

Completing Kornblith's Project

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ABSTRACT: In his *Inductive Inference and Its natural Ground: An Essay in Naturalistic Epistemology*, Hilary Kornblith presents an argument for the justification of induction that is bold, brilliant, and plausible, but radically incomplete. In the development of this position, Kornblith relies heavily on the philosophical work of Richard Boyd as well as on some empirical psychological studies. As Kornblith sees it, the philosophical position entailed by his proposed solution to the problem is a thoroughgoing realistic, scientific materialism. I will argue that the brand of realism that Kornblith's solution to the problem of induction presupposes is inexplicable within the context of the non-reductive materialism that he espouses. Although Kornblith provides us with valuable elements for a solution to the problem of induction, it needs to be supplemented with something like a renovated Aristotelian notion of form in order for the solution to be plausible.

ALTHOUGH IT WAS originally suggested by Quine, Hilary Kornblith has become the standard-bearer of naturalized epistemology, and in *Inductive Inference and Its Natural Ground: An Essay in Naturalistic Epistemology*¹ he proposes the outline of a solution to the problem of the justification of induction that is bold, brilliant, and plausible but radically incomplete. In the development of this position, he relies heavily on the philosophical work of Richard Boyd as well as on some empirical psychological studies. As Kornblith sees it, the philosophical position entailed by his proposed solution to the problem of induction is a thoroughgoing, realistic, scientific materialism. However, in this paper, I will argue that the brand of realism that Kornblith's solution to the problem of induction presupposes is inexplicable within the context of the non-reductive materialism he espouses. I will argue that although Kornblith provides us with valuable elements for a solution to the problem of induction, it needs to be supplemented with something like a renovated Aristotelian notion of form in order for the solution to be plausible.

In order to defend the appeal to the Aristotelian conception of form and formal causality and yet be consistent with the spirit of naturalized epistemology, I will rely upon the ecological theory of perception of James J. Gibson. Gibson's work makes possible—in fact it cries out for—a naturalized epistemological renovation of form. Although I see my project here as being within the general contours of naturalized epistemology, one of the global implications of the position I propose

¹Hilary Kornblith, *Inductive Inference and Its Natural Ground: An Essay in Naturalistic Epistemology* (Cambridge: MIT Press, 1995). All in-text citations will be to this work.

to develop here is that although naturalized epistemology can make genuine, valuable contributions to the tradition of epistemology, it cannot supplant the entirety of epistemology as conceived in the dominant epistemological tradition. Even if naturalized epistemology is generally a correct epistemological path to take, there is still much for traditional epistemology to do.

KORNBLITH'S NATURALIZED JUSTIFICATION OF INDUCTION

The justification of induction that Hilary Kornblith presents goes roughly as follows:

1. Inductive inferences by human reasoners typically exemplify the law of small numbers.
2. The law of small numbers is applied by human reasoners not on the basis of superficial characteristics of similarity, but on the basis of properties that are ontologically relevant to natural-kind membership.
3. Inferences based on properties ontologically relevant to natural-kind membership are reliable.
4. Therefore, inductive inferences by human reasoners are generally justified.

The psychological studies of Tversky and Kahneman provide Kornblith with the main evidence for the first claim above. Their empirical studies show that the inductive inferences of human reasoners are typically based on the use of very small numbers. Discussions about the justification of induction usually presuppose that the examined sample upon which justified inductive inferences need to be based is of a significant number, that is, a number that would provide statistical warrant. However, as the studies seem to indicate, this is not the way in which real human inductive inferences usually proceed. Inductive inferences of human reasoners regularly proceed on the basis of numbers that are statistically unwarranted. The conclusion that one may draw, and the one Tversky and Kahneman do in fact draw, is that inductive inferences by human reasoners are typically unwarranted (90).

Kornblith accepts that the evidence shows that human reasoners do in fact typically use the law of small numbers when making inductive inferences, but he does not think that this shows such inferences to be unjustified. Of course, if classical empiricism or conventionalism were correct, then this would be the proper conclusion to draw. Classical empiricism and conventionalism entail that our inferences about kinds in nature are based merely upon nominal kinds. If kinds upon which our inferences are based are merely nominal and if there is no intrinsic connection between the nominal kinds upon which our inferences are based and the real kinds or essences that constitute the objects in question, then it is hard to see how it is possible for induction ever to be justified, even if our inductions about natural kinds were based on large numbers instead of small ones. This is the fundamental problem with which Locke himself wrestles with in his discussion of real versus nominal essence, where he concludes with a skeptical position in relation to real natures or essences. On the other hand, if our inferences are in some way grounded upon the properties that are ontologically constitutive of real kinds or essences in

nature, there may a way of justifying induction, despite our reliance in induction upon small numbers.

It should be apparent how the strategy of Kornblith entails a naturalistic turn in the epistemological discussion. If Kornblith is right and if there is no possibility of resolving the issue of the justification of induction within the domain of epistemology proper as generally conceived, it must be resolved within the context of a naturalized epistemology:

I see epistemology in general, and Quinean epistemology in particular, as addressed to two questions: (1) What is the world that we may know it? and (2) What are we that we may know the world? As science has progressed, it has offered an increasingly detailed account of the nature of the world around us, as well as an increasingly detailed account of what we ourselves are like. Moreover, the very success of the scientific enterprise entails that these two accounts must dovetail in important ways. Precisely because the scientific enterprise has been so successful, it must be able to explain, given its account of what the world is like, how knowledge of such a world is possible. Similarly, given the scientific account of what we are like, it must be possible to explain how we could have knowledge of the world. One and the same phenomenon is here examined from two different angles. (2)

The questions that Kornblith claims epistemology must address are much broader than the questions typically considered in contemporary epistemology and entail that there can be no clear methodological boundaries between metaphysics and epistemology. In order to answer the questions to which Kornblith claims that epistemology is directed, we must have a science of human nature and the world. Such a science would be a significant part of what has traditionally been conceived to be metaphysics. Kornblith may not see it this way because metaphysics in the dominant modern tradition has been conceived of, like epistemology, as an *a priori* science separated from the empirical sciences, whereas Kornblith and others in the tradition of naturalized epistemology think that we must look to the empirical sciences for the correct theory about human nature and the world, and not to any metaphysics constructed *a priori*. However, this view of the strict separation of the empirical sciences from metaphysics is based on a mistake in the modern philosophical tradition, and this is not the way it is viewed by epistemologists in the Aristotelian and other classical realist positions.

As a naturalized epistemologist sees it, considerations of the nature of justification and the canons of inductive logic and probability theory are at best incomplete and may be even irrelevant to the issue of whether or not our inductive inferences are justified naturalistically. What difference does it make what the canons of inductive logic prescribe if our actual reasoning does not follow such prescriptions and, more importantly, if the grounds of our inferences are based not upon *a priori* conditions of justification for induction, but rather upon a connection between ontologically determined implicational relations and our pre-reflective natural processes of inference? As Kornblith states:

Tversky and Kahneman compare the logical form of our inferences with the logic of statistical inference and, on that basis, declare us sinners. Given the standards of proper statistical inference, our inferences receive a failing grade. But is the logic of statistical inference a reasonable standard against which to measure our own inferences? . . . I argue that this seemingly natural standard of comparison grossly distorts the phenomenon of human inference. (90–91)

The fact that making inferences from small samples violates canons of good statistical inference, however, is simply irrelevant to assessing how well or badly we are served by such a tendency. (94)

The canons of good statistical inference are irrelevant to the question of the justification of induction because the law of small numbers is applied by human reasoners not on the basis of superficial characteristics of similarity found in objects, but on the basis of properties that are ontologically relevant to natural-kind membership (2nd premise above). As Kornblith argues, the reliability of inductive inference is not based upon the canons of inductive reasoning but upon the fact that “we have a tendency to project the right feature of natural kinds, those features which, in fact, are universally shared by the kind” (105). Hence, although our inductive inferences are typically based upon very small numbers, since the properties of objects that we typically induce from are properties of the object constitutive of kind membership (3rd premise above), our inductions will typically be reliable and hence justified:

When our inductive inferences are guided by our intuitive grasp of the real kinds in nature, and when we project those properties which we intuitively recognize to be essential to those kinds, our tendency to make inferences in accord with the law of small numbers serves us well. Our conceptual and inferential tendencies jointly conspire, at least roughly, to carve nature at its joints and project the features of a kind which are essential to it. This preestablished harmony between the causal structure of the world and the conceptual and inferential structure of our minds produces reliable inductive inference. (94)

Successful inductive inferences about kinds entails that we be successful in detecting covariation. The result of studies on the detection of covariation in the psychological literature is mixed. Studies show that sometimes we are quite successful in detecting covariation (for instance, when the covariation is nearly perfect) and yet “it was only when the degree of covariation was nearly perfect that subjects’ ratings of covariation were remotely accurate” (98). Since most natural kinds do not exhibit perfect covariance of their properties, the evidence seems to suggest that our inductive inferences are not going to be typically successful. But Kornblith argues that the empirical studies that showed detection of covariation to be unsuccessful were artificial and based upon single pairs of covariant properties. There are other studies by Bellman and Heit that indicate clustered feature facilitation. Quite simply, the thesis of clustered feature facilitation entails that, when objects covary in larger numbers of clusters rather than in single pairs, our detection of covariation is dramatically improved (100–05). This is good news for our ability to

detect covariation in nature because natural kinds exhibit covariation of large clusters of properties rather than single pair covariation.

Regarding the nature of natural kinds, Kornblith appeals to the scientific realism of Richard Boyd, and in particular, to Boyd's conception of natural kinds. In a number of works, Boyd presents a view of scientific realism which entails that there are real essences in nature, which science enables us to discover *a posteriori*. The relevance of this perspective to the question of induction and Kornblith's thesis is, in fact, suggested by Boyd himself. "It seems possible to argue that inductive inferences in science *about observables* are reliable only because they are guided by methodological principles which reflect previously acquired (approximate) knowledge of unobservable real essences."² The centrally important thesis of Boyd's view that Kornblith adopts in his argument for the justification of induction is that natural kinds are defined by "homeostatic property clusters."³ These homeostatic property clusters are primarily unobservable and are modeled on the notion of a property cluster commonly found in ordinary language philosophers influenced by Wittgenstein's notion of family resemblance concepts. When Boyd and Kornblith appeal to the properties of kinds that are plausibly projectible in our inductive inferences, these (or properties derivative of them) are the properties they have in mind. In one of his articles, Boyd provides us with a detailed list of criteria for homeostatic property clusters as he sees them. Since the concept is so crucial to Kornblith's account and my analysis of that account, I need to paraphrase them in some detail here:

- (i) Homeostatic property clusters are a family of properties that are contingently clustered in nature in the sense that they co-occur in an important number of cases.
- (ii) Their co-occurrence is the result of what may be described as a sort of homeostasis. Either the presence of some of the properties tends to favor the presence of the others, or there are underlying mechanisms or processes that tend to maintain the presence of the properties, or both.
- (iii) The homeostatic clustering of the properties is causally important.
- (iv–v) There is a kind term, *t*, applied to things in which the clustering occurs and the term has no analytic definition; its definition is an *a posteriori* question.
- (vi) Imperfect homeostasis is nomologically possible or actual.
- (vii–viii) The determination of whether a thing falls under the concept is a theoretical rather than a conceptual issue and there will be many cases of irresolvable extensional vagueness.
- (ix–x) The causal importance of the homeostatic property cluster and its underlying mechanisms is such that the kind denoted by the term *t* is a natural kind and there is no significantly less vague term that could replace *t* and still preserve the naturalness of the kind.

²Richard N. Boyd, "Realism, Anti-Foundationalism and the Enthusiasm for Natural Kinds," *Philosophical Studies* 61 (1991) 127–48, here 133.

³Boyd, "What Realism Implies and What It Does Not," *Dialectica* 43 (1989) 5–29, here 17.

(xi) The homeostatic property cluster that defines *t* is not individuated extensionally, and the conditions for falling under *t* may vary over time or space.⁴

The paradigm cases of natural kinds—biological species—are homeostatic property clusters.⁵

This is the view of natural kinds that Kornblith adopts and endorses in his argument for the justification of induction. As he states: “If this account is on the right track, then we have the beginnings of an explanation of what it is about the world that makes it knowable. Because there are natural kinds, and thus clusters of properties which reside in homeostatic relationships, we may reliably infer the presence of some of these properties from the presence of others” (36).

Following Boyd, Kornblith conceives of the unobservable properties of objects that reside in homeostatic relationships to be definitive of real natural kinds (37, 40); our inductive inferences are guided by these properties of objects rather than by superficial properties of objects: “What we do have natively, I want to argue, is a set of dispositions which incline us in the right direction: a tendency to carve the world into kinds in ways which presuppose a certain causal structure; a tendency to look beyond the superficial characteristics of objects in classifying them into kinds; a sensitivity to those features in objects which tend to reside in homeostatic clusters; and a tendency to project those characteristics which are indeed essential to the real kinds in nature” (95). This is what completes the puzzle regarding the epistemological questions about inductive inferences. As a matter of fact, our inductive inferences are based upon the law of small numbers and, as a matter of fact, humans are generally not very successful detectors of covariation of properties in objects. However, as science indicates, natural kinds are constituted and defined by homeostatic clusters of unobservable properties. Also, as a matter of fact, we are quite successful in detecting covariation of properties in objects when there are clustered properties covarying rather than single pairs of covariation and humans do not just project any old properties of objects: we have a natural tendency to project properties that are essential to objects. If I see a female platypus in a zoo lay eggs, I will project that they are all egg-layers, but not that they are all in a zoo. If I see one black crow, it may incline me to believe that all crows are black, but if I see one black book, it does not incline me to believe that all books are black (93). Hence, if we do in fact make projections on the basis of those homeostatic properties of objects that are definitive of their being real natural kinds, then our inductive inferences will be generally highly reliable and thereby justified.

The picture Kornblith gives us is something like this. We make inductive inferences on the basis of the observation of small numbers of objects of a kind, but we are discriminating in our selection of the properties of objects we project. This discrimination does not seem to be based upon careful evidential or reflective considerations (even young children exhibit these tendencies) but nonetheless corresponds to properties that are relevant to real natural-kind membership, which

⁴Ibid.

⁵Ibid., 17–18.

is how the world is structured. Hence, our inductive inferences are justified not on the basis of *a priori* formal canons of reasoning but on the basis of a fit between our natural tendencies in performing inductive inferences and the structuring of the world.

I think that there is much to be said for Kornblith's thesis. It does seem to be so that unless there is some way in which induction is coordinate with properties that are constitutive of objects, there does not seem to be any way that the epistemological problem of induction can be resolved. Unless there is some ontological distinction between an object's being grue and an object's being green, the projection of green rather than grue is just arbitrary in the end. This entails that the epistemological problem of induction can only be solved by taking a broadly naturalized epistemological approach. Solving the problem entails having both a correct theory of the world as well as a correct theory of inductive inference. However, that there *are* any such properties constitutive of objects belonging to kinds is definitive of a metaphysically realist point of view; hence it seems that Kornblith is right in adopting a robust metaphysical realism into his argument for the justification of induction. I cannot assess the psychological evidence that Kornblith includes in his argument, but such evidence surely seems to be quite important to the issue of whether or not induction as generally practiced is justified. *If* we typically use the law of small numbers in induction, then it is quite important, in order to determine whether or not we are justified, to determine whether the sorts of properties we induce are properties that are in some way based upon ontologically constitutive properties; and this is the sort of information with which empirical psychological studies can provide us. Although Kornblith does not argue for, nor even specifically address the thesis, it is obvious that he relies upon the primacy of observational knowledge and its integrity in getting at the real essences of natural kinds and the recognition of the distinction between essential and accidental features of objects.

There are some problematic questions about Kornblith's view, however. Is there anything to account for the fact that we have a tendency to project properties relevant to natural-kind membership rather than projecting other superficial or irrelevant properties? If Kornblith and the evidence from the studies of Bellman and Heit are correct, then we do not just project any old features of objects; we have a fortuitous tendency to project significant properties of objects rather than superficial properties. And, of course, what leads us to call such properties "significant" rather than "superficial" is that such properties enable us to come to know the world and the way things are in it. It is our interest as cognitive agents in attaining what is really true that is at stake in our tendencies to project properties. In a full-blown naturalized epistemology that encourages appeal to the available resources of all the sciences, we ought to strive for an explanation of such an epistemologically fortuitous tendency. As far as I can tell, neither Kornblith, nor Boyd, nor any of the psychologists appealed to by Kornblith provide us with such an explanation.

There is, however, an even more basic question than this one. Is there any explanation of how organisms like us even get access to those properties of objects that are constitutive of kind membership, or, in fact, of how we have access to any

properties of objects at all? Let us say that there is a way that the world generally is and that the world and the objects in it are basically the way that Boyd and Kornblith say they are. Let us say that they are right and that the natural world is divided into not just individuals but also kinds and that objects belonging to kinds are defined or constituted by naturally caused and causally efficacious homeostatic property clusters and that these homeostatic clusters or the mechanisms responsible for them are basically unobservable properties of objects. Of course, in such a view we are one of those kinds of things in the world and hence we are also defined or constituted by a naturally caused and causally efficacious homeostatic property cluster. I do not think that there is any real problem with taking a naturalized view of nature, knowledge, and the human person as far as it can go. But if Kornblith is right, there is at least one critical feature of the human organism (one of those properties in the homeostatic property cluster that constitutes us) about which he is totally silent, and that is our intentionality. Now, one of the obstacles for Kornblith here is that he is an avowed materialist and most accounts of intentionality appeal to immaterial entities or properties of entities. Hence there is an substantial gap in world views between Kornblith (and Boyd) and those who generally talk of intentionality. However, the fact of intentionality upon which I wish to focus attention here—the fact that our awareness is an awareness of objects—seems to be undeniable within a realistic view like the one Kornblith supports. All that he argues for in his book seems to presume that we are somehow or other aware of the natural world and the objects in it. How are we to account for this capacity within his naturalized epistemology and the resources of natural science to which we are methodologically allowed to appeal in the development of such an epistemology? Kornblith himself is aware of the issue:

The striking fit between our psychology and the structure of the world stands in need of explanation. It is surely no coincidence. The best explanation for the extent of fit, to my mind, is that it is a product of the evolutionary process. Evolution should thus not be called upon as evidence that our psychology fits well with the causal structure of the world, for the fact of good fit is independently established. Evolution is only called upon *after* we establish the fit between our psychology and the world, as an explanation of how that fit came about. (3)

Of course, evolution generally explains how *everything* about natural, and in particular, living organisms comes about and so, if true, would also explain at some level how it came about that there is such a good fit between our psychology and the structure of the world. But that sort of explanation (that is, how such a thing came about) is *not* what is primarily needed. What is more pressing is a specific explanation of just what it is about humans and the cognitive processes of humans that enables us to become aware of and apprehend the structure of the world. Take what I would assume to be, from the point of view of a scientific materialist, a paradigm example of the sort of causal explanation I have in mind here. We now know that DNA provides an explanation of how it is that properties are passed on to our progeny. Let us say that it is also a fact that DNA came about through

evolution. So, we can say that evolution explains, at some general level of explanation, how properties are passed from one generation to the next. However, appealing to evolution as *the* explanation of the particular facts that DNA now enables us to understand and explain, in abstraction from a consideration of DNA itself, is pretty thin as a specific explanatory device. To say that evolution is the explanation is tantamount to merely saying that this is what happened, period! The value of DNA as an explanation is not that it explains that it is a fact that properties are passed from one generation to the next. That fact is blatantly obvious without knowledge of DNA or of evolutionary theory. The theory of DNA is an important explanatory device with or without evolution because it is a specific description of the mechanism that enables us to understand the specific nature and causality of the process of the inheritance of traits. Likewise, for a realist, that it is a fact that there is a good fit between our psychology and the world is not what needs to be explained, and how it came about (presumably through evolution) is not what we need. What we need is something akin to the specific sort of explanation that DNA provides for procreation: an explanation that provides a description of the causal mechanisms or processes of cognition and thereby enables us to understand how it is that we are aware of the objects in the world. Evolution is an historical explanation. We do not need history to explain intentionality; we need psychology. So it seems to me that Kornblith misses the point that he himself raised on this issue.

The problem of the “good fit” between our psychology and the structure of the world that Kornblith mentions is a crucial one for his theory, and would be for any naturalized epistemology. Contrary to what Boyd claims to be the success of the empirical sciences in giving us an adequate picture about the workings of the mind, it rather seems that there has been very little progress whatsoever in the empirical sciences to offer us an explanation of the critical fact of intentionality. And if Kornblith’s views about induction are correct, then the facts are even much more complex than is typically viewed by the general run of empirically minded thinkers. If Kornblith is right, there is an enormous amount of explanation needed, for he posits a complex network of structures of mind and reality and their interrelations to explain. Take these selected quotes:

If inductive knowledge is to be so much as possible for us, there must be certain features of the human mind which make it so. The human mind is well provided for; it has an innate structure which is conducive to the possibility of such knowledge. Without such a structure, our inductive inferences would be unreliable or simply fail to exist. With such a structure in place, however, all that is needed for inductive knowledge to follow is cooperation from the environment. (61)

If we are to account for the possibility of learning, then, we should ask not whether there is an innate structure to the mind, but rather what innate structure the mind has. (62)

Our conceptual and inferential tendencies jointly conspire, at least roughly, to carve nature at its joints and project features of a kind which are essential to it. This preestablished harmony between the causal structure of the world and the conceptual and inferential structure of our minds produces reliable inductive inference. (94)

[O]ur inferential tendencies may best be understood by seeing how they dovetail with the causal structure of the world . . . our inductive tendencies are tailored to the causal structure of the world. (107)

The way in which our conceptual and inferential tendencies operate, what innate equipment we need for those operations to occur, what those operations need to be like in order to account for the fact that these operations “dovetail” with the causal structure of the world, how they are “tailored” to the causal structure of the world, the way in which the environment “cooperates” with our cognitive operations, all this is left wholly unexplained by Kornblith’s discussion or the resources to which he appeals in his discussion. In order for Kornblith’s account of induction to be complete, we need much more elaborate descriptive explanations of cognition.

There is another related issue here. If Kornblith and Boyd are correct, then the real essences of natural objects are primarily constituted by unobservable properties, but our access to the world is primarily through its observable properties. If the real essences of objects are constituted by unobservable properties, how is it that our inductive inferences, which are based on observable properties, meet conditions of reliability? The best that I can figure is that it must go something like this: Although the homeostatic property clusters (or the mechanisms that cause them) that constitute the essence of natural objects are primarily unobservable, it is not necessarily the case that these properties are unobservable and, more importantly, there is at least a causal connection between the property clusters that constitute the real essence of the object and the property clusters that we use in induction. Kornblith sympathizes with Locke’s skeptical problem concerning real essences, but he, unlike Locke, is able to escape skepticism regarding real essences because he thinks that the sorts of properties upon which we rely in induction are “tailored” to the properties that constitute the real essences of natural objects. Kornblith’s position not only entails that we account for the way in which, in general, our inferential and conceptual tendencies could possibly “dovetail” with the causal structure of the world, we must also have an account of how our tendencies (which are primarily reliant upon observation) enable us to access properties of objects that are primarily unobservable.

There is one last question we need to ask about Kornblith’s position, and this is the most important one. What is the nature of the causality of the homeostatic property clusters? Although Boyd says something about the causal importance of the homeostatic property clusters, what he says is not very helpful for the issues that I am interested in here regarding the causal significance of the homeostatic property clusters. Let us begin the consideration of the nature of the problem here. Boyd develops his conception of the homeostatic property clusters from the notion of property clusters commonly found in discussions of concepts or universals in linguistic philosophy. In such a context, however, the property cluster notion is generally thought to provide some explanation of how, given the absence of a reliance upon a knowledge of real universals in things out there in the world, we might still be able to form coherent sortal concepts. The general explanatory motivation for linguistic philosophers’ appeal to property clusters seems to be antithetical to

what motivates Boyd to appeal to property clusters. His property clusters are clusters that are not linguistic or conceptually constructed sortals, but are sortals that *really* constitute the nature of the things out there. Sure, there are common features, *viz.*, that linguistic property sortals and Boyd's do not have clearly definitive boundaries, that they are extensionally vague, and that they may vary over time and space, but their fundamental explanatory natures are entirely disparate.

We know how linguistic property clusters are clustered and we know what they do. We just *make* the clusters by sorting things as we wish to sort them, and linguistic property clusters have no real (as opposed to intentional) causal power. For the homeostatic property clusters upon which Kornblith relies, we need explanations of what, in nature, makes for such clusters to be clustered as they are; and, even more importantly, how such clusters operate causally in nature: what are their causal powers?

Kornblith's book on induction is very short, and some of the questions I have raised concerning Kornblith's position range far beyond the limited scope of that book. Nonetheless, these questions need to be raised. Once one leaves the cozy confines of *a priori* epistemological theorizing for the new frontiers of naturalized epistemology, one needs to dramatically expand the range of questions that are to be considered. Also, although Kornblith has broken away from some modern epistemological and metaphysical prejudices that have hampered epistemological progress, he has not sufficiently shed the yoke of some other of the prejudices. First, despite the fact that he and Boyd claim to reject the Humean notion of event causation, they still seem to be held somewhat bound within that tradition in their conception of causation. The most telling example of this is in Kornblith's consideration of the explanation of the fit between our psychology and the structure of the world. His appeal to evolution at the initial point of that consideration shows that, *a priori*, he rules out the notion of formal causality. Second, Kornblith rejects reductionism. He does not hold that it is only atoms, quarks, or physical forces that exist, but also things like hemlocks, horses, and humans (47ff). However, he also holds that "the inventory of microphysics is in some important sense complete" and "[t]he same is true, it seems, in the case of causal powers" (53). His rejection of reductionism and affirmation of materialism may appear to be contradictory, but he insists that, although it is the case that all things are entirely composed of microphysical parts, "the identity conditions for biological objects are quite different from those of the physical objects which compose them" (55). He takes the same position in relation to the causal powers disclosed by the special sciences:

[T]he biological sciences attribute various powers to animals, viruses, internal organs and so on; psychology attributes various causal powers to mental states, features of personality and the like. The reasons for taking these causal powers seriously is precisely that they are essential parts of successful scientific theories. If we want to know what causal powers there are in the world, we can do no better, now, than to consult our best current theories. Moreover, the causal powers of the special sciences are indifferent to some real changes at the microphysical level. Not every change at the microphysical level corresponds to a medical, biological or psychological change in causal powers.

This is not to say that these causal powers arise out of nowhere, or that they are not entirely physically composed. Of course they are entirely physically composed. It is to acknowledge, however, that the special sciences provide just as much of a key to ontology as does metaphysics. (56)

It is clear that Kornblith wants his ontology to include not just microphysical entities and causal powers, but also biological and psychological objects and the causal powers attributed to them. But, of course, the parts of all of the things in his ontology must be physical parts: to believe otherwise is just “sheer silliness” (53).

Now Cartesianism or theories like it that posit immaterial entities may be false, but to imply that all such theories are silly is somewhat reckless. If I had to guess why Kornblith thinks that views that posit immaterial entities are silly, it would be that he has a decidedly Cartesian caricature of what that would be like. It appears to me that Kornblith thinks that either all things in nature are physical, and that means material; or that over and above physical things, which primarily consist of material parts, there are immaterial entities that constitute parts of the things that exist in nature. I can sympathize with someone like Kornblith who thinks that the notion of there being things that are constituted by parts, some of which are material and others which are immaterial, is not the way to go. The difficulties associated with such a view are notorious and promise little hope of resolution. However, universal materialism and substance dualism are not the only ways to go.

Aristotle thought that all entities in nature were physical entities, that is, that they were made entirely of matter in the sense that matter was the only stuff there was. But Aristotle did not think that this entailed universal materialism. Rather, Aristotle thought that even for all material being, a principle separable from matter—its form—was necessary to account for its being and for its being what it was. The contrast between the sort of view that an Aristotelian would hold and the one that Kornblith holds is illustrated clearly by the different way that each would conceive of, say, a hydrogen atom. For Kornblith, it appears as if a hydrogen atom is solely material; whereas, for an Aristotelian, a hydrogen atom is material with a specific form. If someone holds that hydrogen atoms, water molecules, muscle tissue, kidneys, brains, bones, and so on are entirely material, then it does seem as if any kind of immaterialism sneaking in to explain something like human life, thought, intentionality, or the like, *is* silly. Once someone like Descartes raises the bar where the demarcation between that which is solely material and that which includes the immaterial puts brute animals below that bar, dualism loses its traction in the real, and we can hardly blame someone like Kornblith for thinking that such a view is silly. Nonetheless, I think that Kornblith goes seriously wrong in not considering an Aristotelian inspired dualism, and his going wrong entails the problems for his position that I raised above. But not all is lost, for I believe that Kornblith’s basic conception can be supplemented in a way consistent with fundamental standards of naturalized epistemology, with an Aristotelian inspired conception of form and formal causality that would enable him to respond satisfactorily to the question I have raised. I will now turn to that supplement.

FORMAL CAUSALITY AND NATURALIZED EPISTEMOLOGY

I have said that I wish to appeal to an Aristotelian inspired conception of form. But what is this notion of form and formal causality and why do I refer to it as "Aristotelian inspired" rather than merely Aristotelian? Answering the second question is easy. I know enough about Aristotle's notion of form and the scholarship on it to know that I do not have the confidence to claim what I present here to be Aristotle's notion of form. Hence, it would be mere hubris for me to present this as Aristotle's notion of form. However, what I will claim about form and formal causality in what follows was developed in reflection upon what I understand to be Aristotle's notion of form, and so unless I am off in left field, it ought to bear significant resemblance to Aristotle's notion of form.

What is this notion of form, inspired by Aristotle, that I wish to import into naturalized epistemology? Since it is so basic (with matter, it constitutes the whole being of an object), it covers a wide range. Form is the actuality of an object. As such it is the metaphysical basis of the acts, operations, capacities, and so on of an object. Form is also the principle of the intelligibility of an object; it is that aspect of the object by which we sensibly or intelligibly apprehend the object. Form is that aspect of the object that is conceptualizable; and it is that aspect of the object that is in the knower when the object is known. Form is the ground of the essence of an object, and as such it is that which determines the species of the object.

Now all this seems like an awful lot of work for one and the same thing to do. I think that one of the difficulties that contemporary thinkers have with an Aristotelian notion of form is the fact that it appears to be the mysterious elixir that Aristotelians promise as the cure for just about any fundamental philosophical problem; but since contemporary philosophers have such an inflated conception of what matter is, form is nowhere really apparent to them and cannot possibly do or be all that is claimed for it by Aristotelians. (Notice that the same contemporary philosophers do not seem to have any problem with matter functioning as their elixir.) In order for an Aristotelian inspired notion of form to return to philosophical and scientific currency, two things must be achieved. First, matter must be deflated to its proper state and recognized as an incomplete ontological principle. Second, there needs to be an explanation of the Aristotelian notion of form that accounts for the unity of the sort of principles that I articulated in the last paragraph. Hopefully, I can make some progress in this regard.

What about formal causality? In what way am I conceiving it? There are three different, but related, sorts of formal causality, and they are as follows. The first sort and the most natural is that type of formal causality that is exemplified in generation and procreation within species. When dogs or humans produce an offspring, or a geneticist clones a sheep, formal causality is paradigmatically exemplified. Form is transmitted from one object or objects to another in such a way that the object becomes that sort of thing. The second type of formal causality is that which is exemplified in intentionality. When I apprehend the fern over there in the corner, the form of the fern is transmitted to me. The third type of formal causality is something like the reverse of the second type. Whereas in the second

type, the form of the object is transmitted to the mind, in the third type, form is transmitted from mind to the object. When I built my shed, I transmitted the form of the shed from me to the object that became (through the transmission of that form) the shed.

Now I take it that what I said in the last three paragraphs is both very close to the sort of things that traditional Aristotelians say about form and also is very foreign to the way in which contemporary philosophers or modern scientists think and talk. This is the situation that I think needs to—and can—be rectified. I will approach the problem from the perspective of the critical issues that we found in the examination of Kornblith's work. Those problems were centered around two of the types of formal causality mentioned above. I will try to show how Boyd's theory of natural kinds and homeostatic property clusters that Kornblith adopts entails that there be formal causality of the first type. There needs to be some account of the nature of causality of the homeostatic property clusters, and in order for that account to be coherent, it will involve formal causality. In addition, Kornblith's assumption of the good fit between our psychology and the causal structure of the world, in order to account for intentionality, needs something more than the evidence from psychological studies concerning how in fact we perform inductions and the appeal to the causal efficacy of evolution. The account needs to be supplemented by a specific version of formal causality of the second type.

Consistent with and sensitive to the principles of naturalized epistemology, in order to make the case for the plausibility of an Aristotelian inspired formal causality, we need to do more than just reaffirm and/or translate the standard Aristotelian formulas into a contemporary idiom. We need to provide considerable evidence from the perspective of naturalized epistemology. Such evidence will need to be primarily empirical evidence provided by the best current theories. I think that such evidence is available, and I will begin with a consideration of the evidence for the basis of a naturalized epistemological account of intentionality, an account that coincides with the scientific realism Kornblith and Boyd affirm (which, of course, is also grounded in evidence provided by the best current theories.)

The empirical basis for such a theory of intentionality can be found within the ecological theory of perception developed by James J. Gibson. Gibson's view of perception is a direct theory of perception and is opposed to a sensation-based theory of perception.⁶ Sensation-based theories of perception assume that visual perception is built from snapshot views of the object. They provide us with a view of perception that is premised upon a "peep-hole" theory of vision within which the optic array is conceived of as "a frozen picture, and ambiguities of size, distance, edges, and layout arise in viewing a picture."⁷ In such a view "sensory inputs are converted into perceptions by operations of the mind."⁸ Sensation-based theories of perception are based on the unquestioned assumption that perception is

⁶James J. Gibson, *The Ecological Approach to Visual Perception* (Boston: Houghton Mifflin, 1979) pp. 60–61.

⁷Gibson, "New Reasons for Realism," *Synthese* 17 (1967) 162–72, here 165.

⁸Gibson, *The Ecological Approach*, p. 20.

based on sensations, or sense data, or sense impressions, and that in some way the mind converts these sensations into percepts. In a sensation-based theory “the brain is faced with the tremendous task of constructing a phenomenal environment out of spots differing in brightness and color. If these are what is seen directly, what is given for perception, if these are the data of sense, then the fact of perception is almost miraculous.”⁹ Gibson’s theory is an ecological theory of perception because it is premised upon the fact that perceivers are animals operating within an environment. As such they move around in and interact with the environment in multifarious ways. Because of that interaction and through our perceptual systems, the invariants in the environment can be perceived. The theory is a “direct” theory of perception because, unlike in the sensation-based view, the invariant objects in the environment are not constructed by the subject or the subject’s brain from the visual images on the retina transmitted to it; the animal with its physiological components is a perceptual system that is able to obtain information about the environment directly:

It is not necessary to assume that *anything whatever* is transmitted along the optic nerve in the activity of perception. We need not believe that *either* an inverted picture or a set of messages is delivered to the brain. We can think of vision as a perceptual system, the brain being simply part of the system. The eye is also part of the system, since the retinal inputs lead to ocular adjustments and then to altered retinal inputs, and so on. The process is circular, not a one-way transmission. The eye-head-brain-body system registers the invariants in the structure of ambient light. The eye is not a camera that forms and delivers an image, nor is the retina simply a keyboard that can be struck by fingers of light.¹⁰

As Gibson notes, whereas sensation-based theories of perception are premised upon sense data as the elements of perception, his direct theory of perception is based upon the assumption that there are certain properties of the energy flux at the skin of the animal that do not change, and there are other properties in that energy flux that do change. The properties in the energy flux that do not change are the invariant properties, and these invariant properties are the invariant properties of the environment.¹¹

Ecological optics is based on the notion of the medium of ambient light, and the notion of an ambient medium is predicated upon the fact that animals move about in an environment and such locomotions create transformations in the medium of perception. Similarly, in an ecological theory of perception, we would get ambient arrays for the other sense modalities:

If we understand the notion of a medium, I suggest, we come to an entirely new way of thinking about perception and behavior. The medium in which animals can move about (and in which objects can *be* moved about) is at the same time the medium for light, sound, and odor coming from sources in the environment. An enclosed medium can be

⁹Ibid., 61.

¹⁰Ibid.

¹¹Gibson, “New Reasons for Realism,” 163.

“filled” with light, with sound, and even with odor. Any point in the medium is a possible point of observation for any observer who can look, listen, or sniff. And these points of observation are continuously connected to one another by paths of possible locomotion. Instead of geometrical points and lines, then, we have points of observation and lines of locomotion. As the observer moves from point to point, the optical information, the acoustical information, and the chemical information change accordingly. Each potential point of observation in the medium is unique in this respect.¹²

Gibson’s notion of the ambient array is the empirically based theoretical concept that enables him to construct a direct theory of perception, in contradistinction from a representation or sensation-based theory of perception. Gibson has no objection to their being sensations or retinal images, and so on, but he does object to the view that our perception of the world is epistemically based upon these entities: “Seeing of an environment by an observer existing in that environment is direct in that it is not mediated by visual sensations or sense data.”¹³ At best sensations, sense data, the retinal image, and so on would be merely physiological or psychological vehicles that contribute to the causality of perceptual awareness: “The theory of information-based perception begins with the assumption that sensory impressions are occasional and incidental symptoms of perception.”¹⁴ In any case, in Gibson’s view, it is clear that “we do not *see* retinal images” or anything like that. “We see the world.”¹⁵ We see the world because the world is our environment and that is *given* to our awareness through the medium of the ambient array. “We have a direct knowledge of the world around us.”¹⁶ “The perceptual systems yield an awareness of objects—one that sometimes does not include any awareness of the receptors stimulated. It is admitted that the qualities of sight, sound, touch, taste, and smell are interesting and that they reflect important facts of neurology. They are not to be confused, however, with the acts of looking, listening, touching, tasting, and sniffing which have a quite different neurological basis.”¹⁷

Although Gibson is not a philosopher or an epistemologist, there are clear epistemological implications of his view. That perception is not based upon sensations, sense data, the retinal image: this is an epistemological proposition. Gibson’s theory is that perception is epistemically grounded in the picking up of information: “Direct perception is not based on the having of sensations. The suggestion will be that it is based on the pickup of information.”¹⁸ The pickup of information is possible only because the energy impinging upon the perceiver comes packaged with a pattern or structure or form.¹⁹ Whatever the mechanism of perception is, its functional role is that information about the environment is conveyed to the animal that

¹²Gibson, *The Ecological Approach*, 17.

¹³Gibson, “A Theory of Direct Visual Perception” in *The Psychology of Knowing*, ed. Joseph R. Royce and Wm. W. Rozeboom (New York: Gordon and Breach, 1972) pp. 215–40, here 215.

¹⁴Gibson, “New Reasons for Realism,” 162.

¹⁵Gibson, “A Theory of Direct Visual Perception,” 224.

¹⁶*Ibid.*, 227.

¹⁷Gibson, “New Reasons for Realism,” 163.

¹⁸Gibson, “A Theory of Direct Visual Perception,” 215.

¹⁹Gibson, “New Reasons for Realism,” 163.

exists and acts within that environment. There is stable, unbounded, permanent stimulus-information in the ambient optic array and the visual system can explore and detect this information. Hence, in Gibson's view, I do not perceive fleeting fern-ish images or sense data and from them construct the invariant fern; I just perceive the fern. As I look at the fern from this angle and that and see it within the pot in the corner of the room, there may be images alright, but these images are not the objects of awareness: "No one is aware of the sequence (of images) but only of the total sum."²⁰ Hence, in Gibson's view we have an epistemic foundationalism with the foundations being the information concerning the variants and invariants in the environment, which is picked up in perception. In a sensation-based theory, the implication is that if there are foundations and if the foundation is information, it is information about sensation or something of the sort.

There are some specific examples of the way in which Gibson's view of perception differs from the sensation-based view that are particularly helpful. A sensation-based view of perception has difficulties accounting for our perception of depth, edges, obstacles, surfaces that are occluded, and so on. If one's theory is that the perception of the world is grounded in the sensations themselves, where there is no sensation (say, of an occluded surface), it is hard to explain how there could be any perception. However, in Gibson's view of perception as the pickup of information about the environment, we directly perceive depth, edges, occluded surfaces, and so on, even though there are no sensations or images upon which they are based: "When the information for occlusion of one surface by another is picked up there is no sensation for the occluded surface but it is nevertheless perceived. And the information for the occlusion of one surface by another *is* picked up by vision."²¹ Visual perception is determined by the information in the ambient optic array, but the observer is not by any means a passive spectator here, for she selects the information that is of interest and the pickup of information is dependent upon the animal's attention: its maturation, practice, and perhaps even training and education.²² The information that is there to be perceived is not just a set of signs or representations that need to be interpreted by the animal; the information actually *specifies* the environment. Gibson himself believes that his theory of perception gives us new reasons for realism, and he thinks that the principal hypotheses from his theory of perception that call for realism are the following: (1) the existence of stimulus information, (2) the fact of invariance over time, (3) the process of extracting invariants over time, and (4) the continuity of perception with memory and thought.²³

Not being a cognitive psychologist, I am not capable of assessing the validity of Gibson's theory, but it is a respected theory in the discipline and is viewed by many in the field as one of the leading contenders for the best empirical account of perception. It is programmatic and requires development, particularly regarding the

²⁰Gibson, "A Theory of Direct Visual Perception," 222.

²¹*Ibid.*, 224.

²²*Ibid.*

²³Gibson, "New Reasons for Realism," 167–68.

notion of the pickup of information. How does it happen, what is the mechanism by which information is picked up? More needs to be said about this by Gibsonian psychologists and other empirical investigators. But if something like Gibson's theory of perception rather than a sensation-based theory is correct, it will satisfy two objectives. First, it provides the empirical base for an Aristotelian inspired conception of the sort of formal causality that is operative in intentionality. Having such an empirical base is crucial for the plausibility of an Aristotelian inspired notion of formal causality. Aristotle's epistemology was grounded in his empirical sciences of physics, biology, and psychology. Once the empirical base of Aristotle's view was rejected, his conception formal causality operative in intentionality lost its moorings and became a mysterious dogma. Dogmatic acceptance of standard sensation-based theories of perception increases the mystery near to the level of paradox. Conjoining an Aristotelian conception of intentionality with sensation-based theories of perception is just not feasible. But Gibson's view of perception entails a realism and an epistemological foundationalism of the Aristotelian sort: one based upon the notion of formal causality and the natural operations of the human organism. The second benefit of Gibson's theory of perception is that it provides Kornblith with the sort of resources he needs to adequately address the questions I raised about his position on the justification of induction. As I argued in detail above, Kornblith needs an account of the good fit that exists between our psychology and the causal structure of the world. A Gibsonian psychology of perception can provide him with that. If I am right then, a Gibsonian psychology is what clinches the synthesis of naturalized epistemology with an Aristotelian conception of formal causality.

Let us take a look at the way that a Gibsonian theory of perception helps Kornblith address the problem of fit. According to Kornblith, we are somehow able to apprehend the objects in the world and their causal structures. Our apprehension of these objects in the world is not based on superficial properties of the objects, but upon deeper properties that are relevant to the object's being of a natural kind. As detailed above, there are two questions here for Kornblith: how is any awareness of the world at all possible, and how is it that our apprehension is focused on salient rather than superficial properties of objects? Kornblith himself recognizes the difficulty of accounting for these abilities within the context of sensation-based theories of perception. Gibson's theory, if true, seems to provide simple answers to these questions. Our awareness of the world is direct. As he says, "We see the world." If it is information about the world that is directly transmitted from the environment to the perceiver, the perceiver is aware of the world because that is just what perception *is*: our apprehension of the world. As we saw above, Gibson does not just state this as a metaphysical dogma; it is a clear and unequivocal deductive consequence of his empirically based ecological theory of perception. The question of how it is that we focus our apprehension on salient rather than superficial properties of objects is likewise answered. Gibson's theory of perception entails that one of the critical abilities a perceiver has is the ability to distinguish between the invariant versus the variant properties of the environment and the objects within the environment and that perception is intimately linked with memory and thought

in the enterprise of perception. It seems clear that the invariant properties of objects are going to generally correspond to the salient rather than the superficial properties of objects, and the superficial properties of objects would correspond to the variant properties of objects. Hence, given such a theory of perception and its links to memory and thought, we would seemingly be inclined to project those invariant or salient properties of objects rather than those that are variant or superficial. If perception disclosed the distinction between the kinds of properties Kornblith argues must be distinguished in order for induction to be reliable, then perception provides the grounds for our inductive practice. If perception discloses the distinction between the kinds of properties which Kornblith argues must be distinguished in order for induction to be reliable, then perception provides the grounds for our inductive practice.

The way in which formal causality comes into play here is as follows. Gibson's theory entails that in perception we apprehend the invariant properties of objects even though the sensations that we have continually vary. Gibson exaggerates the separation between his direct theory of perception and traditional sensation-based theories, for his theory must be sensation-based as well—there can be no perceptions without sensations. Gibson argues that his theory is not sensation based but rather based upon the pick-up of information; however, he confuses epistemic and ontological grounds. Gibson may be right that from the set of sensations that correspond to an object of perception, we cannot and do not rationally infer or construct the object. In other words, the set of sensations does not provide us with an adequate epistemic ground for the perception of the object. On the other hand, Gibson cannot be correct when he states that “[d]irect perception is not based on the having of sensations.”²⁴ Of course, perception is based on sensations in the sense that without sensations there can be no perception. I think that Gibson was cornered into this exaggeration by the poverty of his metaphysical and epistemological pre-suppositions. In the Aristotelian position, the cognition of the invariant within the variant is a consequence of the fundamental relation between the ontological principles of form and matter in objects, which is also the psychological ground of the epistemic principle of human perception. In a substance, the substantial form is invariant despite its matter and superficial (accidental) forms varying. Gibson's theory entails that there are invariant properties of objects in the environment and that human perception is epistemically grounded in our recognition of such invariant properties. Gibson's theory of perception improves upon the Aristotelian theory of perception by providing it with a mechanics that is consistent with current scientific theory, but it retains the essential Aristotelian insight of formal causality.

As we saw above, Kornblith holds that our conceptual and inferential tendencies “dovetail” with the causal structure of the world, that they are “tailored” to the causal structure of the world, and that the causal structure of the world “cooperates” with our conceptual and inferential tendencies. He even mentions a “preestablished harmony.” In Gibson's view, this is all quite comprehensible. Our

²⁴Gibson, “A Theory of Direct Visual Perception,” 215.

conceptual and inferential tendencies “dovetail” with the causal structure of the world because the function of perception is the transmission of such information about the environment. And the causal structure of the world “cooperates” in a very strong sense with our conceptual and inferential tendencies. Perception is a dynamic process. The environment, as it is, is there to be perceived, the media of perception include the information about the world that would disclose the nature of the world. Perceivers acting upon the environment (that is, looking about, feeling, moving) can and do exploit the media for the information that it needs.

It seems clear to me that Kornblith needs something like Gibsonian psychology in order to explain the conceptual and inferential tendencies that ground his argument for the justification of induction. With a Gibsonian view complementing his argument, the good fit that exists between our psychology and the nature of the world is accounted for in a way that explains the general reliability of our capacities. It also seems clear to me that Gibsonian psychology presumes a sort of Aristotelian formal causality. Gibson’s view that perception is the transmission of information and the sort of information that he thinks is transmitted is what makes this clear. The information transmitted in perception is information about the variants and invariants in the environment. What is information, how is it transmitted, and what are the alternatives to information transmission in a theory of perception? In a sensation-based theory of perception or any other sort grounded upon a stimulus-response model, what one gets is merely something like a physics or mechanics of perception, even if the theory is couched in immaterialism. It seems to be the focus in such theories to determine what matter is being transmitted to the organism and how it is transmitted. Gibson disavows such an approach when he rejects the images, sense data, and so on as essential to the information transmission by which perception occurs.²⁵ This view probably seems bizarre, but only if we ignore the Aristotelian distinction between form and matter. In an Aristotelian conception of information, it is clear that the physics or material of transmission is epistemically irrelevant to what is transmitted. You may be reading this in e-mail, on white bond paper, as imprints in the sand, or even listening to it on tape, but none of these material modes of receiving the information is essential to the information transmitted. Whatever the vehicle of transmission, the only fact that is important is that the information is somehow conveyed to you; and it is clear that in communication we do in fact achieve such information transfer and that it is the information transfer that grounds, explains, and as such causes there to be communication at all. The same basic sort of transmission occurs when I receive, in perception, the information that there is a fern in the corner of the room. What is essential to (successful) perception is that I pick up that information through perception, not the mechanics of how that information is transmitted to me. Clearly there will be conditions attached to what constitutes successful material or mechanical modes of information transmission in perception, as with any information transmission, but when information cannot be transmitted through a medium, it is

²⁵Gibson, *The Ecological Approach*, 61.

not because of the material elements as such, but merely whether the material elements can be identically (in)formed.

Gibson's theory of perception presumes a formal causality because he holds that the form or structure of the environment and the objects within it is transmitted through perception to the perceiver such that the perceiver apprehends the form or structure of the object perceived. What is essential to his conception of perception is that successful perception occurs when the form or structure of the object perceived is identical to the form or structure by which the perceiver apprehends the object and that identical form or structure is what is transmitted through perception. It is no wonder that Gibson himself affirms that at the ecological level, Aristotle's conception of the world is the correct one.²⁶

So, the argument here has been that in order for Kornblith to account for the good fit that exists between our psychology and the world, he needs something like a Gibsonian psychology. But what is distinctive about such a psychological theory that enables the question of fit to be resolved is that such a psychological theory entails an Aristotelian type of formal causality. So, if I am right, in order for Kornblith to adequately account for the fact of intentionality, he needs to supplement his naturalized epistemology with a new old fashioned Aristotelian inspired conception of formal causality. But Kornblith needs formal causality not only in order to account for intentionality; he also needs it to account for the homeostatic property clusters to which he appeals in his conception of natural kinds.

Following Boyd, Kornblith holds that natural kinds or their essences are constituted by homeostatic property clusters. These are property clusters that co-occur in important cases as a result of homeostasis, and the "presence of some of the properties tends to favor the presence of the others, or there are underlying mechanisms or processes which tend to maintain the presence of the properties." Boyd admits to the causal importance of these homeostatic property clusters but is vague as to what that amounts to. There are a number of issues involved here regarding the causal efficacy of these property clusters. The first issue concerns what Boyd claims to be the "contingency" of the cluster. In affirming the contingency of the property clusters, I gather that he wants to maintain that these property clusters are not determined *a priori* and also that it is not necessary (either *a priori* or *a posteriori*) that the properties in a cluster *always* co-occur. There may be some exceptions to co-occurrence. But in this sense, all accidental, random, or non-essential property clusters will be contingent as well. But if Boyd and Kornblith want homeostatic property clusters to constitute natural kinds, and if Kornblith wishes to use projections of these natural kinds to justify induction, then the contingent clustering of the homeostatic properties must be in some way tighter or stronger than mere accidental or random clustering. Unless we get this implication from Boyd and Kornblith, their scientific realism makes no sense: there is no cutting the world at its joints, because then there would not be any significant joints, or every cut made would be constitute a cutting of a joint.

²⁶Ibid., 99.

Now it is clear that Boyd wants the homeostatic property clusters to be a tighter cluster than the mere contingency found in accidental clusters when he says that these clusters, as homeostatic, “tend to favor the presence of the others, or there are underlying mechanisms or processes which tend to maintain the presence of the properties.” But the notion of tending *to favor* is a mere metaphor, these clusters are not capable of favoring at all; and the notion of *tending to maintain* makes sense only if it is interpreted as some sort of causal efficacy. He presumably means to deny causal determinism here: these properties *tend to* but do not *entail* the presence of the others. What other sort of interpretation can we give to the homeostatic property clusters or their underlying mechanisms or processing *tending to* maintenance of the other properties besides there being some sort of *causation* of co-occurrence? Additionally, if the paradigm cases of homeostatic property clusters are biological species, then the causal significance of the clusters even goes beyond a mere tending to favor the presence of other properties in the cluster (however that is to be determined)—there is the tendency of the homeostatic property cluster to replicate itself. There are then two ways in which causality is featured by the homeostatic property clusters. There is the causality involved in the homeostasis itself; if there really is something homeostatic about these clusters, then there must be some causal ground for it. Second, there is the causality involved in the property cluster replicating its kind. Both of these causal connections are examples of formal causality, not efficient or material causality.

The replication of DNA is the paradigm example of formal causality in nature. DNA replicates by separating into two single strands, each of which serves as a template for a new strand. The new strands are copied by the same principle of hydrogen-bond pairing between bases that exists in the double helix. Two new double-stranded molecules of DNA are produced, each containing one of the original strands and one new strand. This “semiconservative” replication is the key to the stable inheritance of genetic traits.

If DNA exists, if it is the mechanism responsible for the inheritance of genetic traits, and if it replicates as stated above, this is empirical scientific proof of formal causality. And if what Boyd and Kornblith and Aristotle hold is true, namely, that biological species are the paradigm examples of natural kinds, formal causality is operative at the most physical and epistemologically fundamental level. Versions of efficient, material, final, or Humean causation, either separately or conjointly, will not be sufficient to account for the type of process that is evident in the replication of DNA. We have here, in nature, a clear mechanism whereby the form or structure of one bit of matter is transmitted to another bit of matter.

Now, of course, Aristotle did not know this and so the way in which he describes formal causality, namely, on the basis of his conception of physics and biology, is incomplete and tainted by its association with the outmoded Aristotelian physical sciences. However, contemporary philosophers, especially naturalized epistemologists like Kornblith, need to cull the insights of Aristotelian realism. If philosophers like Kornblith and Boyd are intent upon developing

a scientific realism that is non-reductive, implies a non-Humean concept of causation,²⁷ includes real natural kinds and an epistemological position wherein which the apprehension of those natural kinds is affirmed and is the basis of induction, the completion of such a position will require formal causality. There is at least one element, however, of Aristotle's conception of form at the level of species that, it seems to me, is not salvageable, and that is his view that the forms that are species are eternal. Holding that species are eternal is tantamount to holding a sort of formal causal determinism. If we translate Aristotle into Boyd, we would get homeostatic property clusters that necessarily co-occur; and I do not think that that sort of position is defensible in the face of empirical science. On the other hand, facing up to this and modifying one's metaphysics and epistemology accordingly seems to me to be compatible with the way in which Aristotle conceived the relation between the natural and the philosophical sciences. So, I would suggest that a true contemporary Aristotelian would accept the evolution of species and consequently reject formal causal determinism.

Another problem for importing an Aristotelian conception of form into a view that also takes contemporary science as an accurate description of the world is that Aristotle holds that "no substance is composed of substances which exist in actuality" (*Meta. Z* 13, 1039a4). But it seems that according to contemporary science, the parts of substances, particularly the micro-particles, have essences and therefore also exist in actuality. It is so that Aristotle holds that the parts of substances are not themselves substances; as he says, a severed hand is not really a hand. Well, this view is a bit more subtle than just the position that the parts of substances are not themselves substances. A severed hand is not a hand all right—it lacks the actuality of a hand, but it is surely *some* kind of substance. What a human being is, is determined by its form, and knowing what a human being is means apprehending its form or substance. But the human being is not constituted by the form of the hand plus the form of the arm plus the form of the brain and so on. These parts, as parts of a human, are informed as human parts. When separated from the human, they no longer have that same form. Likewise, a human is constituted mostly by water, which means H₂O, but this does not entail that we consider a human being mostly a body of water. The water that constitutes a human being, when constituting the human becomes, firstly, a part of a human, and not primarily a water molecule.

There are certain elements of Kornblith's and/or Boyd's conception that should be rejected as well. Kornblith and Boyd reject reductionism but embrace materialism. As I argued above, this is based on a skewed notion of the physical and the consequent ignorance of the importance of form and formal causality. Second, although naturalized epistemology and Aristotelianism is a good marriage, it is one that needs counseling. Neither an Aristotelian nor a naturalized epistemological view nor its synthesis will be able to resolve all of the significant epistemological problems without the aid of traditional epistemology. I think that it is undeniable

²⁷Boyd, "What Realism Implies," 13ff.

that the natural and other empirical sciences can supply us with essential information and boundaries for constructing a plausible epistemology. On the other hand, it does not seem that this makes the standard epistemological questions (e.g., “What are the conditions for epistemic justification?” or “Is our knowledge foundational?”) pointless or resolvable according to the principles in either a naturalized epistemology or a new old fashioned Aristotelianism. There is enough epistemological grist to keep all kinds of mills going.²⁸

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