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Metaphysicians and philosophers of science have a varied and longstanding interest in classification but (in my view) an unimpressive track-record of getting things right. One plausible explanation for this state of affairs is an excessive deference to *a priori* philosophical theory. For example, realists often suppose that scientific categories are "legitimate" to the extent that they correspond to natural kinds. If the accompanying metaphysics of such kinds is essentialist, then legitimacy is implausibly denied to many (if not *most*) categories in "special science" domains like biology, materials science, and psychology. Though naturalistically-inclined philosophers are apt to reject such austerity as unmotivated and out of step with the way scientists conduct their investigations, they face the difficult challenge of unifying an apparently heterogeneous set of classificatory practices via a philosophical theory (or, less ideally, a collection of philosophical theories).

Muhammad Ali Khalidi's *Natural Categories and Human Kinds* is firmly rooted in the second tradition and faces its peculiar challenges. Starting from cases of "paradigmatic natural kinds" — such as elementary particles, chemical elements, chemical compounds, biological species — Khalidi toggles between careful and well-informed analyses of what allows them to play the role that they play in their respective sciences and the delicate work of theory-building, seeing his method as an instance of Goodmanian "reflective equilibrium" (3). The theory that emerges borrows from some brief remarks of Carl Craver's from a ([2009]) paper critiquing Boyd's well-known Homeostatic

Property Cluster (HPC) account. Khalidi fleshes out this "Simple Causal Account" over the course of the book, applying it to both the paradigmatic natural kind categories and a diverse array of distinctive and little-examined case studies, and drawing out a number of substantive theses about natural kinds in the process.

Though an excellent offering overall, I found myself unconvinced and unsatisfied at various points in the book. No surprise there; as someone who already has a view in this area, disagreement is all but inevitable. In the end, the book does not quite meet the second challenge described above; the Simple Causal Account remains, to my mind, too simple to do all that Khalidi wants it to do. Perhaps these concerns just reflect my own hangups. Wait and see. First, let me describe Khalidi's position and discussion in a bit more detail.

As he points out in the first chapter, those concerned with natural kinds typically ask two questions: *what are natural kinds?* and *which kinds are natural?* His own interest lies primarily with the second question — on how to demarcate the natural from the nonnatural kinds (41). Metaphysical Realists do not provide an answer to this question. Essentialists do, but it's the wrong answer — or so Khalidi argues in Chapter 1 as he patiently picks apart various theses about natural kinds often espoused as a packaged deal with essentialism (e.g., that kinds are definable by intrinsic, microstructural properties that are ultimately discoverable by scientific inquiry and possessed by those kinds of necessity (12–13)).

While on its surface a somewhat narrow ground-clearing exercise — Khalidi has as his opponents primarily Ellis ([2001]) and Wilkerson ([1988]) — the arguments in this chapter are rich and by and large convincing (though not, of course, above criticism). They'd be an excellent way to introduce the uninitiated to (recent) historically important metaphysical disputes in this area. In

many cases, the arguments pivot on taking a certain interpretation of particular cases of plausible natural kinds and pointing out how they falsify one of the theses in question.

This strategy recurs throughout the book. Khalidi's naturalism subordinates the metaphysics of natural kinds to their role in scientific investigation. This leads, in Chapter 2, to a collapse of the distinction between natural kinds on the one hand and "epistemic" or "investigative" kinds on the other. As he puts it, "natural kinds *are* investigative or epistemic kinds, in the sense that they are the categories revealed by our systematic attempts to gain knowledge of nature. Since science provides us with the best insight into the kinds that exist in nature, all the categories of science can be corrigibly considered natural kinds" (43). One might quibble about the scope of this claim (can we not think of important "categories of science" — say, 'double-blind randomized clinical trial' or 'eppendorf tube' — that are not credibly natural kinds?), but Khalidi's naturalist credentials are prominently on display here. Epistemic considerations drive his metaphysics of natural kinds, to the extent that he has one at all. Here Khalidi looks to Locke and, more prominently, Mill for historically-grounded inspiration. He accepts the spirit, if not the letter, of Mill's insistence that natural kinds should be associated with many properties; he sees "no good reason" to require they be "indefinite in number or inexhaustible" (54). He also allows that different disciplines can construe the scientific importance of natural kinds (and thus the conditions under which a category should be recognized as a kind) in different ways (57), a stance that leads to some interesting conclusions in later chapters. The softening of Mill continues with the allowance that kinds might have indefinite boundaries and nevertheless be real and projectible. Such "fuzzy kinds" are distinct from the cluster, or polythetic, kinds that Khalidi embraces in the special sciences. Nor must kinds be disjoint or even hierarchically ordered (72), a case that he extends informatively from previous work (Khalidi [1998]).

Though the picture emerging towards the end of Chapter 2 begins to resemble Boyd's HPC view in outline and posture, Khalidi rejects the requirement that the "sociability" of a property cluster, to use Chakravartty's apt term ([2007], p. 170), must be underpinned by causal homeostatic mechanisms. Even if biological species can be accommodated in the HPC picture, there's reason to be more skeptical about higher taxa: "Here, the only serious candidate for a mechanism is genealogical descent…. But if that is the case, then it might seem as though there is no work left to do for the homeostatic property cluster" (75). This stretch of argument seemed somewhat weak. For as Khalidi develops the dialectic, the proponent of HPC ends up being saddled with yet stronger theses concerning the role of the relevant mechanisms to individuate the kinds. I could easily imagine a committed advocate of HPC responding. In the end, I agree with Khalidi's conclusion about the HPC account (and have independently argued along similar lines (Slater [2014])), but remain unconvinced about his alternative account.

This Simple Causal Theory (SCT) of natural kinds is first described by Craver: "natural kinds are the kinds appearing in generalizations that correctly describe the causal structure of the world regardless of whether a mechanism explains the clustering of properties definitive of the kind" ([2009], p. 579). Khalidi notes the coherence of this weakened stance with early remarks of Boyd's: that "successful induction and explanation always require that we accommodate our categories to the causal structure of the world" ([1991], p. 78) and points out that HPC "posit[s] something that any account of natural kinds should — namely, causal relations among the properties associated with a natural kinds" (73). The abandonment of causal homeostatic mechanisms in the SCT thus represents a relatively minor change from the HPC stance. For the causal structure of the world — though "more variegated and diverse" (78) than HPC's mechanistic strictures officially require — is

still structure enough to ground the role of natural kinds in inductive inference (79). About this grounding relation, however, Khalidi has relatively little to say — an issue to which I return momentarily.

With his SCT sketched, Khalidi turns to extending it and revealing its worth in accommodating a diverse collection of case studies and its relevance for addressing a number of questions in the philosophy of science more generally. Chapter 3 addresses the possibility of multiply realized kinds in the special sciences, reductionism, and crosscutting. Here, kinds from fluid dynamics (*viscosity*, *Newtonian fluid*), chemistry, and astronomy figure prominently and illustrate what Khalidi refers to as the aspectual nature of natural kinds (128). Chapter 4 takes up the complications raised by categories in biology and the social sciences. Is there an important distinction between kinds defined by their synchronic causal properties and those defined by their causal history (etiological kinds)? Yes: "etiological kinds do seem to constitute a genuinely different type of natural kind" (135), but they should still be ranked among the natural kinds. Not so for Millikan's "copied kinds": Khalidi denies that these mark an important distinction within the natural kinds. Arguments for these conclusions are detailed and largely compelling.

The most interesting discussions in this chapter (and perhaps in the entire book) concern social and psychological kinds. Khalidi argues convincingly that realists' insistence on the "mind-independence" of natural kinds is too blunt a requirement to be plausible. Nor have previous attempts to nuance this concept succeeded. Yet Khalidi argues that there can be some "human kinds" — including some "institutional", "conventional", and "normative" kinds — that are "in some sense mind-dependent and interact with our beliefs about them" but in such a way as not to "render them subjective" or "undermine a realist attitude towards them" (150). Our aim, he argues,

"should not be to guarantee mind-independence but to ensure world-dependence" (165). I cannot do justice here to Khalidi's discussion in this section, but suffice it to say that anyone working on classification in the social sciences should pay attention to it.

Chapter 5 examines several more putative natural kinds — including *lithium*, *polymer*, *virus*, *cancer*, *Attention Deficit Hyperactivity Disorder* — filling in details of his account and illustrating contrasts with competitors. The final chapter turns back to more abstract theoretical concerns concerning the precise relationship between natural kinds and properties, the importance of causality in his account, and whether we should accept pluralism about natural kinds. Here Khalidi defends several interesting theses that have been brewing throughout the book, the most noteworthy in my view being the claim that the "naturalness" of natural kinds comes in degrees turning on the range of background conditions against which a given kind maintains its associated properties, the degree of stability which the kind enjoys, and the prevalence of the members of the kind (81, 213). While I fail to see the relevance of the last consideration, the former dimensions of natural kinds do seem important and I suppose lead to interesting consequences for a metaphysics of natural kinds. This is not a matter which Khalidi pursues very far, however. Remember: his focus is on the demarcation question more than the *what are they* question.

To my mind, this is the biggest missed opportunity in the book and hence where I found myself wanting to hear much more. While Khalidi places great emphasis on the projectibility of natural kinds, he fails (in my estimation) to explain why causality is necessary for it. Nor is it always clear whether projectibility is sufficient for being a natural kind. He writes that categories like "*viscosity* and *Newtonian fluid* earn their keep in science by virtue of their projectibility, and *projectibility is an indication* that these categories track properties and kinds that enter into real causal relations" (90)

and that "projectibility is a *diagnostic* feature of natural kinds" (98, my emphasis), but elsewhere he suggests that the category *Newtonian fluid* "is a natural kind *because* it is projectible" (108, my emphasis). In the end, I read Khalidi as placing the focus in the SCT on categories carving along joints in the "causal structure of the world"; natural kinds are best understood "as nodes in causal networks" (207). Their projectibility is a reflection of "their causal nature" (123); "[w]hat enables us to project from one property associated with the natural kind to another, or from one natural kind to another, is the fact that they enter into causal relations with one another" (98).

But one might fairly wonder: is the fact that some property instantiations associated with a category enter into causal relations with other property instantiations enough to explain the category's projectibility? Khalidi has relatively little to say on this point. And what he *does* say suggests a quite weak stance on what projectibility requires. At one point, he writes that "[s]ince the causal relationships among the properties associated with natural kinds are capable of being captured in laws or generalizations, these kinds are eminently projectible" (99). But for most philosophers, the gap between laws and generalizations is vast and important. Even if one doubts (as Khalidi does) that strict laws with unrestricted ranges of application are needed and can be found in the special sciences, one still might wish to characterize the continuum that lies between accidental generalizations and fundamental laws. As causation can be found at both ends of this continuum, the SCT *seems* to allow for gruesome, unprojectible counterinstances.

One of the things that HPC was supposed to explain is how a cluster of properties could come to *reliably* be found together, irrespective of whether that kind participated in any natural laws. Khalidi and I agree that the HPC story is too demanding in certain ways; I'd go on to contend that both HPC and the SCT Khalidi advocates is not demanding enough. Nor is it clearer to me now what

precisely is meant by such phrases as "the causal structure of the world" or "causal patterns". These concepts seem to evoke a notion of type and similarity — Khalidi refers to "types of causal processes" recurring across different contexts (110) and the sameness or similarity of causal patterns (111) — but says little about how these notions should be understood. Can the SCT recursively account for kinds causal processes that characterize certain kinds of causal processes? I'm not sure.

Without clearer guidance, I found it difficult to apply the account to some cases. For instance, in his discussion of institutional kinds, Khalidi distinguishes between several classes of conventional kinds, the *most* conventional of which are disqualified from being natural kinds:

> the properties associated with them are so associated because they are explicitly
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> codified in a set or rules or laws. Therefore, if a conventional kind *K* is associated
>
> with a set of properties, that is not because there are *causal* connections between these
>
> properties. Rather, they are associated with one another because a social institution or
>
> community has decided to associate these properties with the kind. (156)

But presumably even artificial sets of rules enter into networks of causal relations too — otherwise, what would be the point of declaring them? While Khalidi makes room for subsequent participation in causal patterns that fit his model ("we might discover that most permanent residents are urban dwellers"), he wishes to draw a sharp line between the kind of "discovery" this would represent and a discovery stemming directly from the conventional kind's associated rules (e.g., "that most permanent residents do not have a criminal record at the time of becoming permanent residents"). I am skeptical that this distinction can be cleanly drawn given the resources Khalidi offers us.

Clearly there is much more to be said about this particular example and the general issues at stake. That's characteristic of Khalidi's thoughtful work. My (potentially idiosyncratic) concerns

aside, *Natural Categories and Human Kinds* is clearly a "must-read" for anyone working anywhere near this area of philosophy. It is to my mind the most up-to-date, comprehensive, and interesting book-length treatment of natural kinds available today. Both newcomers to this area of inquiry and seasoned veterans will doubtless benefit from its study. Khalidi's straightforward prose and careful argument makes the book a pleasure to read and think about; his patient stage-setting and summary make it a live option for advanced undergraduate courses in the philosophy of science.

Acknowledgements

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