**Essay Review**

# Natural Kinds, Causes and Domains: Khalidi on how science classifies things

Vincenzo Politi

University of Bristol

Department of Philosophy

Cotham House

BS6 6JL, Bristol (Uk)

E-mail address: plxvp@bristol.ac.uk

**Natural categories and human kinds: classification in the natural and social sciences.**

M.A. Khalidi; Cambridge University Press, Cambridge, 2013, pp. 264, Price $ 90 hardback, ISBN 978-1-107-01274-5

## 1 Natural Kinds, Essences and Scientific Categories

We live in a world full of things: a world which is full not only of particulars, but also of groups or collections of things. Scientific laws and explanations are often about such groups or collections of things. It is often assumed that the groups of things science is about reflect the actual structure of the world. It is assumed, in other words, that science discovers *natural kinds* - that is, Nature's actual joints.

Philosophers often define natural kinds in essentialistic terms: to be a member of a natural kind means to share an 'essence' with the other members of that kind. Such an essence can be an idea (Plato), a list of essential attributes (Aristotle), a set of necessary and jointly sufficient properties (Putnam and Kripke). Essentialism is traditionally opposed to conventionalism, for which kinds do not correspond to the real structure of the world and are useful human constructions.

In more recent times, some philosophers have started to question the 'natural kinds-essentialism' link. Some have argued that the existence of an essence is an unnecessary metaphysical assumption (Mellor, 1977). Others have urged us to consider whether the idea of a rigid or static essence can do justice to the often dynamic and mutable kinds in biology and in the other special sciences (Dupré, 1981, 1993). For these philosophers, speaking about natural kinds does not imply speaking of essences.

Moreover, the debate on natural kinds is gaining a renewed momentum due to a general shift in how metaphysics is conceived. A growing number of philosophers

has abandoned the a priori speculations typical of the so-called 'armchair philosophy' and is pursuing philosophy in a naturalistic fashion: in a way, that is, which is both consistent and continuous with the sciences. Naturalized metaphysicians, therefore, look at the sciences to develop and test their philosophical conceptions of natural kinds.

It must be specified that while naturalism is opposed to a priori speculations and while essentialism is opposed to conventionalism, naturalism is not necessarily opposed to essentialism. Although philosophers like Dupré use examples from the special sciences to argue against essentialism, philosophers like LaPorte (2004) accept the idea that natural kinds have essences, but argues that such essences are discovered a posteriori and through the self-correcting dynamics of conceptual change and precisification characteristic of the development of the sciences.

*Natural Categories and Human Kinds* (Khalidi, 2013) is a recent and timely contribution to current debate on natural kinds. Because of the growing sophistication of this debate, it is necessary to make careful distinctions in order to appreciate the originality of Khalidi's position. Khalidi's view on natural kinds is *naturalistic*: if we want to know what Nature's joints really are, we should look at the actual carving job carried out by our best scientific practices. Like LaPorte, Khalidi is a *fallibilist*: our best scientific theories may be revised or abandoned and so can our current classifications of natural kinds. Unlike LaPorte, however, Khalidi is an *anti-essentialist*: he argues against the idea that membership in a natural kind is a matter of possessing an essential set of necessary and sufficient properties. Like Dupré, Khalidi is a *pluralist* and *anti-reductionist*: he does not believe that there is only one true classification system and that there are natural

kinds only at the so-called ‘fundamental level’ of microphysics. Khalidi develops his pluralistic and anti-reductionistic position on the basis of a deep appreciation for the special sciences but, unlike Dupré, he thinks that only the scientific inquiry, which is driven by epistemic purposes, discover natural kinds and that, therefore, there are important differences between scientific and folk classifications.

Khalidi’s conception of natural kinds has both an epistemic and a metaphysical component. The epistemic component is evident from the title of the book: Khalidi does not speak of ‘natural kinds’ (things the human independent world really consists of) on the one hand and of ‘human categories’ (human-made categories devised for classificatory purposes) on the other. In his view, natural kinds correspond to the categories that (both natural and social) scientists use in inductive generalizations, explanations and scientific laws.

The metaphysical reason for why natural kinds correspond to scientific categories is that they are “nodes in causal networks” (Khalidi 2013, 200): in other words, natural kinds are “associated with properties instantiated by the co-instantiation of other properties” (Khalidi 2013, 80) clustered together in virtue of some causal relation. One of the examples Khalidi uses to explain his conception of natural kinds is the property of *viscosity*, that is the measure of the resistance to flow within a substance. In fluid mechanics, the property of viscosity is associated to the natural kind of *Newtonian fluid*, the viscosity of which remains constant. Viscosity can be associated to different sets of properties: in fact, while the viscosity of a fluid depends on the strength of its chemical bonds, the viscosity of a gas depends by the density of its molecules and the viscosity of a porous solid is

depends by the size of its pores. This means that different 'networks of properties' instantiate the property of viscosity, which in turn is associated with some natural kinds like Newtonian fluid.

It is important to stress that, for Khalidi's, the link between properties and natural kinds is not accidental. In his account, and in a sense which will be discussed in more detail in section 3, some properties are causally associated with others; the 'networks of properties' Khalidi speaks about are 'causal networks'. Khalidi follows Chakravartty (2007, 170), who says that "Properties, or property instances, are not the sort of things that come randomly distributed across space-time. They are systematically 'sociable' in various ways". Khalidi adopts Chakravartty's metaphor of the systematic sociability of some properties, adding that natural kinds are "the locus of this sociability" (Khalidi 2013, 14).

To summarize: since natural kinds are implicated in the repeatable causal patterns of their properties (metaphysical component), natural kinds are 'projectible' and, therefore, are the basis for the explanations, generalizations and laws in the sciences (epistemic component).

One of his book's merits is that, before developing a positive account of natural kinds, in Chapter I Khalidi analyses and ultimately refutes essentialism, both in its traditional formulations and in its more recent developments (i.e., Ellis 2001, Wilkerson 1988). Khalidi disentangles with great clarity five essentialist theses: necessity and sufficiency, modal necessity, intrinsicality (the members of a natural kind always possess all its essential properties, no matter what their relation with the other things in the world is), microstructure (the essential properties of a kind are located at the 'fundamental level') and discoverability by science. For Khalidi,

all the members of the same natural kind do not have to share the same set of necessary and sufficient properties, the special sciences discover natural kinds the properties of which cannot be reduced to some more fundamental level, there is not only one true classification and natural kinds may be 'fuzzy' and overlapping. He develops compelling arguments against all of the essentialistic theses but the last one: Khalidi in fact agrees that natural kinds are discoverable by science.

In Chapter II, Khalidi develops his view of natural kinds as nodes of causally linked properties instantiated by the co-instantiation of other properties. He further develops this argument in Chapters III, IV and V, where he discusses several examples of natural kinds in the special sciences, including the social sciences.

In the final chapter, Khalidi reflects on his naturalistic approach and tackles in more depth the thorny issue of realism. In his view, the categories of the social sciences are natural kinds despite being 'mind-dependent'. For instance, although the categories of the human sciences 'depend' on the existence of human minds, such a mind-dependence does not undermine the fact that some of them are real kinds. Khalidi's view invites a serious reconsideration of the traditional realism debate, starting from a finer characterisation of the 'mind-dependent *vs* mind-independent' dichotomy.

*Natural Categories and Human Kinds* is full of interesting arguments to which I cannot do justice within the limits of this review. In the following sections, I will limit myself to a general assessment of the epistemic and the metaphysical components of Khalidi's conception of natural kinds. In particular, I will discuss the relationship between kinds, generalizations and laws on the one hand (section 2) and Khalidi's 'simple causal theory' on the other (section 3). I will conclude my

review by discussing what I think is one of Khalidi's most original insights: his view about levels and domains (section 4).

## 2 The Epistemic Component: Science, Generalizations and Laws

In Khalidi's view, science discovers natural kinds and their properties, which are projectible. In virtue of such projectibility, natural kinds possess explanatory power and are used as a basis for inductive generalisations and laws. Natural kinds therefore corresponds to categories appearing in generalisations and laws.

Khalidi disagrees with those philosophers, like Dupré (1999), who argue that both scientific *and* folk classifications may reflect real subdivisions. This is because, in his view, scientific classifications are primarily introduced to serve what he calls 'epistemic purposes', while folk classifications often serve 'non-epistemic' purposes. If folk classifications happen to individuate some natural kinds, then these natural kinds will "tend to be aligned with categories found in one or the other branches of the sciences or they become so aligned in the course of inquiry" (Khalidi 2013, 64). Khalidi maintains that his position should not be deemed as "insular or scientistic", since it "merely identifies natural kinds with the categories that are posited as a result of a systematic inquiry, as opposed to categories that we might be inclined to conceive as a result of a casual or passing acquaintance with some aspects of reality". (Khalidi 2013, 55-56).

It is not entirely clear, however, whether it is always possible to make a neat distinction between the epistemic and non-epistemic purposes driving an activity or a form of inquiry. It is also debatable whether science is the only systematic inquiry, or whether it is always the case that non-scientific activities have a casual

or passing acquaintance with the natural world. Gastronomy, for instance, appears to be a rather systematic inquiry which is driven by the purpose of discovering some interesting and projectible properties of food; it would be difficult, however, to say whether the purpose of 'discovering some properties of food in order to know how to make dishes which taste good' is either 'completely epistemic' or 'completely non-epistemic'. This point is exemplified by a recent monograph on the 'science of chocolate' published by the Royal Society of Chemistry (Beckett, 2008). Is the 'science of chocolate' an actual science? If it is, is it driven only by epistemic purposes? If it is not, does it nonetheless happen to discover something true about the properties of cocoa? Furthermore, it is also debatable whether science is driven only and exclusively by epistemic purposes. Here I will not try to assess, or even summarise, the current status of the debate on whether science is an exclusively epistemic and 'value-free' activity. I will only suggest that perhaps the separation between epistemic and non-epistemic purposes is not as clear-cut as Khalidi seems to suggest.

Leaving aside Khalidi's (perhaps too rigid) distinction between epistemic and non-epistemic activities, in the remainder of this section I want to focus on another issue concerning the epistemic aspect of his account of natural kinds. Throughout his book, Khalidi claims that natural kinds corresponds to the scientific categories used in inductive generalisations and scientific laws. However, he does not discuss the differences between 'generalizations' and 'laws' (or whether such differences may pose some problems to his view).

A widely discussed example of the differences between generalizations and laws is the comparison between two general statements involving two natural kinds,

namely *gold* and *uranium*: ‘every sphere of gold (*Au*) is less than a mile in diameter’ and ‘every sphere of enriched uranium (*U235*) is less than a mile in diameter’. The first statement is only contingently true: it just happens that there is not enough gold in the world to make a gigantic gold sphere, but there is nothing in the nature of gold which would forbid the in principle existence of a gold sphere with a mile long diameter. A uranium sphere of a mile in diameter, by contrast, would be well beyond uranium’s critical mass, the amount of mass necessary to maintain a nuclear chain reaction. The second statement is therefore necessarily true: it is physically impossible to have a sphere of uranium of that size. That is why the second statement is a law, not a simple generalization (see the discussion in van Fraassen, 1989, p. 27).

Khalidi is interested in how science groups things on the basis of ‘relevant properties’ – properties which are projectible and possess explanatory power. The difference between laws and generalizations is that the latter may group things on the basis of properties which are not prejectible and do not possess explanatory power. Do these consideration pose a threat to Khalidi’s account of natural kinds? Not necessarily. For instance, Khalidi could just amend his position by saying that natural kinds correspond to the categories of science appearing *only* in scientific laws (after carefully distinguishing scientific laws from generalizations). The point remains, however, that Khalidi’s account would benefit from a better articulation of the relationship between ‘natural kinds’, ‘generalizations’ and ‘scientific laws’.

In concluding this section, I must clarify that Khalidi says that natural kinds are discoverable by science, not that all scientific categories of science correspond to natural kinds. Paraphrasing Socrates’s response to Euthypro’s definition of piety,

Khalidi explains that “a kind is not natural because it is a scientific kind; rather, it is a scientific kind because it is natural” (Khalidi 2013, 79). Saying that natural kinds are scientific categories may tell us something about how to recognize natural kinds, but it still does not tell us what makes something a natural kind. It is in order to solve the “Ehuthypro’s problem of natural kinds” that Khalidi adds a metaphysical components to his conception.

## 3 The Metaphysical Component: From Causal Mechanisms to Simple Causes

Science does not determine what natural kinds are, it only gives us a reliable guide to discover them. What we need is an explanation of *why* natural kinds correspond to scientific categories. What begins as an epistemic conception of natural kinds leads Khalidi to take a metaphysical step toward causality.

Things can be classified in different ways, depending on the set of properties one looks at. On the one hand, not every set of properties defines a natural kind. For example, the class of ‘all the white things in the world’, defined by the property ‘being white’, is not a natural kind. On the other hand, having rejected the essentialist conception for which membership in a kind is determined by an intrinsic set of necessary and sufficient properties, Khalidi needs to find an alternative theory to explain how natural kinds are associated with some relevant properties.

Khalidi develops his own position by firstly examining and assessing a fairly recent non-essentialist view: the so-called ‘homeostatic property cluster’ (HPC) account of natural kinds developed by Boyd (1999). In Boyd’s account, the properties associated with a natural kind are there for a reason – namely, a causal

reason. Properties are not associated with a kind on conventionalist grounds but, rather, on the basis of a causal mechanism which keeps them together into a homeostatic cluster. Following HPC, to be a member of a kind entails possession of at least some of the properties involved in the causal mechanism which defines that kind.

HPC has been widely discussed by philosophers of science, who have questioned whether such an account of natural kinds manages to escape the Scylla of essentialism and the Charybdis of conventionalism. On the one hand, it has been claimed that HPC simply substitutes the set of necessary and sufficient properties of traditional essentialism with causal mechanism, so that one could just say that the essence of a natural kind is its causal mechanism (Griffiths, 1999, p. 218). On the other hand, it has been pointed out that the individuation, delimitation and characterisation of a causal mechanism always involves a degree of conventionalism, especially when it comes to deciding whether two mechanisms are 'mechanisms of the same kind'. For example, saying that scientists look at what goes on in the hippocampus of a mouse in order to get a better understanding of how the human hippocampus works means saying that scientists agree to focus on the similarities between mice's and humans' hippocami while disregarding their (many) dissimilarities. In other words, in order to study the hippocampus of a mouse as if it was 'the same as' a human hippocampus, scientists must conventionally agree that the causal differences between the two hippocampi are negligible (Craver, 2009, pp. 585-589).

After examining the problems faced by HPC, Khalidi proposes to save the causal ingredient of Boyd's account while dispensing with its homeostatic requirement

and with the idea of a causal mechanism. With regards to the homeostatic requirement, Khalidi argues that the cluster of properties associated with a kind does not need to remain stable through time. Giving up the homeostatic requirement allows one to see why 'etiological kinds' and kinds characterized by a 'causal history' are as natural as the kinds characterized by a homeostatic and synchronic cluster of properties. It is therefore possible to explain, among several other examples, why the ever-evolving biological species are indeed natural kinds.

Khalidi also dispenses with the idea of causal mechanism. As Anscombe (1993) pointed out, 'cause' is a general concept, an umbrella term which covers different types of causal relations. To say that "C caused E" does not necessarily imply that "C caused E in virtue of a causal mechanism". This means that properties belonging to the same cluster may entertain various types of causal relations without necessarily being part of a causal mechanism.

Khalidi borrows from Craver the expression 'simple causal theory' (SCT), for which "natural kinds are the kinds appearing in generalisations that correctly describe the causal structure of the world regardless of whether a mechanism explains the clustering of properties definitive of the kind" (Craver, 2009, p. 579). In Khalidi's views, natural kinds are 'nodes' associated with a set of properties whose co-instantiation causes the instantiation of other properties. For the SCT, such properties are not necessarily co-instantiated in virtue of a 'homeostatic causal mechanism', but may be linked in virtue of other causal relations.

One may wonder whether Khalidi's SCT manages to dispense with the idea causal mechanisms after all. In other words, could it be that the 'causal networks' of co-instantiated properties Khalidi talks about are actually causal mechanism in

disguise? Khalidi's rejection of the concept of a causal mechanism is motivated by his desire to include etiological and historical kinds among the natural kinds. What Khalidi argues against, therefore, is a particular conception on which mechanisms are rigid and unchangeable. However, several philosophers have moved away from this rather simplistic characterisation of a causal mechanism and toward more nuanced definitions. In recent years, causal mechanisms have been characterised as structures performing a function in virtue of their components (Bechtel and Abrahamsen, 2005), as complex systems in which some of their components produce a behaviour (Glennan, 2002), and as entities or activities producing regular changes (Machamer et al., 2000). More recently, the concept of a mechanism has become even more 'liberalized' and it has been defined as organized entities and activities responsible for a phenomenon (Illari and Williamson, 2012).

Khalidi's 'simple causal theory' thus risks being indeed too simple. Philosophers of a mechanistic persuasion may argue that 'causal networks of co-instantiated properties' are still 'mechanisms'. Such mechanisms are not static, rigid and homeostatic; but, in fact, to reject the idea of a homeostatic mechanism does not imply rejecting the idea of a mechanism. For example and interestingly enough, Craver - from whom Khalidi borrows the idea of SCT - argues that functional explanations are just incomplete explanations awaiting the discovery and specification of the underlying causal mechanisms (Craver, 2007). It is true that Craver speaks only of neurological mechanisms – in other words, he does not develop a general theory of causal mechanisms across the sciences – but the point still remains that it is not entirely clear to what degree Khalidi's argument for

dispensing with causal mechanisms is capable of persuading someone who is convinced about the necessity of speaking of causality in mechanistic terms.

If on the one hand it is debatable whether the substitution of causal mechanisms with SCT is successful, on the other hand one may even wonder whether Khalidi's view could actually dispense with the concept of causality *tout court*. Khalidi speaks of properties clustered in causal networks without such causal networks necessarily being mechanisms; but why do these networks need to be 'causal' to begin with? Perhaps one problem with *Natural Categories and Human Kinds* is that too little space is devoted to the hugely problematic concept of causality, which Khalidi presupposes without further clarification. Of course, making presuppositions is not bad in itself and it is often necessary: one cannot simply talk about everything and must make some assumptions in discussing any topic, especially considering that a topic like causality would arguably need a book-length treatment on its own. Nevertheless, since the concepts of causality, causal mechanism and causal explanation play a crucial role in his conception of natural kinds, Khalidi could have attempted to provide clearer definitions of such concepts.

Finally, I wonder whether the metaphysical component of Khalidi's conception of natural kinds can solve the "Euthyphro problem" mentioned at the end of the previous section. For Khalidi, defining natural kinds as "nodes in causal networks" should clarify why natural kinds correspond to the categories of science, even if not every category of science is a natural kind. In fact, while it may be the case that natural kinds are described by scientific laws, not every scientific law is about

a natural kind. As Bird (2011) reminds us, this is the case of Newton's law of gravitation, which takes the form of the following equation:

(1) $F = G\ (m_1 m_2 / r^2)$

where F stands for force, G for the gravitational constant, $m_1$ and $m_2$ for the masses of two objects and r for the distance between them. Equation (1) is indeed a scientific law, but no natural kind appears in it: 'mass', in fact, is a property possessed by many kinds of entity.

Bird also considers Coloumb's law of electrostatic force:

(2) $F = -\varepsilon 0\ (q_1 q_2 / r^2)$

where F is force, ε0 is the Coloumb's constant, $q_1$ and $q_2$ are two electrically charged bodies and r is the distance between them. As in the previous example, 'being electrically charged' is a property possessed by many kinds of entity. Although one may say that both Newton's law of gravitation and Coloumb's law of electrostatic force are about the different kinds of entity which possess a mass and an electrical charge respectively, the point here is that such laws are not about a specific natural kind. The case of (2) does not even discriminate between positively charged entities and neutrally charged entities. To say that the scientific category of 'either charged or neutral object' which appears in Coloumb's law corresponds to a natural kind may stretch the concept of a natural kind too far.

The problem is now the following: how can Khalidid's conception explain *why* Newton's law of gravitation and Coloumb's constant do not involve natural kinds? It should not be controversial to say that 'mass' is a projectible property associated with other properties: in fact, the mass of an object is associated to its resistance

to being accelerated by a force and to its gravitational attraction to other bodies. In light of these considerations, perhaps it would be possible to regard 'objects with a mass' as a node in a causal network of co-instantiated properties: does it mean that 'objects with a mass' is a natural kind after all? We intuitively know that 'objects with a mass' and 'either charged or neutral object' are not natural kinds, but it is not entirely clear how Khalidi's conception can save this intuition.

## 4 Scientific Domains

As I explained in the previous sections, Khalidi argues against essentialism: he rejects the ideas that natural kinds must not overlap and that there is only one true classification system. Instead, he adopts a pluralistic and anti-reductionistic stance and he defends the idea that kinds may be both natural and cross-cutting. Khalidi's view is developed on the basis of an appreciation of the structure of the sciences: we don't find natural kinds only at the fundamental level of physics; special sciences (including the social sciences) discover and are about natural kinds too. In other words, "contemporary science reveals a world of multiple domains, each characterized by distinct causal process". It is by looking at the actual structure of science that Khalidi comes to the conclusion that "there may be many more natural kinds than some philosophers might have expected" (Khalidi 2013, 219). Indeed, one of the most interesting parts of Khalidi's book is the account of scientific domains.

In Khalidi's view, natural kinds are associated with domains which are in turn the objects of study of scientific disciplines. For Khalidi, scientific domains are both 'spatio-temporal' and 'aspectual'. They are spatial in the sense that the

properties of a domain depend on its spatial scale – i.e., it makes sense to speak of the properties of viscosity or concentration only for large collections of molecules, while other properties are found only at a very small spatial scale. A domain also has temporal characteristics in the sense that, generally speaking, the size of the entities is inversely proportional to the time-scale of the processes they undergo – i.e., elementary particles decay in a matter of microseconds while the evolution of living organism by natural selection takes a much longer time.

Domains are also aspectual in the sense that they reflect the 'interests' with respect to which phenomena are investigated. Different domains may classify some of the entities at the same spatio-temporal level in different ways because they are interested in some of their properties rather than others. For example, the Linnaean subdivision in species and the entomological categories of *larva* and *pupa* group some of the same individuals in different ways because these classifications are interested in different properties at the level of the biological realm.

In order to understand its novelty, I suggest contrasting Khalidi's account of domains with some philosophical conceptions of so-called levels of reality. That Nature is organized into a hierarchy of levels is a view that may result palatable to many reductionists. In this view, in fact, there is the 'fundamental level' of physics from which all the higher levels of the pyramid supervene. Not every scientist and philosopher accepts the pyramidal conception of Nature. Perhaps the world is not structured in a hierarchic fashion; instead of being organized into levels, it may contain a multiplicity of domains, governed by different laws, tracking different causal patterns and individuating different kinds. The world may be

'dappled' (Cartwright, 1999). Although it represents one of the best known alternatives to the pyramidal conception of Nature, however, it must be said that Cartwright's work is more concerned with the truth and scope of scientific laws, with what scientific models are about and with the boundaries between the sciences and their domains, rather than with the explication of what scientific domains consist of.

A middle-way between the pyramid view and the dappled world view has been recently developed by Mitchell (2009). In Mitchell's view, the world consists of levels of increasing complexity, with the higher levels not being completely reducible to the lower ones. The lower levels offer a range of possibilities, some of which will be actualized at the higher levels; which possibilities will be actualized at the higher levels, however, is a matter of contingency and cannot be predicted by looking at the lower levels only. In fact, not all the properties and phenomena manifesting at higher levels can be reduced to lower levels. Nevertheless, the range of lower-level possibilities puts non-trivial constraints on what can be realized at higher levels: they establish, in a sense, the 'rules' that must be followed at higher levels. For example, although it is not entirely reducible to the physical level, the chemical level cannot instantiate 'physical impossibilities'.

To clarify her view, Mitchell analyses the example of *clinical* or *major depression*. Depression has genetic causes (the presence of the gene *5-HTTP*), bio-chemical causes (at the level of the inhibited neurotransmitter), psychological causes (at the level of the personal history of the individual), social causes (at the level of the social context the individual lives in). The genetic cause is not sufficient, since the presence of the gene *5-HTTP* simply increases the chance of

developing depression (and, for yet unknown reasons, the chance is even higher if the gene is inherited from the mother). Furthermore, causes can work both ways – that is, both in a bottom-up and in a top-down fashion. For example, living in a deprived social environment may have an effect on bio-chemical processes at the neurological level. This example shows how, in Mitchell's view, the world is not as dappled as Cartwright seems to claim, but the fact that it is organised into levels does not support reductionism either.

It is unfortunate that Khalidi does not develop his conception of scientific domains in more detail, because I think it represents both a reasonable middle-way between the dappled and the pyramid views and, at the same time, adds further complexity to Mitchell's view. For Khalidi, scientific disciplines formulate laws and explanations about scientific domains; the scientific categories used in the scientific laws correspond to natural kinds, which are clusters of properties co-instantiated by other properties. The properties associated with natural kinds do not need to be instantiated by the same clusters of properties – as in the already discussed case of the different networks of properties which instantiate the property of viscosity in solid, liquid or gaseous materials. But not only. On my reading, Khalidi's proposal can help us to understand that the kinds of a particular domain do not need to be all associated to all the properties instatiated of all the levels of that domain.

To put Mitchell's example in Khalidi's terms, clinical depression is a kind of mental disorder associated to properties which have causes at the genetic, bio-chemical, psychological and social level. However, not every kind of mental disorders classified by current psychiatry are associated to properties at so many

levels. This would be the case, for instance, of the developmental disorders once known as *autism*, *Asperger syndrome* and *pervasive developmental disorder not otherwise specified* (PDD-NOS), and which the fifth edition of the American Psychiatric Association's *Diagnostic and Statistical Manual* has recently lumped together under the category of *autistic spectrum* (AS). It appears, in fact, that AS is a node in a network of properties at the genetic, biochemical and neurological level, but not at the social and environmental level. Although there is not a clear understanding of all its causes yet, in fact, the theories for which AS is caused by the psychological trauma of growing up in an emotionally cold environments (for example, with a detached mother) have been discarded. On the other hand, it may be the case that some mental disorders are mainly associated to properties at the psychological or environmental level, but not necessarily with properties at the genetic level. In short, the domain of psychiatry contains kinds associated to properties at different levels, but not every psychiatric kind is associated to properties situated at all the levels of the psychiatric domain.

Khalidi defines scientific domains in spatio-temporal and aspectual terms. What emerges is a complex image of natural kinds associated to partially overlapping and domains which compenetrate different levels. I think that his view deserves to be developed in more detail and can potentially shed some new light on the relation between 'domains', 'levels' and 'scientific disciplines' – a topic that more philosophers should paid more attention to.

## 5 Conclusions

Khalidi has developed a naturalistic theory of natural kinds which is anti-essentialist and pluralist. His book offers a fresh perspective on the philosophy of natural kinds and it is my hope that both essentialists and anti-realists will respond accordingly, thus re-sparking the debate.

Khalidi's view relies on the notions of causality and causal mechanisms, which are hotly debated among philosophers. Progress in the understanding of these notions may shed new light on Khalidi's original proposal.

That said, *Natural Categories and Human Kinds* is written with exemplary clarity and the numerous examples from the special sciences are discussed patiently. This book is an exciting and timely contribution to the current debate on natural kinds and anyone remotely interested in this debate should read it.

**References**

Anscombe, G. (1993). Causality and determination. In E. Sosa and M. Tooley (Eds.), *Causation*, Oxford: Oxford University Press, pp. 88–104.

Bechtel, W. and A. Abrahamsen (2005). Explanation: a mechanist alternative. *Studies in History and Philosophy of the Biological Sciences*, 36, 421–441.

Beckett, S. (2008). *The Science of Chocolate*. Cambridge: The Royal Society of Chemistry.

Boyd, R. (1999). Homeostasis, species and higher taxa. See Wilson (Ed.), *Species: new interdisiciplinary essays*, Cambridge, MA: MIT Press, pp.141–185.

Cartwright, N. (1999). *The Dappled World. A study of the boundaries of science*. Cambridge: Cambridge University Press.

Chakravartty, A. (2007). *A Metaphysics for Scientific Realism: knowing the unobservable*. Cambridge: Cambridge University Press.

Craver, C. (2007). *Explaining the Brain*, Oxford and New York: Oxford University Press.

Craver, C. (2009). Mechanisms and natural kinds. *Philosophical Psychology*, 22, 575–595.

Dupré, J. (1993). *The Disorder of Things*. Cambridge, MA: Harvard University Press.

Dupré, J. (1981). Natural kinds and biological taxa. *Philosophical Review*, 90, 66–90.

Dupré, J. (1999). Are whales fish? In D. Medin and S. Atran (Eds.), *Folkbiology*, Cambridge, MA: MIT Press, pp. 461–476.

Ellis, B. (2001). *Scientific Essentialism*. Cambridge: Cambridge University Press.

Glennan, S. (2002). Rethinking mechanistic explanation. *Philosophy of Science*, 69, S342–S353.

Griffiths, P. E. (1999). Squaring the circle: Natural kinds with historical essences. See Wilson (Ed.), *Species: new interdisiciplinary essays*, Cambridge, MA: MIT Press, pp. 209–228.

Illari, P. and J. Williamson (2012). What is a mechanism? Thinking about mechanisms across the sciences. *European Journal of Philosophy of Science*, 2, 119–135.

Khalidi, M. A. (2013). *Natural Categories and Human Kinds: Classification in the natural and social sciences*. Cambridge: Cambridge University Press.

LaPorte, J. (2004). *Natural Kinds and Conceptual Change*. Cambridge: Cambridge University Press.

Machamer, P., L. Darden, and C. Craver (2000). Thinking about mechanisms. *Philosophy of Science*, 67, 27–39.

Mellor, D. (1977). Natural kinds. *British Journal for the Philosophy of Science*, 28, pp. 299–331.

Mitchell, S. (2009). *Unsimple Truths. Science, complexity and policy*. Chicago: Chicago University Press.

van Fraassen, B. (1989). *Laws and Symmetry*. Oxford: Claredon Press.

Wilkerson, T. (1988). Natural kinds. *Philosophy of Science*, 63, 19–42.