Stable Property Clusters and Their Grounds

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I argue against Matthew Slater's rejection of what he calls the grounding claim in his stable property cluster (SPC) account of natural kinds. This claim states that the epistemic value of natural kinds depends on the existence of some ground to bind together a kind's properties. Using two test cases from academic medicine, I show that grounds are genuinely explanatory of scientific epistemic practices and that the SPC account should not do without them in its philosophical analysis of natural kinds.

1. Introduction. Outside of the neater confines of certain paradigm cases, philosophers of science have struggled to account for the myriad, messy natural kinds in fields such as biology. Matthew Slater provides a response to this challenge with an account of natural kinds as stable property cluster (SPC) kinds.[1] This account rejects what Slater calls the grounding claim, which states that the epistemic value of natural kinds depends on the existence of some ground, such as an essence or mechanism, that binds the kind's properties together. In this article, I argue that we should retain the grounding claim in the philosophical analysis of natural kinds. Using two test cases from aca-

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1. Slater defends the SPC view in multiple places (Slater 2013a, 2013b, 2015), but the most thorough articulation comes in his 2015 paper "Natural Kindness," which will be my focus here.

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demic medicine, I show that grounds are genuinely explanatory of scientific epistemic practices and argue that the SPC account should not go without an account of grounds.

In section 2, I briefly review the dialectic between the homeostatic property cluster (HPC) natural kind view, as articulated by Richard Boyd, and Slater's SPC alternative. In section 3, I discuss Slater's arguments that homeostatic mechanisms are neither sufficient nor necessary to justify our epistemic practices. I then raise two cases to test the SPC view in sections 4 and 5, and I argue that the SPC view does not avoid the challenge of developing an account of grounds. In section 6, I offer an appraisal of the grounding claim and argue that the grounds of property clusters should retain a role in the philosophical analysis of natural kinds.

2. Boyd's HPC Account of Natural Kinds and Slater's SPC Alternative. Richard Boyd's HPC account is attractive because of its flexibility to include kinds left out by the traditional essentialist view of natural kinds. Traditional essentialism appeals to intrinsic properties to define natural kinds with reference to necessary and sufficient conditions. As a result, it cannot accommodate the messier kinds used in fields like biology. This is troublesome because scientists make use of these kinds in classification, induction, and explanation with great success (Boyd 1991, 140–43). To fill this gap, Boyd describes a more flexible type of natural kinds: HPC kinds.

HPC kinds have a "contingently clustered" family of properties. These properties co-occur because of a sort of homeostasis whereby the presence of some properties and their underlying mechanism(s) tends to favor the presence of the other properties in the family (Boyd 1989, 15–16). The natural kind term, which picks out the things in which these properties cluster, is defined by all or part of the property cluster and the mechanisms that underlie it (16). While there are different ways to go about interpreting or filling out the details of this sort of account, the basic picture is that at least some natural kinds are characterized by the clustering of properties and the homeostatic mechanisms that bring about that clustering.

However, not every HPC kind is a natural kind for Boyd. To be a natural kind, an HPC kind must satisfy the accommodation thesis, which states that the representation of a phenomenon as a natural kind makes possible "the accommodation of inferential practices to relevant causal structures" (Boyd 1999, 147). The idea is that scientists can make true generalizations about phenomena because reference to natural kinds allows them to accommodate their inferential practices to the causal structures that sustain these generalizations. The accommodation thesis is important because it facilitates the epistemic role of a natural kind, which is to provide the basis for inductive and explanatory success by helping our inferential and classificatory practices track objective causal structures (141, 148).

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Slater takes issue with the central role of homeostatic mechanisms in the HPC account. He argues that they are neither sufficient nor necessary for the stable clustering that makes natural kinds epistemically valuable (Slater 2015, 385). Slater's alternative, the SPC account, is meant to avoid some of the problems associated with appeals to mechanisms, such as the difficulty of individuating mechanisms and determining when they count as homeostatic. The SPC account does this with a focus on the sort of stability that is necessary to justify our epistemic practices rather than on what causes this stability (396).

The SPC account identifies natural kinds with reference to "cliquishly stable" clusters of properties. By cliquish stability, Slater (2015, 397–98) means that the presence of a subcluster of the defining cluster of properties probabilistically entails that the other properties in the cluster are also present. In filling in the details of this requirement, Slater adds a robustness condition to cliquish stability. The robustness condition states that probabilistic entailment among the subclusters of properties must hold over some relevant set of counterfactuals. Which counterfactuals are relevant is determined by the context or domain of inquiry and depends on the interests and norms of this domain (399–402). Slater notes that his view entails that natural kindness can be domain relative and that natural kind is not an ontological category. Instead, natural kindness is a status that things can have that allows them to facilitate our epistemic contact with the world (403–7). This status allows practitioners to identify a certain property cluster as a "fixed point" under a series of different manipulations within a domain of inquiry (402). Practitioners in this domain can then count on the property cluster being present in various cases of manipulation.

3. The Necessity and Sufficiency of Mechanisms and Grounds. In his critique of the HPC account, Slater objects to both the sufficiency and necessity of homeostatic mechanisms to justify our epistemic practices with regard to natural kinds. Slater is correct that the presence of homeostatic mechanisms is not always sufficient for this justification, and his arguments point to an important burden to develop a more detailed account of mechanisms or other grounds (Slater 2015, 404). For example, it is not always clear how to individuate mechanisms or under which conditions they should count as homeostatic (388–90), although, of course, we may inevitably face some indeterminate cases (Wilson, Barker, and Brigandt 2007, 201).

I also grant to Slater that the presence of an underlying mechanism is not necessary for being a natural kind. It seems that Boyd would admit this as well, as the HPC account is meant to identify a "class of natural kinds," not a set of necessary conditions for them (Boyd 1999, 141). This does not rule out the claim that some ground, be it an essence, a mechanism, or some other ground, is necessary to be a natural kind. Slater does note this possibility, so we might take his argument against the necessity of mechanisms to cast doubt on their necessity in paradigmatic cases. If successful, the argument would

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then cast doubt on the need for grounds in any account of natural kinds (Slater 2015, 391).

Slater's argument against the necessity of mechanisms relies on two main observations. The first is that some property clustering seems driven by factors not obviously mechanistic (Slater 2015, 391). The second is that some supposedly homeostatic mechanisms can also work to pull apart natural kinds (393). He provides the example of two morphologically almost indistinguishable species of fruit flies: *Drosophila persimilis* and *Drosophila pseudoobscura*. While they are distinct species, they can plausibly serve as one natural kind as a genus (392).[2] His contention is that in these cases, the property clustering at the genus level is best characterized by Griffiths's notion of phylogenetic inertia (Slater 2015, 392–93), which is the tendency for organisms to maintain their current form until an adaptive force acts to change it (Griffiths 1999, 220). One problem with phylogenetic inertia is that it seems to appeal to the absence of mechanisms rather than to a homeostatic mechanism. HPCers could argue that reproduction and development are the mechanisms underlying this inertia and the homeostasis of the property cluster. But these mechanisms also lead to the variation within a population that drives evolutionary change, so their homeostatic function can be disrupted by natural selection—hence Slater's (2015, 393) second observation.

Taking these objections seriously, however, does not rule out the importance of the grounds of property clustering in accounting for these cases. Those working in the HPC tradition have taken steps to explain the interplay among underlying mechanisms and with respect to phylogenetic history. For example, Barker and Wilson (2010, 76) argue that species exhibit response cohesion: the members of a species are disposed to respond as a unit to selection, drift, migration, and other evolutionary pressures. As they note, this tendency might also be exhibited by higher taxa. Response cohesion could then serve as a more explicitly mechanistic explanation for genus-level natural kinds.

However, we can imagine extreme cases in which the lack of adaptive forces seems to be the main explanation for the existence of a natural kind and in which the kind exhibits limited response cohesion but is stable enough to remain a natural kind in the short term.[3] The appeal to phylogenetic inertia in such a case would still involve an appeal to the past effects of mechanisms in the kind's phylogenetic history and to knowledge about the limited effects of evolutionary mechanisms in the relevant time frame. Such explanations may move far beyond the homeostasis metaphor and do not appeal to singular mechanisms, but they need not lead to an appeal to brute stability to justify classificatory or inductive activities.

2. Slater picks up on this case from Mayr (1963).

3. Thanks to Matthew Slater for pushing me to consider this possibility.

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We can also acknowledge that forces of natural selection can continuously disrupt the stability of a property cluster within a certain biological taxon without abandoning the grounding claim. Grounding-claim advocates might move beyond the HPC view and adopt something like Ereshefsky and Matthen's (2005) Population Structure Theory, which appeals to heterostatic, homeostatic, and heterotic mechanisms to explain the distribution of phenotypes in populations. Such a view takes seriously the different effects that evolutionary mechanisms can have on a population but still appeals to mechanisms as causes of the property distribution of a population.

Slater's (2015, 393) concern with these strategies seems to be that they are ad hoc and trivialize the role of mechanisms. Mechanisms no longer provide a guarantee of stability. Instead, they sometimes promote homeostasis and sometimes do not, depending on contextual factors. However, this might just reflect the importance of a posteriori investigation in cases in which multiple mechanisms affect the members of one kind. We need a flexible account of the grounds of property clusters to capture these complex causal structures. Slater is right that more work needs to be done to better specify the roles that mechanisms or other grounds can play and when they can define a kind. But I will argue in the next few sections that the SPC account cannot avoid this challenge either.

4. Property Cluster Stability via Multiple Grounds. One of the key virtues of the SPC account is that it provides an analysis of natural kinds independent of any metaphysical debates about what grounds their properties. This is especially useful given the need for a better-developed account of the role of mechanisms and grounds. However, in order to preserve this benefit, SPC advocates must be able to show that assessing the relevant counterfactuals preserves the independence of the property cluster from its underlying ground(s). Otherwise, the grounding claim retains its importance, and the SPC account cannot avoid the work of articulating a better account of grounds. To see why this might be particularly difficult, we can try to interpret the cliquish stability condition and apply it to some key examples.

Slater (2015, 400–401) describes cliquish stability as depending, in part, on the relevance of different counterfactuals to a domain or field of inquiry. He does not spell out the truth-conditions for these counterfactuals but does specify that the interests, aims, and norms of special sciences play a role in determining what is relevant (401). He also states that the relevant counterfactuals are situations that we can reasonably expect to come to pass in the time frame of interest (402). Slater cites an example of counterfactuals about distant evolutionary history, which would not be relevant to the domain of medicine (399–400).[4] It is clear that a doctor trying to help a patient with a

4. Slater's example is originally from Lange (2004).

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heart attack is not interested in counterfactuals about evolutionary history, but other counterfactuals will require more detailed knowledge to assess and may not be as obvious.

The historical development of lung cancer treatments provides a more challenging example. Medical researchers have historically classified lung cancers into small cell (SCLC) and non-small-cell lung cancer (NSCLC). In the 1980s, scientists noticed that NSCLC was associated with increased expression of the epidermal growth factor receptor gene (EGFR), which helps cells to grow and divide. This led to the hope that treatments targeting the EGFR could treat NSCLC as an alternative to standard chemotherapy (Veale et al. 1987). However, further clinical studies showed that only a subset of NSCLC patients responded to targeted therapy, and these patients had specific mutations to the EGFR (Lynch et al. 2004; Paez et al. 2004). Further research has shown that patients with EGFR mutations experience better survival rates with targeted treatment than standard chemotherapy (Maemondo et al. 2010).

In this case, NSCLC can be caused by multiple gene mutations, and identifying the relevant mutation is important for choosing the optimal treatment. Yet, the property cluster used to identify NSCLC is still preserved when caused by different genetic mutations. How can we make sense of this case in terms of the SPC account? It is clear that we cannot rely solely on the stability of the property cluster that scientists used to pick out NSCLC, as this fails to distinguish EGFR-positive cancers from those caused by other mutations.

One option open to an SPC advocate is to appeal to an updating procedure to the classification scheme. Slater (2015, 405) is aware of the potential for classification error in terms of whether a property cluster is actually stable: "We certainly can be mistaken about whether a certain category is associated with properties that stably cluster given certain norms and interests." Just as a mistake about whether the relevant category corresponds to a SPC might lead us to revise or abandon the category, we might similarly revise a classification scheme to account for distinctions that were previously not thought to be relevant given our aims. In this case, such an updating procedure might lead to a classificatory distinction between two different kinds of NSCLC, EGFR and non-EGFR. These kinds differ because the former includes the property of responsiveness to EGFR-targeted treatment and the latter does not.[5] The SPC advocate can explain that responsiveness to EGFR treatment is relevant to the cluster, given the medical interest in understanding these natural kinds in order to treat them. This property would be added to the NSCLC property cluster for the further classification between the different types of NSCLC.

One problem with this strategy is that it does not capture the explanatory relationship between the NSCLC property cluster and its ground. The presence of the EGFR mutation can explain the presence of NSCLC symptoms

5. Thanks to Josh Hunt for helping me to clarify this point.

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because of the causal link between them. Capturing this causal structure solely in terms of additional clustering properties obscures this fact. It is important that researchers sought out a set of explanations for the presence of NSCLC, as it led to epistemic and practical success.

A more fundamental problem with this strategy is that it disrupts the independence of the grounds and the stability of the property cluster. Once the property clusters of EGFR and non-EGFR NSCLC are updated to include responsiveness to EGFR-targeted treatment, assessing whether the property cluster is stable directly bears on an understanding of the grounds of the cancer. The SPC account allows that identifying grounds can contribute to some epistemically fruitful classification schemes but also maintains that this contribution does not mean that grounds should play a role in the philosophical analysis of natural kinds (Slater 2015, 402–3). However, with properties like responsiveness to EGFR-targeted treatment, assessing the stability of the property cluster directly depends on the identification of the grounds. That is, when we determine whether the property cluster is stable in the relevant counterfactuals, we have to look for the presence of the EGFR mutation. As a result, we need to include grounds in our analysis of these kinds to explain the stability of the relevant cluster.

If grounds are so intimately tied to assessing cliquish stability, then it is not clear that the SPC account can do without an account of grounds. SPC advocates need to have an account of what kinds of grounds—mechanisms or otherwise—will provide the requisite stability of different property clusters, in order to assess the stability of potential natural kinds. This is most apparent in cases like NSCLC, in which the aims of the domain call for a classification scheme based on different possible causes, but it will be true to some degree in many other cases. If so, we can better explain these cases by retaining the grounding claim and make the justificatory work of grounds explicit in our philosophical account.

5. Changes in Grounds over Time. Another set of problem cases for the SPC account involves stability of the defining properties of a proposed natural kind while the underlying mechanism for this property cluster changes over time. In these cases, the originally identified properties can remain stable, but knowledge of the grounds for these properties is important because of other interests within the domain. Scientific investigation of the explanations for property clustering has enabled practitioners in different disciplines to better understand natural kinds and redraw the borders between them when necessary.

The history of influenza virus research provides such an example. In the 1930s, the influenza virus was first isolated from humans and transmitted to ferrets. Certain symptoms of the virus were identified, such as lethargy, re-

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duced appetite, muscular weakness, nasal discharge, sneezing, and nasal obstruction (Smith, Andrewes, and Laidlaw 1933). This virus was classified as influenza along with a virus isolated from swine and transmitted to ferrets with the same symptoms (Shope 1931). Early researchers identified the distinctive combination of symptoms that picked out the influenza virus even though, as with many other biological phenomena, each instance of influenza did not manifest every symptom. This identification of influenza is in line with Slater's notion of a property cluster. The property cluster used to identify the virus would be stable across many counterfactuals. However, as we now know, many different viruses can cause these symptoms, and the viruses causing the symptoms can change over time. The initially identified properties could be reasonably projected into the future and across many different grounds for these properties. However, treating the different viruses as the same kind would be both epistemically and medically irresponsible, so a more fine-grained classification is needed.

The classification of influenza became more nuanced as subsequent research led to the distinction between three types of the virus, A, B, and C, based on their respective genetic structures and virulence. Type A influenza can infect many species, which makes it particularly prone to the phenomenon of antigenic shift. Antigenic shift occurs when viruses exchange gene segments while infecting the same host, which creates a new strain of the virus. The newly formed strain can be particularly dangerous if a human-adapted strain acquires new genes, as the immune system is ill equipped to recognize it, possibly leading to pandemics (Webster et al. 1992). The different strains of the influenza virus preserve the symptoms that were first used to identify and define the virus. In this sense, the property cluster may be preserved over time and over many relevant counterfactuals. However, it is crucial to continuously track why these symptoms are showing up in different hosts, if doctors and epidemiologists are to reliably form inferences or projections about influenza into the future. It is clear that a group of practitioners relying solely on the stability of the initial cluster of properties used to identify influenza would make both epistemic and practical mistakes with potentially catastrophic consequences.

The SPC advocate faces two hurdles in accounting for this case. First, the division of influenza into A, B, and C depends on the identification of different genetic structures, which are grounds for the SPC used to identify the virus. So, the SPC view must construe this classification in terms of properties identified via grounds. The second hurdle is that these genetic differences and the mechanism of antigenic shift justify many inductions and inferences that are yet to be made.

One way to make sense of antigenic shift with the SPC account is to identify familiarity to the human immune system as an important property for

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SPCs in medicine and especially in the classification of viruses. It is true that this revision depends on the discovery of antigenic shift as a mechanism, but Slater (2015, 402–3) explicitly states the proviso that mechanisms underlying properties can contribute to epistemically fruitful classification schemes. However, this again disrupts the independence between the grounds of the property cluster and the stability of the cluster, which makes it difficult to maintain one of the main benefits of the SPC view. Determining whether the property cluster is cliquishly stable would require determining the relevant properties and the relevant counterfactuals given the domain's aims. Since some of the properties will closely depend on the grounds for the initially identified cluster, reaching these relevance determinations will require identifying and understanding the underlying mechanisms at work. This in turn requires an understanding of how mechanisms contribute to our epistemic needs.

The influenza case differs importantly from the lung cancer example because it is not simply that grounds seem to play an important individuating role. Since the strains of the virus themselves are also changing, we have new grounds coming into existence with potentially new properties in addition to the stable set of symptoms. The stability of any particular cluster of properties does not fully explain the success of our epistemic practices in this domain. Instead, scientific investigations of antigenic shift have uncovered an important causal mechanism that underlies the more immediate causes of symptoms, the strains of the virus, and this understanding partially explains their epistemic success. Boyd's accommodation demands are particularly relevant here, as in this case scientists need terms to track the causal structures at work (e.g., antigenic shift and the genetically distinct strains of influenza virus it creates) rather than solely describing a property cluster.

SPCers might respond by pointing out that this case is difficult to explain regardless of one's view on natural kinds. A proponent of the grounding claim might have to answer similarly challenging questions. The change in grounds over time could make it difficult to make inferences with regard to the various strains of influenza viruses, and we cannot simply presuppose that we can have knowledge of changing and future strains, even with an understanding of antigenic shift. Slater's criticism about the ambiguity of the notion of a homeostatic mechanism is particularly salient in this kind of scenario, as it seems that antigenic shift actually might pull the strains of the influenza virus apart rather than sustain a natural kind.

This is a case in which a grounding-claim advocate may have to cede ground to Slater's critique and allow for a more flexible notion of mechanism or allow for other types of natural kinds beyond essentialist and HPC kinds. Even though antigenic shift creates new strains of the virus, a grounding-claim advocate can explain both the higher-level kind and the lower-level kinds in virtue of both underlying mechanisms and property clusters. The higher-level kind of influenza is clustered around particular properties, and these proper-

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ties can define this kind along with the historical relations of the virus's genetic history thus far and its propensity to change over time.[6] Within a relatively short time, knowledge of both the property cluster and these grounds can justify inferential practices, as antigenic shift would still proceed in somewhat predictable patterns. However, one can also appeal to the differences in lower-level kinds between the different viruses based on their genetic composition, in the way that an approach focusing on stable properties alone could not.

With this approach, we can do justice to the complex and messy causal structure underlying the influenza virus while explaining the epistemic success of our classification system. This approach makes clear that an awareness of how these grounds would change over time is crucial to explaining scientists' success in this domain. Furthermore, this kind of explanation would be consistent with Boyd's emphasis on accommodation demands, in that natural kind terms would track the causal structure underlying the phenomena of interest.

6. Appraisal of the Grounding Claim. The previous discussion has established that the stability of a property cluster and the grounds that maintain the cluster are not as independent as the SPC account suggests. When it comes to actually applying the relevance condition on counterfactuals, it is difficult to establish a firm basis for our epistemic practices without appealing to an understanding of the relevant mechanisms or other grounds underlying a natural kind. While views that rely on the grounding claim, such as the HPC account, also face problem cases and their own ambiguities, it is not clear that these kinds of problems can be easily avoided with the SPC account. Thinking of natural kindness as a status may be a fruitful conceptual framework, but it will not allow us to avoid the difficult work of investigating and understanding the grounds of a kind's stability and consequently of our epistemic practices.

SPC proponents, if they are to preserve this benefit of their view, must articulate the conditions for the relevant counterfactuals in such a way that both domain relativity and relative independence from the grounds of the property cluster can be maintained. If the former is lost, then the SPC account will not be able to accommodate many important natural kinds employed in empirically successful science. If the latter cannot be preserved, then the SPC account cannot avoid the work of developing an improved account of the grounds of property clusters, which advocates of the grounding claim must also take on.

6. This strategy might appeal to a relational essence as the main ground of the kind or some combination of a relational essence and mechanisms. Thanks to Quayshawn Spencer for helping me to clarify this point.

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An SPC advocate might accept a larger role for metaphysical grounds in his or her account but maintain that the account can still do without the grounding claim, as the grounds are still used in service of identifying SPCs. However, we might worry that this approach fails to take full advantage of the explanatory role that grounds can play. As the aforementioned cases suggest, spelling out the SPC account in greater detail involves an appeal to mechanisms and other grounds, and we will thereby need an account of how these grounds contribute to stability. Instead of leaving grounds as an intermediate step in our account of natural kinds, I maintain that we should make explicit the integral role that they play in the justification of our epistemic practices. Like Boyd's notion of accommodation demands suggests, natural kinds help us to identify the causal structure of the world, and identifying these grounds is crucial to aligning our practices with this structure.

Given these considerations, we should continue to endorse the grounding claim to capture the strongest justification for successful scientific epistemic practices. Successfully applying the SPC account to explain particular cases can disrupt the independence between metaphysical grounds and SPCs, which dampens a virtue of the view. In addition, directly including grounds in our account of natural kinds can better capture the justificatory and explanatory role that grounds play for our inductive and classificatory practices.

7. Conclusion. I have argued against the SPC account's rejection of the grounding claim. In so doing, I have demonstrated why grounds are genuinely explanatory of the success of our epistemic practices. I have shown that there are important cases in which appealing to a ground is crucial to our epistemic practices and in which the SPC account faces some challenges without grounds in its analysis. While Slater raises some important worries about the nature of homeostatic mechanisms, his SPC view does not succeed in avoiding the work of better specifying an account of mechanisms and other grounds. As a result, we should retain the grounding claim and take advantage of grounds' explanatory and justificatory potential in our philosophical analysis of natural kinds.

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