The Grounded Functionality Account of Natural Kinds

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Abstract: Most philosophical theories of natural kinds fail to reflect successful classificatory practice in science. Some are developed from a priori considerations and are too detached from actual classificatory practice. Other theories of natural kinds are more naturalistic, but they posit overarching criteria for natural kinds that fail to capture the diversity of reasons scientists have for positing natural kinds. This paper highlights these problems and offers an account of natural kinds that better reflects actual classificatory practice in science. The account offered has two normative components. First, natural kind classifications should achieve the functions they are posited to attain, whether those functions are epistemic or non-epistemic. Second, how natural kind classifications achieve those functions should be grounded in the world and not merely in our thoughts about the world. The resultant account of natural kinds, the Grounded Functionality Account, is properly attuned to scientific practice and at the same time has a significant normative component.

Introduction

What are natural kinds? In addressing this question, philosophers have started from various interpretations of what the problem of natural kinds is –a metaphysical question about the fundamental building blocks of the world, a question about the reference of substance terms in everyday language, an epistemological question about the basis of inductive inferences, and so on. Answers to these questions radically diverge. Some philosophers posit robustly metaphysical accounts of kinds, positing that natural kinds have essences (Ellis 2001) or that they are universals (Hawley and Bird 2011). Other accounts of natural kinds emphasize the causal nature of such kinds –they either are based upon causal mechanisms (Boyd 1999a) or are nodes in casual networks (Khalidi 2018). Still others offer less metaphysical accounts of natural kinds. Such accounts see kinds as clusters of co-occurring properties (Slater 215), or as groupings that best support our inductive and explanatory practices (Magnus 2012), or as those groupings identified by converging epistemic practices (Franklin-Hall 2015).

In this chapter we argue that philosophical theories of natural kinds are insufficiently focused on classificatory practice in science. Available theories of natural kinds tend to suffer from two defects. First, some of those theories are developed according to a priori considerations (Reydon 2010a, 2010b, 2014; Ereshefsky 2018). As we will show, the result is that such theories of natural kinds fail to help us understand why classificatory practices in science are successful. Furthermore, theories of natural kinds are frequently overarching theories –they claim that all natural kind classifications are posited to capture the same universal aim, such as highlighting the causal structure of the world. However, we argue that scientists have a variety of reasons for positing natural kind classifications and extant philosophical theories fail to capture that variety. Given these features of philosophical accounts of natural kinds –their a priori basis and their overarching nature– there is a discrepancy between the philosophical literature on natural kinds and classificatory practices in science.

This chapter highlights the above problems, and it offers an account of natural kinds that better reflects classificatory practices in science. We call this account the 'Grounded Functionality Account of Natural Kinds' or 'GFA' for short. On the one hand, this account is attentive to the local practices of classificatory projects. On the other hand, it offers two constraints on natural kind classifications, namely that such classifications serve the epistemic (as well as non-epistemic) functions they are posited for, and that they satisfy those functions because they are grounded in the world. The GFA, in other words, suggests that natural kind classifications help scientists achieve various aims and that success is due to those classifications properly capturing some aspects of the world. Which aspects of the world natural kinds classifications should be grounded in will vary dramatically, and that diversity makes sense given the variety of aims scientists have for constructing classifications.

As mentioned earlier, there are various accounts of natural kinds in the philosophical literature. Those accounts tend to be positive accounts of natural kinds –they give an account of the nature of natural kinds. But there are also negative or skeptical accounts of natural kinds. Hacking (2007a) and Ludwig (2018), for instance, argue that philosophical research on natural kinds has been fruitless and philosophers should stop trying to develop theories of natural kinds. We believe that the GFA blunts such skepticism. The GFA offers an account of natural kinds that is attentive to the variety of reasons scientists have for positing natural kind classifications. At the same time, it highlights a positive philosophical project that philosophers and scientists engage in when they think about natural kinds and classification.

What follows is broken into four parts. The next section of this chapter illustrates that philosophical accounts of natural kinds tend to be overly detached from actual classificatory practice in science. In that section we answer the question why a new account of natural kinds is needed. The third section suggests a way to better align a theory of natural kinds with the diverse epistemic aims of scientists and presents the main aspects of our account of natural kinds, the GFA. In the section that follows, we flesh out some of the details of our account and tackle the vexing question: What makes a natural kind natural? In the final section we turn to recent skepticism concerning natural kinds and suggest that our account blunts that skepticism.

Philosophical Accounts of Natural Kinds are not Naturalistic Enough

As mentioned in the introduction, we are concerned that philosophical accounts of natural kinds are too divorced from actual classificatory practice to be relevant to that practice. In our investigation of natural kind theories we start from the assumption that philosophical theories of natural kinds should be relevant to successful classificatory practices in science. There are various ways in which a philosophical theory of natural kinds can be relevant to classificatory practices in science. Consider two straightforward – and, we think, uncontroversial – desiderata of natural kind theories. One is that we would like a philosophical approach to natural kinds to help us understand why classificatory practices in science are successful. That is, we'd like a philosophical analysis of natural kinds to tell us why certain classifications help achieve the epistemic and non-epistemic aims of the scientists that use them. Another desideratum of a philosophical theory of natural kinds is that we would like such a theory to give us some guidance in determining whether a classification is indeed a classification of natural kinds, and to distinguish natural kinds from other kinds. An account of natural kinds should have some normative force and give some guidance in telling us whether a classification is a good candidate or a poor candidate for being a natural kind classification.

In the philosophical literature there is a class theories of natural kinds that do not meet either of these desiderata. Here we have in mind philosophical theories of natural kinds that are developed on primarily a priori grounds. Such accounts of natural kinds are not developed by observing and learning from actual classificatory practices in science, but are developed on the basis of a priori considerations and intuitions. Such accounts often come from the philosophical school of analytic metaphysics. One problem with such approaches to natural kinds is their reliance on intuitions. A well-known example of such analytic metaphysics is Putnam's (1975) argument for natural kind essentialism involving his infamous Twin Earth thought experiment. Many philosophers have noted that intuitions can be misleading when it comes to metaphysics (see for instance, Callender 2011, Papineau 2015, and Bryant 2017). That is certainly a major concern. But our target here is that such a priori approaches to natural kinds fail to help us understand the success of natural kind classifications in science, nor do they provide guidance in judging whether a classification is a classification of natural kinds.

Consider the debate among philosophers who believe that natural kinds are universals. Such philosophers disagree over the appropriate type of universals that natural kinds are thought to be. Lowe (2006) maintains that natural kinds are substantial universals, as does Ellis (2001). For Lowe, substantial universals are an irreducible type of ontological category in his four-category ontology: natural kinds are a fundamental part of our universe, whereas properties are non-substantial universals. For Lowe, natural kinds are substantial universals characterized by properties. For instance, the kind *water* is a substantial universal characterized by the property of being H_2O. Hawley and Bird (2011) also hold that natural kinds are universals. However, they think that natural kinds are complex universals rather than substantial universals. Complex universals, they suggest, are universals whose parts are universals. They offer the example of the kind *electron*, which is a complex universal consisting of the universals of an electron's mass, charge, and spin.

We won't go into any further details of the debate among philosophers that hold that natural kinds are universals. Instead, we want to highlight that their debate about the nature of natural kinds is so abstract that their a priori theories of natural kinds neither illuminate successful classificatory practices nor give guidance in how to conduct such practices. Take, for example, the shift in taxonomic practices concerning biological species in the early 20th century that shifted from a morphological approach to one focussing on interbreeding. The morphological approach uses morphological similarity to sort organisms into species, while the interbreeding approach does that according to which organisms can successfully interbreed and produce fertile offspring. The interbreeding approach allowed biologists to more accurately sort organisms into species than the morphological approach. The morphological approach incorrectly sorts similar males in different species into the same species, whereas the interbreeding approach revealed that those males belong to different species (Ridley 1996). When considering this case of taxonomic progress one might ask whether the debate over whether natural kinds are substantial universals or complex universals has any relevance to it? Knowing that natural kinds are a particular type of universal does not help us understand why the interbreeding approach is more successful than the morphological approach. Furthermore, knowing that natural kinds are a particular type of universal does not help us judge whether the interbreeding approach is a better approach to biological species than the morphological approach. There is, we submit, a significant disconnect between a priori theories of natural kinds and classificatory practice in science. As indicated by this case of species, a priori approaches to natural kinds do not illuminate why certain classificatory practices in science have been progressive. Similarly, such a priori approaches to natural kinds provide no guidance in discriminating between natural kind classifications and non-natural kind classifications in actual taxonomic practice.

Let's turn to another and more recent a priori account of natural kinds –Franklin-Hall's (2015) "Categorical Bottleneck" account of natural kinds. Franklin-Hall locates natural kinds at the intersection of investigations conducted by different epistemic agents. In particular, she writes that "natural kinds are groupings that match those categories that well serve actual inquirers along with (what I call) 'neighboring agents' – those different somewhat from actual inquirers in their particular epistemic aims and cognitive capacities" (2015, 940). A virtue of Franklin-Hall's account is that it highlights the role inter-subjectivity plays in identifying natural kinds. However, the sort of inter-subjectivity that Franklin-Hall requires is too a priori and too distant from actual classificatory practice in science. The sort of inter-subjectivity her account employs turns on "neighboring agents" where those neighboring agents are, as seen in the quote above, not "actual inquirers." Such "neighboring agents" are *possible* inquirers who occupy positions in what Franklin-Hall (2015, 940) calls an "epistemic agent space" – that is, a conceptual space with all possible epistemic aims and cognitive capacities as its dimensions, and in which all possible inquirers occupy specific locations. Natural kinds, on Franklin-Hall's account, then are identified as those kinds that robustly continue to serve the aims of inquirers under comparatively small movements in "epistemic agent space" towards slightly different aims or cognitive capabilities. But by relying on an abstract "epistemic agent space" and possible inquirers, Franklin-Hall's account is not an account of what natural kind classifications are in actual scientific practice, but an a priori, otherworldly account of natural kinds. Indeed, Franklin-Hall's account is non-operational: how could we check that non-actual inquirers would pick out the same kinds as actual inquirers? Just as in the case of universalist natural kind theories, Franklin-Hall's account is too distant from actual classificatory practice to illuminate such practices: relying on non-actual epistemic agents does not help us understand the success of actual classificatory practices. Moreover, relying on non-actual epistemic agents fails to give guidance in choosing among real classificatory practices.

We have seen that a priori approaches to natural kinds tend to be too distant and irrelevant to actual classificatory practice in science to be useful for understanding how science works. This is a big strike against them. There are of course other approaches to natural kinds that attempt to be more naturalistic and rely less on a priori and intuitive reasoning. However, many of these approaches also fail to capture actual classificatory work in science, and they do so for a different reason. A standard feature of many accounts of natural kinds is that they are overarching accounts of natural kinds. That is, they are theories of the form 'All natural kinds have some feature X.' Proponents of such accounts disagree on what 'X' refers to, but they tend to agree that philosophical accounts of natural kinds should be overarching accounts that apply to all natural kind classifications throughout the sciences. We don't take issue with theories of natural kinds being overarching theories. Our concern is that such overarching theories of natural kinds neglect large swaths of classificatory practice in science. If a philosophical account of natural kinds neglects large parts of classification in science, then it is of little help in understanding many parts of classificatory practice in science. Let's consider some prevalent philosophical accounts of natural kinds that do just that –they neglect large parts of classificatory practice in science.

One overarching criterion often placed on natural kinds by philosophers is that such kinds should be causal kinds (e.g., Boyd 1999a, 1999b, 2003; Wilson *et al*. 2007; Samuels 2009; Craver 2009; Khalidi 2013, 2018). According to this criterion, the members of a natural kind should share a similar set of causal components, mechanisms, or nodes. Boyd, for instance, talks of "causal structures" (1999b, 159) and "homeostatic mechanisms" (1999b, 165), while Khalidi talks in terms of "clusters of causal properties" (2018). Despite the enthusiasm among philosophers for capturing the causal structure of the world, a significant number of scientists produce classifications that do not aim to capture causal kinds (see Ereshefsky and Reydon 2015).

Microbiologists, for example, construct classifications of microbial kinds, but not with the aim of capturing the causal structure of the world. Instead they aim to posit classifications of microbial kinds that are stable and readily identifiable. Why? Because identifying kinds with such properties is vital for research in microbiology and medicine. If, for instance, a bacteriologist is studying the relations among bacteria within a biofilm, she needs to refer to a stable and readily identifiable set of microbial kinds. The same applies to the medical researcher that studies bacteria in our digestive system. The most widely accepted approach to bacterial kinds, the Phylo-Phenetic Species Concept (PPSC) (Roselló-Mora and Amann 2001, Stackebrandt 2006), uses several types of genetic markers to identify bacterial kinds. Those markers are not chosen because they capture the causal structure of the world, or any causal mechanisms in microbes, but because they provide stable and readily identifiable groups of microbes. As Stackebrandt (2006, 36-37) writes, "[b]acteriologists in particular follow guidelines and recommendations that provide stability, reproducibility, and coherence in taxonomy." Though many philosophers are keen on science revealing the causal structure of the world, the pursuit of causal kinds is not of interest to these microbiologists. Those biologists use genetic markers to identify and re-identify groups of organisms in the world such that taxonomy in bacteriology is both do-able and a stable. Philosophers that maintain that natural kinds are causal kinds offer an approach to natural kinds that is irrelevant to the taxonomic work of these biologists. In other words, there is a mismatch between the philosophical desideratum that natural kinds be causal and the reasons many biologists have for positing natural kind classifications.

Let's turn to another requirement that is commonly placed on natural kinds by philosophers, namely, that the members of a natural kind should share numerous co-occurring properties such that natural kind classifications can underwrite induction. Many philosophers hold this assumption (Boyd 1999a, 1999b, 2003; Lowe 2006; Wilson *et al.* 2007; Hawley and Bird 2011; Magnus 2012; Khalidi 2013; 2018; Slater 2013, 2015), which goes back to the British Empiricists, especially Mill's *System of Logic*. Despite the popularity of this assumption, many scientific classifications do not highlight inductive kinds (see Ereshefsky and Reydon 2015).

Consider the kinds of biological taxonomy. One aim of biological taxonomy is to identify branches on the Tree of Life. Taxa, such as species and genera, are considered branches on the Tree of Life. Such taxonomic kinds are first and foremost historical entities and only secondarily groups of organisms with numerous similarities (Ereshefsky 2001). The challenge for those that assert that natural kinds are groups of entities with numerous similarities is that classifying by similarity and classifying by history can conflict. And when they do conflict, the view that natural kinds are inductive kinds fails to capture the classificatory practices of those biologists that classify by history.

As an example, branching on the Tree of life frequently occurs through allopatric speciation, i.e., when one population becomes geographically separated from the rest of a species and gradually evolves into a new species. When a population branches off from its ancestor species, the organisms of both the isolated population and the ancestral branch continue for a while to have the same family of properties. Splitting need not be accompanied by immediate changes in traits; and often traits remain conserved over considerable evolutionary time scales, such that two different branches on the Tree of Life contain organisms that are overwhelmingly similar (Reydon 2006). If we follow the philosophical position that kinds are inductive kinds, we should consider the new branch and the ancestral branch as constituting one species, given that their organisms share a large number of properties. Yet, generally recognized models of speciation hold that when an isolated population branches off from its ancestral species speciation occurs (Coyne and Orr 2004). In short, the aim of biological taxonomy is to classify distinct branches on the Tree of Life rather than clusters of similar organisms. Biologists interested in classifying the Tree of Life reject the common philosophical assumption that all natural kinds should be inductive kinds.

From this example, we see that the philosophical assumption that natural kinds are inductive kinds is inconsistent with some classificatory practices in biology. From the earlier example concerning microbiology, we see that the philosophical assumption that natural kinds are causal kinds is also inconsistent with some classificatory practices in biology. Putting these together we see a pattern. Philosophers promote all-encompassing accounts of natural kinds: *all* natural kinds in science should be causal, or *all* natural kinds in science should be inductive. However, such overarching accounts of natural kinds are inconsistent with highly successful classificatory practices in science. Note that we are not denying that some classifications in science underwrite inductions and some are causal kinds. We are merely pointing out that the tendency of philosophers to propose overarching accounts of natural kinds is mistaken: universal approaches to successful classifications in science fail to capture the breadth of classificatory practices in science.

There are other overarching requirements that philosophers place on natural kinds besides the requirements that natural kinds be causal kinds or inductive kinds. Consider some of the criteria listed by Bird and Tobin (2017): that all natural kinds are mind-independent; that natural kinds should form hierarchies; and that natural kinds should be categorically distinct. Each of these requirements is inconsistent with some successful classificatory practice in science. As we will see later, the requirement that natural kinds be mind-independent is inconsistent with classifications in the human, social, and medical sciences. The requirement that natural kinds be hierarchically arranged conflicts with classificatory practices in chemistry (Hendry 2010, Khalidi 2015). And the requirement that natural kinds be categorically distinct, that is, don't bleed into one another, is violated in some areas of biology (Ereshefsky 2001).

The problem with many philosophical theories of natural kinds is not merely that those theories have counterexamples. It is more pressing than that. If philosophical research on natural kinds is supposed to provide an understanding of our classificatory practices, then such research should learn from our best classificatory practices. By failing to capture the array of epistemic reasons scientists have for positing natural kind classifications, available theories of natural kinds fail to provide an understanding of many classificatory practices in science. Couple that problem with the one we saw earlier, namely that many philosophical approaches to natural kinds are a priori and too removed from actual classificatory practice, and we see that a more practice-oriented account of natural kinds is needed. In what follows, we suggest such an account.

Balancing Naturalism and Normativity

The account of natural kinds we offer is in part inspired by Laudan's (1987, 1990) Normative Naturalism and Woodward's (2014) Functional Account of Causal Reasoning. Laudan developed Normative Naturalism for evaluating the methodological rules of a research tradition.

According to Laudan, science consists of research traditions, which contain theories, methodological rules, and overall aims. By 'methodological rule' Laudan means such rules as: prefer simpler theories, or prefer more unified theories over less unified ones. According to Normative Naturalism, scientists should adopt those methodological rules that best promote the aims of their research tradition. His Normative Naturalism is naturalistic in that the actual aims of a discipline (rather than some philosophical abstraction of science, or an ideal of what science should be) are used to judge which methodological rules to use. It is normative in a goal-directed sense because there are norms for evaluating methodological rules. Woodward's Functional Account of Causal Reasoning works in a similar fashion. According to Woodward, different types of causal reasoning are used to achieve different epistemic goals. He suggests that a type of causal reasoning should be judged by how well it helps achieve the epistemic goal it was posited for. As he writes, "causal information and reasoning are sometimes useful or functional in the sense of serving various goals and purposes that we have," such that talking about causes is best seen as "a kind of epistemic technology—as a tool—and, like other technologies, judged in terms of how well it serves our goals and purposes" (Woodward, 2014, 693-694). Woodward's account is naturalistic because scientists' actual epistemic goals (rather than metaphysical views about what causes are) are used to judge types of causal reasoning. It is normative in a goal-directed way because a type of causal reasoning is evaluated by how well it satisfies the particular epistemic aim it was posited for.

We would like to suggest an approach to natural kinds that is similar in spirit, which we call the Grounded Functionality Account of natural kinds (GFA). It is a functional approach because on the GFA a natural kind classification is judged by how well it functions in achieving the epistemic aims it is posited for.[1] Call this the 'Functionality Condition' on natural kinds. (We will discuss the 'Grounded' aspect of the GFA in the next section.) We can illustrate how the GFA works by using the notion of a *classificatory program* (Ereshefsky 2001, Ereshefsky and Reydon 2015). Classificatory programs are analogous to Laudan's research traditions and consist of three parts: classifications, motivating principles, and sorting principles. The classifications produced by a classificatory program highlight putative natural kinds. Sorting principles sort entities into kinds. Motivating principles are the epistemic aims of a classificatory program (as well as its non-epistemic aims – see below) and motivate why that program should sort entities a particular way. In science, natural kind classifications are posited for an array of epistemic as well as non-epistemic reasons. According to the GFA, a natural kind classification should be evaluated by how well it satisfies the aims of its specific classificatory program.

As an example of a classificatory program, consider Mayr's Biological Species Concept (BSC). It classifies organisms into species. Its sorting rules are: sort sexual organisms that interbreed into the same species, sort sexual organisms that do not interbreed into different species, and not sort asexual organisms into any species. The BSC's motivating principle is to classify organisms into groups that are distinct evolutionary units, that is, groups of organisms that evolve in tandem. According to Mayr (1996, 262, 264), species are the principal units of evolution because their reproductive isolation prevents the production of incompatible gene combinations and allows adaptations to become fixed within a species. The GFA suggests that we evaluate the success of the BSC by how well sorting by interbreeding picks out groups of organisms that are distinct evolutionary groups. In other words, we evaluate whether the BSC

[1] The view that classifications are posited to serve particular aims is not new. It was prominently argued for by, among others, Dupré (1993). What is new in our account is the normative aspect – success in achieving an aim for which a classification is posited is part of what makes a classification a natural kind classification.

offers natural kind classifications by how well its sorting principles achieve the classificatory program's motivating principle. This is in part a practical matter – do the sorting principles actually enable us to pick out groups of organisms in the first place? – and in part a theoretical one – do the groups that are picked out constitute distinct evolving entities? As it turns out, in many cases the sorting rules of the BSC successfully pick out distinct evolutionary units (Coyne and Orr 2004), so according to the GFA the BSC does well in classifying organisms into natural kinds.

Contrast the BSC with another species concept, the PPSC of microbiology we saw earlier. The PPSC aims to highlight stable and readily identifiable groups of microorganisms. Its motivating principle is to obtain stable microbial groups for use in microbial and medical research. Its sorting principles use various genetic parameters for sorting microbes into stable groups, such as similarities in 16S rRNA genes and DNA:DNA hybridization. According to the GFA, whether the PPSC offers natural kind classifications turns on how well its sorting principles satisfy that classificatory program's motiving principle, namely to pick out stable microbial species. According to numerous microbiologists (for example, Roselló-Mora and Amann 2001, Stackebrandt 2006), the PPSC does achieve its aim. Thus, it too scores well on the GFA.

The BSC and the PPSC are positive cases where normative naturalism judges classificatory programs favorably. What about negative cases, where the GFA judges a classificatory program unfavorably? Consider the Phenetic Species Concept (Sneath and Sokal 1973). Its aim is to produce classifications of organisms that are free of theoretical assumptions. It sorts organisms according to overall similarity. Pheneticists construct multi-dimensional graphs where each dimension represents a trait and points on a graph represent sample organisms: the densest clusters of points represent species, clusters of species that are closer together on the graph represent genera, and so on. Though Phenetics was popular among some biological taxonomists in the 1960s, it has fallen out of favor. The GFA properly reconstructs why it has fallen out of favor, because Phenetics cannot produce classifications that achieve its overarching aim. Organisms have an indefinite number of similarities, so some similarities must be selected while most are ignored for constructing a classification. Because theoretical considerations must come into play when choosing which traits to use for constructing classifications (Hull, 1970), the Phenetic Species Concept is a classificatory program whose sorting principles result in classifications that violate the school's aim of providing theory free classifications. It thus scores poorly on the GFA.

Notice two things about these examples. First, each of the three classificatory programs discussed above has its own overall aim, and each, according to GFA, should be evaluated according to how well it achieves that particular aim. Second, the GFA treats natural kinds in a strikingly different way than monistic accounts of natural kinds. Those accounts set one overarching epistemic aim for evaluating *all* natural kind classifications, such as the possibility of making inductive generalizations or highlighting of the world's causal structure. The GFA is different, as the epistemic aims of classificatory programs are found in the programs themselves and can vary from program to program. Whether a program offers natural kind classifications depends on how well those classifications achieve the program's specific epistemic aims. Consequently, the GFA is sufficiently sensitive to the various aims scientists have for positing natural kind classifications, while at the same time retaining a reasonable normative component.

One might wonder why we place a functional constraint on natural kind classifications – that a natural kind classification should satisfy the aims for which it was posited. The underlying motivation is that natural kind classifications are tools for scientists to achieve various ends. We've highlighted epistemic aims, such as a classification highlighting evolutionary units, or the desire to obtain stable classifications. A successful natural kind classification, we submit, should achieve the epistemic aims it is posited to achieve. Otherwise, a natural kind classification will not serve well as the tool it was intended to be.

Before moving on, we would like to say something more generally about the reasons that scientists have for producing classifications. So far, we have highlighted *epistemic* reasons scientists have for positing classifications: for example, researchers hold that classifications should be useful for making inductive inferences, or be theory free, or provide stable groupings for research, and so on. Although we have focused on epistemic reasons for positing classifications, we believe that scientists also typically have *non-epistemic* reasons for positing classifications. Scientists routinely use contextual values, such as moral and social values, for constructing classifications (Anderson 1995, Ludwig 2014, Conix 2019). In addition, scientists use what Slater (2017) calls 'cognitive values' to construct classifications. An example of such a value is the rule of avoiding "lonely categories" – categories that have only one member (*ibid*.). We won't further discuss the use of non-epistemic values in producing natural kind classifications. However, we will suggest that cognitive and contextual values can easily be incorporated within the GFA framework, if one wanted to do so.[2] Just as classifications should promote the epistemic aims they are posited for, one can incorporate the idea that classifications should promote the cognitive and contextual aims they are posited to achieve. We see the GFA's ability to incorporate contextual and cognitive aims as a virtue of the GFA.

[2] We plan to take up this matter in future work.

What's Natural About Natural Kinds?

One might worry that the suggested account of natural kinds is too permissive – that merely requiring that a natural kind classification satisfy the motivating principles of a classificatory program might allow too many classifications to be natural kind classifications. The worry is that the GFA merely requires a sort of internal consistency between the aims of a classificatory program and the classifications it provides. In the preceding discussion, we restricted the set of relevant aims for classificatory programs to epistemic aims. But even under this restriction one might worry that the GFA could incorrectly designate some non-natural kinds as natural kinds. Consider the example of 'Canadian permanent resident.' A political scientist might be interested in the different kinds of residents one finds in Canada, such as permanent resident, citizen resident, and various sorts of temporary residents. The aim of such a classification is to accurately describe the different kinds of residents found in Canada. The classification that refers to the category 'Canadian permanent resident' satisfies that aim and thus satisfies the GFA. Nevertheless, one might argue that 'Canadian permanent resident' is not a natural kind but a socially constructed kind. After all, the membership conditions for that kind were legislated by the Canadian government. Citing such an example, one might hold that the GFA provides an insufficient standard for determining if a kind is a natural kind.

To rectify this lacuna one might turn to a standard way that philosophers distinguish natural kinds from non-natural kinds: by adding the requirement that natural kinds exist independently of human thought or action, or represent the mind-independent structure of the world (for example, Bird and Tobin 2017; Lowe 2014; Devitt 2005; Psillos 2002; and Searle 1995). Bird and Tobin (2017) provide the following version of the mind-independence requirement: "to say a kind is *natural* is to say that it corresponds to a grouping that reflects the structure of the natural world rather than the interests and actions of human beings." Despite the widespread acceptance of the mind-independence requirement, we find it too blunt of an instrument for distinguishing natural kinds from non-natural kinds (also see Khalidi 2013, 2016; Ereshefsky 2018). To illustrate our point, we employ Kukla's (2000, Chapter 3) three-fold distinction among the different ways entities or categories can depend on us – material, causal, and constitutive dependence.

Consider first *material dependence*: When we make entities in the lab or the field, such as new plant species, artificially bred animals, or new chemical compounds, the members of these species, varieties and chemical kinds, as well as the kinds themselves, come into existence due to human actions. But clearly such kinds also depend on nature as we cannot make just any organism or compound we can think of –nature constrains what is possible. The second way classificatory categories can depend on us is *causal dependence*: When kinds of people in part depend on what we think about them, those kinds can be said to depend causally on our views and actions. The "looping kinds" highlighted by Hacking (1995; 2007b) constitute prominent examples of this sort of dependence. For example, Hacking (1995) suggests that the kind 'dissociative identity disorder' is affected by what medical professionals think about such people. Depending on the state of research on the disorder, accepted diagnostic criteria, and available therapies, the kind's boundaries may shift considerably. Still, there are biochemical processes and brain states underlying the kind, such that the kind does not entirely depend on our thoughts about the kind. The third way classificatory categories can depend on us is *constitutive dependence*: When membership in a kind *entirely* depends on our thoughts and actions, we may say that the kind depends constitutively on us. Social conventionalists (for example, Woolgar 1988) and those that hold infallibilist views of social kinds (for example, Searle 1995, Thomasson 2003, and Taylor 1971) discuss such constitutive kinds.

We want to suggest that there is a significant difference between kinds that materially or causally depend on us *versus* kinds that constitutively depend on us. Kinds that materially depend on us, such as genetically modified organisms and synthetic chemicals, depend on us for their initial existence. But once we create them, they take on a life of their own that we can study. We can form hypotheses about their behavior, and through empirical investigation we can determine whether those hypotheses are correct or incorrect. Similarly, kinds that causally depend on us are affected by our thoughts but nevertheless can be empirically investigated. Here we have in mind many of the kinds studied in the social and human sciences, such as psychological kinds, sociological kinds, and economic kinds. Those kinds are affected by our psychological states and behaviors, yet we can form hypotheses about them and empirical testing can show that those hypotheses are wrong. For instance, even though professional and societal beliefs affect the behaviors of those with dissociative personality disorder, we can form hypotheses about those behaviors and be wrong about them. On the other hand, constitutive (or conventional) kinds, such as the kind 'mermaid' or the kind 'Canadian permanent resident,' are not open to revision on *empirical* grounds. We (users of English) implicitly define what mermaids are and our governments legislate what permanent residents are such that those kinds' membership conditions are not based on any empirical investigations. We don't form hypotheses about the defining characteristics of such conventional kinds and subject those hypotheses to empirical testing. What mermaids or permanent residents are depends entirely on how we define those categories.

Stepping back from these examples, the significant difference between kinds that materially or causally depend on us *versus* kinds that constitutively depend on us is that kinds in the latter group depend *entirely* on human thoughts and actions, while kinds in the former two groups depend both on the world *and* on human thoughts and actions. We suggest that this partial dependence on the world is the factor that makes the former two groups natural (see also MacLeod and Reydon, 2013, Reydon, 2016), and accordingly we take this dichotomy as determining the distinction between natural and non-natural kinds. Simply defining natural kinds as those groupings that are independent of our thoughts and actions is not an adequate way to distinguish natural from non-natural kinds, because requiring that natural kinds be independent of human thought or action leaves out important kinds in the social and human sciences, as well as many areas of the natural sciences. Yet many of those disciplines provide us with an understanding of the world and the means for predicting and manipulating aspects of the world. The kinds that feature prominently in those disciplines – kinds that materially or causally depend on us– should not be ruled out from being natural kinds on the basis of their partially depending on us.

How then do we distinguish kinds that materially or causally depend on us from those that constitutively depend on us? We can do this by amending the mind-independence requirement that philosophers place on natural kinds. We suggest taking Bird and Tobin's (2017) version of that requirement and changing it to the following.

> To say a kind is *natural* is to say that it corresponds to a grouping that depends on an aspect of the world rather than *merely* on the interests and actions of human beings.

Call this the 'Grounding Condition' on natural kinds. This is why we call our account the 'Grounded Functionality Account' of natural kinds: natural kind classifications should satisfy the epistemic as well as non-epistemic aims they are posited for, and those classifications should be grounded in the world. The grounding condition is different than Bird and Tobin's mind-independence condition in a couple of ways.

First, they write that "a kind is *natural* is to say that it corresponds to a grouping that reflects the structure of the natural world" (*ibid*., 2017). We have dropped the word 'natural' from the phrase 'natural world.' This is done to avoid an a priori constraining of what can be a natural kind by focusing exclusively on the non-human world. Because those aspects of the world that our natural kind classifications may correspond to can be human-made or not human-made, we don't want the word 'natural' to rule out the former. Kinds of technical artifacts, for example, are not fundamentally different from new species of organisms that have been created by genetic technologies or by conventional breeding, or from synthetically created chemical elements (Reydon, 2014). Kinds of artifacts typically are materially and causally dependent on us, but they are not *entirely* dependent on us.[3] Artifacts are not merely social conventions, and artifact kinds can be studied in the same way as kinds of natural entities can be studied: once a new kind of artifact has been designed and the first prototypes have been made, we can formulate hypotheses about them and study their behavior in practice. Much the same holds for many kinds that feature in the social sciences, such as kinds in economics. For example, we study the behavior of economic systems and the various kinds of entities featuring in them (such as consumers, money, credit institutions, and so on), even though their existence in part depends on us. Once they have been brought into existence, they take on a life of their own. We can form hypotheses about them and we can be wrong about those hypotheses. Accordingly, instead

[3] Because of this, Reydon (2014) argues that artifact kinds are not natural kinds in any *traditional* sense of the term, but not artificial (i.e., conventional) kinds either. The GFA recognizes artifact kinds as natural kinds.

of saying that the interests and actions of humans are completely irrelevant for scientific classification, which would be a problem for the social, medical, biological, and chemical sciences, the Grounding Condition allows that kinds can in part, but not completely, depend on us.

Another way that the Grounding Condition differs from Bird and Tobin's (2017) criterion is that they talk in terms of "the structure of the natural world." To avoid making potentially problematic metaphysical commitments, instead of talking about *the* structure of the natural world the Grounding Condition talks about aspects of the world. Doing so avoids any commitment to the world having a fundamental structure. We would like to remain agnostic about whether there is such a structure. Focusing on aspects of the world also allows us to see more clearly that any metaphysical commitment the GFA has is one of *local* metaphysics. Which aspects of the world provide the grounding of a natural kind classification depends on the epistemic aims that scientists using a classificatory program are pursuing. Consider some of the examples mentioned earlier. The sorting principles of the Biological Species Concept (BSC) turn on the assumption that interbreeding causes evolutionary units, so it is the relation between the occurrence of interbreeding among a group of organisms and that group being an evolutionary unit that needs to be grounded in the world. The term 'grounding' here is used to mean the straightforward point that for a natural kind classification to be useful, it should in some way be anchored to, based on, or supported by aspects of the world. Returning to our example, the BSC provides useful classifications of biological phenomena because it is based on a relation found in the world: that interbreeding causes the existence of evolutionary units. The BSC is a useful classificatory approach for biologists because it has latched on an aspect of the world. Similarly, the Phylo-Phenetic Species Concept (PPSC) assumes that certain genetic markers allow us to identify stable taxonomic groups. For that approach to species to be successful, the relation it asserts –that certain genetic markers pick out stable taxonomic groups—needs to be grounded in the world. Here the grounding we are talking about is simply that the world actually contains PPSC-specified genetic markers that microbiologists can use to identify stable taxonomic groups.

The notion of grounding used in this paper should be contrasted with the notion of metaphysical grounding found in contemporary analytic metaphysics (Correia and Schnieder 2012). In metaphysical grounding, something grounds the existence of something else. For example, facts about physical particles are thought to ground facts about larger objects. Such metaphysical ground is not what we have in mind. By 'grounding' in our Grounding Condition, we just mean that natural kind classifications make certain assumptions about the world (e.g., interbreeding causes evolutionary units) and a classification is a natural kind classification only if those assumptions are correct about the world.

Loosely put, the Grounding Condition says that natural kind classifications should in part depend on the world and not merely our conceptions of it. It allows that kinds that depend materially and causally on us can be natural kinds (such as newly bred plant species, or social kinds), but rules out kinds that constitutively depend on us. The Grounding Condition makes sense in the abstract. Natural kind classifications are tools for gaining knowledge about the world – such classifications are made by us in the context of classificatory programs that have specific epistemic (or other) aims. To serve as such tools, natural kind classifications should depend on the world and not merely on our conceptions of it. Otherwise, they will not allow us to successfully investigate and manipulate the world.[4]

[4] The Grounding Condition for natural kinds is far from new. Locke for instance, distinguishes

With the Grounding Condition articulated, let us mention how the two parts of our account of natural kinds – the Grounding Condition and the Functionality Condition – fit together. The Functionality Condition, as discussed in the previous section, says that natural kind classifications should satisfy the epistemic aims (or other sorts of aims) they are posited for. The Grounding Condition asserts that a natural kind classification should be grounded in the world. What determines how a natural kind classification should be grounded is the epistemic (or other) aim for which the classification was posited. That is, the intended function of the classification sets out which aspects of the world should ground a natural kind classification. Returning to our well-worn species concept examples, the BSC aims to give classifications of evolutionary units. The BSC asserts that interbreeding is a factor that underlies evolutionary units. Therefore, the relation that needs to be in grounded in the world for BSC classifications to be natural kind classifications is that interbreeding does indeed cause the existence of evolutionary units. Turning to our example from microbiology, proponents of the PPSC assert that certain genetic markers identify stable taxonomic units. Consequently, the relation that needs to be grounded in the world for the PPSC to provide natural kind classifications is that the

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between two factors that contribute to natural kind classifications: the "workmanship of nature" and the "workmanship of the understanding" (or the "workmanship of men") (Reydon 2016, 62). For Locke, both are important aspects of classifications: while it is nature that makes things similar and different to various degrees, it is us who use these similarities and differences to group things into kinds that can be used for various purposes (*Essay*, III.III.§13, III.VI.§37). According to Locke, purely nominal kinds, that is, those kinds that depend only on how we define kind terms, can be used in practice for communicative purposes. In scientific investigations, by contrast, we look for kinds that to some extent depend on the "workmanship of nature." In Lockean terms, we would say that a kind fails the Grounding Condition and is not natural if it depends *only* upon the "workmanship of men" and not in any way on the "workmanship of nature."

highlighted genetic markers do indeed pick out stable groups of organisms.[5] In both classificatory examples, it is the function of a classification –the aim for which it is posited— that determines how a natural kind classification should be grounded in the world.

Let's take stock of where we are in the search for a more practice-oriented account of natural kinds. In the second section of this chapter, we saw that philosophical accounts of natural kinds fail to properly interact with and account for successful classificatory practices in science. They are either based on a prior reasoning and thus irrelevant to actual classificatory practices; or they overlay a single epistemic aim on why all scientists posit natural kind classifications, when in fact scientists posit natural kind classifications for a variety of reasons. In an attempt to offer a more practice-oriented account of natural kinds we suggested an approach to natural kinds inspired by Laudan's Normative Naturalism and Woodward's Functional Account of Causal Reasoning: we should judge a natural kind classification according to how well it satisfies the epistemic (or other) reasons it was posited for. But then there was the worry that this is a too permissive of an approach to natural kinds. So we suggested that natural kind classifications should satisfy the Grounding Condition: natural kind classifications should in part depend on the world and not *only* on our conceptions of it.

Let's put the Grounding Condition and the Functionality Condition of the GFA together. A natural kind classification should satisfy the Functionality Condition of the GFA –that is, a natural kind classification should achieve the epistemic aims (or other aims) it was posited for. Furthermore, the way that a natural kind classification satisfies that function should be grounded in the world. We take the Grounding Condition and the Functionality Condition each to be

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[5] Obtaining such stability is not a trivial manner. That is why the PPSC uses three different types of genetic markers to identify species. Stability is achieved by triangulating these three markers.

necessary conditions for classifications to be natural kind classifications. To meet the Grounding Condition, we need to know which aspects of the world a kind or classification is supposed to highlight – which is what the Functionality Condition of our account tells us. In other words, without a classificatory program that specifies the basis on which entities are to be grouped together into kinds, there is no way to examine whether and, if so, how the kinds are grounded in the world. This is why both the Grounding Condition and the Functionality Condition are necessary conditions. Together they constitute a jointly sufficient condition for determining which classifications are natural kind classifications. The Grounding Condition is an all or nothing condition: we ask if a natural kind classification is appropriately grounded in the world. That is, we ask whether a natural kind classification at least in part appropriately depends on the world and not merely on our conceptions of it. When it comes to the Functionality Condition, it is reasonable to think there is a sliding scale. How well a classification may achieve its aim may come in degrees. For instance, the stability of PPSC classifications, the aim of such classifications, might not be an all or only affair but may come in degrees. Putting this all together, the GFA asserts that a natural kind classification must be grounded in the world and must satisfy the epistemic (or other) aims it was posited for, though how well it satisfies those aims may come in degrees. The GFA, we submit, is naturalistic enough to capture actual classificatory practices in science, and at the same time it has a significant normative component.

Recent Skepticism About Natural Kinds

Recently, some philosophers have voiced skepticism concerning philosophical research on natural kinds (Hacking 2007a, Ludwig 2018). We believe that the GFA can go some way in answering such skepticism. Consider what Hacking has to say about philosophical research on natural kinds. According to Hacking, modern philosophical research on natural kinds began as a "rosy dawn" with the work of Mill and Whewell in the 19th century. But in the late 20th and early 21st centuries, that work entered a "scholastic twilight" (2007a, 203). Hacking tells us that philosophical research on natural kinds is now "a slew of distinct analyses directed at unrelated projects" (*ibid.*). Moreover, Hacking argues that philosophical research on natural kinds focuses on "an inbred set of degenerating problems that have increasingly little to do with issues that arise in a larger context," where 'a larger context' refers to classificatory projects in science and elsewhere (*ibid.*, 229).

We believe that a fruitful way to answer Hacking's pessimism is to refocus philosophical work on the topic by moving away from a priori considerations regarding natural kinds and more carefully studying classificatory practices in science. We suggest that practice-oriented philosophical analyses of natural kinds *are* related, and that those analyses *do* address issues that arise in a larger context (MacLeod and Reydon, 2013).[6] In particular, we believe that the Grounding Condition captures a common concern among practice-oriented philosophers who work on natural kinds, as well as among those scientists who worry about what makes a classification natural. Those philosophers and scientists attempt to articulate how natural kind classifications should (at least in part) depend on the world and not entirely on our conceptions of it. They just disagree on the ways that natural kind classifications should be grounded in the world.

Consider two opposing practice-oriented philosophical approaches to natural kinds, Boyd's (1999a, 1999b, 2003) *Homeostatic Property Cluster Theory* and Slater's (2013, 2015) *Stable Property Cluster Theory*. For Boyd, natural kinds have two components. They are

[6] By practiced-oriented philosophical theories of natural kinds we mean those theories that aim to be consistent with and learn from actual classificatory practices in science.

groups of entities that have co-occurring clusters of properties that sustain successful induction. Furthermore, that co-occurrence of properties is underwritten by causal mechanisms. For instance, *Canis familiaris* is a natural kind on Boyd's account because dogs have a number of co-occurring properties, such as having four legs and having a tail, and the occurrence of those properties is caused by such homeostatic mechanisms as genealogy and shared developmental pathways. Boyd requires that kinds achieve "the accommodation of inferential practices to relevant causal structures" (1999b, 159). Boyd's account is a realist one in the sense that it requires that causal structures sustain natural kinds. Slater, on the other hand, does not require that natural kinds be sustained by causal structures or any particular mechanism. Like Boyd, Slater requires that natural kinds are associated with stable clusters of properties that can be used for induction. But for Slater bare stability is all that is required for natural kinds: natural kinds are simply stable clusters of properties that underwrite induction, no matter how that stability is realized.

Despite their differences, both Boyd and Slater agree that natural kinds should in some way be grounded in the world and should not merely be the result of our conceptions. They just disagree on *how* natural kinds should be grounded. For Boyd, natural kinds are grounded in clusters of stable properties and causal mechanisms. For Slater, the grounding of natural kinds just depends on there being stable property clusters in the world. Boyd's and Slater's accounts are not, as Hacking puts it, "unrelated projects": they both want to ground natural kinds in the world, they just disagree on which features of the world provide that grounding.

The assumption that natural kind classifications should be grounded in the world is also found in Hacking's own work on human kinds. Hacking (1991, 1995) initially drew a division between natural and human kinds. Human kinds, such as dissociative identity disorder, depend in part on our conceptions of those kinds, whereas natural kinds, such as silver, do not depend on our conceptions. Hacking (2002) revised his view such that the salient division is between "indifferent kinds" and "interactive kinds" (or "looping kinds"). Indifferent kinds (for example, silver) are unaffected by what we think about them, whereas interactive kinds (for example, dissociative identity disorder) are affected by what we think about them. Although the word 'natural' has fallen out, both kinds of kinds depend in part on the world and not entirely on our conceptions. Furthermore, Hacking (1999, 126-127) clearly distinguishes indifferent and interactive kinds from constituent or conventional kinds. He offers 'satanic ritual abuse' as an example of a constituent kind that is not grounded in the world but is merely found in our conceptions. So even in this account of human kinds by a vocal critic of the concept of natural kinds, we find the distinction between kinds that in part depend on the world versus kinds that entirely depend on our conceptions of the world. In other words, we see the Grounding Condition at work even in Hacking's writings.[7] Contrary to Hacking's claim that philosophical accounts of natural kinds are "unrelated projects," we see that several different accounts of natural kinds (Boyd's, Slater's, and Hacking's own account) hold that natural kinds are grounded in the world and not merely in our conceptions of the world.

Let's turn to Hacking's charge that philosophical analyses of natural kinds are "an inbred set of degenerating problems that have increasingly little to do with issues that arise in a larger context" (2007a, 229). For a larger context, let's turn to how biologists characterize the difference between natural and non-natural classifications. Consider the works of several biological taxonomists: Mayr (1982), Panchen (1992), and Baum and Smith (2013). These biologists characterize the history of biological taxonomy as a search for criteria that distinguish

[7] Note that Hacking did not explicitly conceive of his work as involving such a thing as the Grounding Condition formulated here.

natural from non-natural classifications and recount that history in terms of how criteria for natural classifications vary over time. These biologists aim to promote their favored school of taxonomy, so the history told is one where previous taxonomic schools allegedly focused on the wrong criteria for natural classifications. Mayr is a promoter of the taxonomic school Evolutionary Taxonomy, while the other authors subscribe to Cladism. Mayr holds that natural classifications should capture both propinquity of descent and adaptive variation, in other words, classifications should sort organisms into taxa according to their phylogeny *and* their adaptive differences. Cladists, on the other hand, argue that *only* propinquity of descent is the aspect of the world that should be captured in natural classifications. Cladists criticize Evolutionary Taxonomy for relying on what they see as subjective measures of adaptive difference. Stepping back from these details, Cladists and Evolutionary Taxonomists agree that an overall aim of their discipline is to distinguish natural from non-natural classifications. They agree that natural classifications should be grounded in the world and not our mere conceptions of it. They just disagree on which aspects of the world ground natural classifications in biology.

The same can be said of two classificatory programs that we looked at earlier. Supporters of the BSC and supporters of the PPSC agree that natural classifications should be grounded in the world: supporters of the BSC focus on interbreeding causing evolutionary units, whereas supporters of the PPSC focus on certain genetic markers picking out stable taxonomic units. Supporters of the BSC and supporters of the PPSC thus agree that natural kind classifications should be grounded in the world, but disagree on which aspects of the world are the relevant ones for grounding natural classifications.

This brief survey of philosophers working on natural kinds and biologists interested in what makes a classification natural undermines Hacking's charges against natural kind research.

Practice-oriented philosophers working on theories of natural kinds are interested in how natural kinds are grounded in the world and not merely in our conceptions of it. Similarly, biological taxonomists interested in what makes classifications natural ones disagree over how their classifications should be grounded in the world, but they nevertheless agree that natural classifications should be grounded in the world. The project of investigating natural kinds, we submit, is more unified than Hacking claims (see also MacLeod and Reydon 2013, 91).

Before concluding, let us briefly address a more recent article that holds a view similar to Hacking's. David Ludwig (2018) argues that standard philosophical accounts of natural kinds tend to focus on particular and limited reasons scientists have for producing classifications. According to Ludwig, standard philosophical accounts of natural kinds "privilege some dimension of nonarbitrariness over others and can therefore lead to an unnecessarily narrow analysis of classificatory practices" (2018: 47). We agree with Ludwig that standard philosophical accounts neglect the actual variety of reasons that scientists have for classifying entities under investigation. However, we disagree with the inference he derives from this. Ludwig believes that we should let go of the concept of natural kind and instead just focus on the different ways that scientists offer non-arbitrary classifications. We disagree with this conclusion because we believe that the Grounding Condition captures what various philosophers and scientists aspire to when they talk about *natural* classifications. In addition, the Grounding Condition does not face the problem that Ludwig attributes to other accounts of natural kinds: it does not unnecessarily limit analyses of classificatory practices. Furthermore, the Grounding Condition does something that Ludwig thinks an account of natural kinds should do, namely, have a normative aspect, which rule outs "wildly pathological" classifications (such as the group of all animals born on a Tuesday) and "scientifically defunct" classifications (such as hysteria) (Ludwig 2018, 47; see also Franklin-Hall 2015, 926).

The GFA's Principal Virtues

Let us conclude by highlighting that the Grounded Functionality Account of natural kinds has several virtues that other accounts lack. We argued that a new account of natural kinds is required because available accounts fail on one or more of the following counts. First, many accounts are based on a priori assumptions about the nature of natural kinds that cause those accounts to either neglect or be irrelevant to important aspects of scientific practice. Second, many accounts acknowledge just one epistemic aim for which all natural kind classifications are posited; consequently, they miss the diversity of classificatory practices found in science. Third, most accounts fail to acknowledge that legitimate non-epistemic aims may be important in the positing of scientific classifications. Here, again, aspects of actual classificatory practice in science are overlooked.

Our alternative, the GFA, is naturalistic enough to be relevant to actual classificatory practices in science and avoid the three counts of failure mentioned above. The GFA is not an a priori approach to natural kinds, nor does it focus on only one epistemic aim, nor does it exclude non-epistemic aims. Thus it is naturalistic enough to capture the various classificatory practices found in the sciences, unlike standard philosophical theories of natural kinds. Furthermore, the GFA is not only sufficiently naturalistic to capture the diversity of classificatory practices found in science, it also has a significant normative component. Through the application of the Functionality Condition what counts as a natural kind classification is constrained by satisfying the epistemic (or other) goals for which a classification is posited. In addition, what is a natural kind classification is further constrained by the Grounding Condition. Finally, the GFA entails that Hacking's and Ludwig's pessimism about philosophical work on natural kinds is too hasty. Practice-oriented philosophical theories of natural kinds are not an array of unrelated projects that have no connection to scientific classification. There is a common overarching aim of philosophical work on natural kinds and scientific work on natural classifications, namely that natural classifications should be grounded in the world and not merely our conceptions of it. Like Hacking and Ludwig, we are pessimistic about many of the available philosophical theories of natural kinds, but unlike those authors we are optimistic about the usefulness of 'natural kind' as a philosophical concept.

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