-predication, MQ theory accords well with attempts to reduce special kinds to lower-level kinds. The analysis of special predicates in the third chapter of this thesis combined with MQ theory provides a parsimonious metaphysical framework worthy of further consideration. If my arguments turn out to be sound, then all that lies at the nexus of causal processes and kind-predication is physics of the most fundamental kind.

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