AN *EVEN BETTER* BEST SYSTEM ACCOUNT

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Contents

1. Introduction

In this paper, I will propose a modification to the so-called "better best system account" (BBSA) of natural laws that Johnathan Cohen, Craig Callender, and Markus Schrenk put forth.[1] The BBSA is a variant of the Mill-Ramsey-Lewis or best system account (BSA) of natural laws and is designed to accommodate special science laws, a feature that the original best system view lacks. The original BBSA allows for mutually incomparable best systems formulated in different languages with no intrinsic criteria to decide between them. Hence, it implies relativism. I will argue for a modification of the BBSA in order to render ist less relativistic. The source of the problem is the fact that the BBSA is built upon what Philip Kitcher called "modest realism". I will try to solve this issue by divorcing the BBSA from modest, or, how Cohen and Callender call it "explosive", realism. I will argue that the BBSA should be paired with a naturalistic account of natural kinds. This allows us to exclude systems that are formulated in a wildly outlandish vocabulary. Naturalism also allows for a criterion of choice between systems formulated in different languages, since in naturalism, different sets of kinds are held to be differently well projectible.

First, I will portray the BBSA as it was proposed by Cohen, Callender, and Schrenk. I will then turn to a brief exposition of explosive realism and identify a number of problems that explosive realism has which are independent of its application in the BBSA. Following this, I will discuss the problems that modest realism generates for the BBSA, i.e. its relativism and the impossibility to exclude best systems formulated with outlandish vocabularies. To solve these problems, I will then propose to substitute explosive realism with naturalism concerning natural kinds. This way, we can retain the advantages of the BBSA such as the possibility to accommodate special science laws into a version of the best system account, but without BBSA's shortcomings.

2. Better Best Systems

The better best system view is a variant of the best system (BSA) view of laws of nature. The original BSA view in Lewis's variant states that the laws are those universal generalisations that could serve as theorems of a deductively closed system that represents the best balance between simplicity and strength.[2] This view has the notorious problem that the standards of simplicity, strength, and even balance are relative to the language the system is formulated in: what is evaluated as simple in one language might not count as simple in a different language. Hence, systems formulated in different languages are not comparable regarding simplicity, strength, and balance. If there are multiple vocabularies available in which we could formulate best

[1] Cohen and Callender (2009), Cohen and Callender (2010), and Schrenk (2008)
[2] Lewis (1994), 231-232

systems, we cannot decide on a best system. Cohen and Callender named this "the problem of immanent comparisons".[3]

Lewis's own version of the BSA evades the problem that there would not emerge a single (set of[4]) best system(s) if there were multiple vocabularies available in which one could formulate best systems. Lewis allows only perfectly natural predicates as the building blocks of best systems.[5] This way, all candidates for a best system are formulated using the same set of predicates. But since Lewis's perfectly natural predicates refer only to fundamental properties, a Lewisian best system cannot accommodate special science laws, which would require non-fundamental predicates. Obviously, the sciences differ in the vocabulary they need. A biological law would e.g. need terms such as "population", which would not be part of the vocabulary of fundamental physics. Such a richer vocabulary with macro-predicates such as "population", however, is incompatible with any view of kinds that only allows for fundamental predicates. This is what Cohen and Callender call the "problem of supervenient kinds".[6] In order to be able to accommodate special science laws into one big best system, one would either have to formulate special science laws like those of biology using only fundamental predicates, which would vastly complicate the system. Or one would have to drop Lewis's requirement and use non-fundamental predicates, which would then turn out to be redundant, because they are replaceable by the more fundamental predicates already in use for fundamental laws.

The guiding idea of BBSA is to propose a best system account that can accommodate special science laws. In order to achieve this, Cohen, Callender, and Schrenk hold that there should rather be a multitude of best systems, one for each special science. Each of these best systems uses the vocabulary of that special science.[7] This is meant to circumvent the problem of supervenient predicates that results if one tried to build a one size fits all best system that has as theorems or axioms all the laws of physics but also of the special sciences. As an alternative, Cohen, Callender, and Schrenk adopt explosive realism about properties, which is the claim that there are possibly infinitely many ways of carving up nature, each "equally good from the perspective of nature itself".[8] Which set of predicates we choose for a particular special science is up to us: we choose it according to our own epistemic needs and preferences. So we pick one vocabulary when we want to talk about fundamental physics, and another when we want to talk about, say, behavioural biology. With each of these vocabularies, the proponents

[3]Cohen and Callender (2009), 5

[4]Lewis allows for several best systems all equally good but formulated in the same language. Cf. Lewis (1973), 73.

[5]Lewis (1983), 42

[6]Cohen and Callender (2009), 14-15

[7]Cohen and Callender (2009): 22-24

[8]Cohen and Callender (2009): 22

of BBSA claim, we can now build one best system for every scientific discipline. The resulting best systems for each special science do not rival each other: one will not make the other redundant. That is a consequence of the fact that the only standards that we have to compare between best systems, i.e. strength, simplicity, and their balance, are language-dependent. Hence there is no way in which we could say that the best system for fundamental physics is in any way "better" than that for behavioural biology.

As mentioned above, the BBSA is based on what Cohen and Callender call "explosive realism". In the following sections, I will turn to a brief exposition of explosive realism and the problems it generates, before I will propose to base the BBSA on a naturalised account of natural kinds to avoid these problems.

3. Explosive Realism

Explosive realism was developed most fully by John Dupré and Philip Kitcher.[9] This pluralist view on kinds goes by a number of different names ranging from "promiscuous" (Dupré) and "modest" (Kitcher) to "explosive" (Cohen and Callender) realism, but the views are similar enough to be treated as a single view.[10] In a nutshell, explosive realism is the view that there are infinitely many possible ways to partition nature. According to its proponents, it differs from constructivism in the sense that while it is up to our needs and preferences which of these possible partitions we use, all of these partitions are real: they are out there. But how we draw the lines in the great mess that is unstructured reality, how we lump reality together into categories, is solely due to our preferences and epistemic needs.

Kitcher uses the metaphor of a block of marble which contains infinitely many possible ways to be carved up. All the possible statues, sculptures, and partitions that block of marble can take are equally real: there is no single privileged way to carve up this block of marble.[11] The same goes for our reality: how we draw the devisions between the units of existence is up to us, and all the possible partitions are equally good "from the perspective of nature itself".[12] This has the consequence that we could chose to treat e.g. the manuscript of *Finnegans Wake*, Queen Victoria, and the number two lumped together as one single object.[13] Kitcher holds that this classification is not wrong in the sense that it lumps together things that are objectively dissimilar. According to him, we simply do not use languages that treat these things as one single object, but only because such classifications would not be useful to our purposes:

[9]Dupré (1993) and Kitcher (2001)

[10]I will use the terms "explosive", "modest" and "promiscuous" realism interchangeably in this paper.

[11]Kitcher (2001), 44

[12]Cohen and Callender (2009), 22

[13]Kitcher (2001), 44

> [...] we are driven to the conclusion that the languages we use are apt for the description of nature in the sense that they are good for *creatures like us* to formulate the kinds of descriptions of the world *that we care about*. In other words, human languages strike us as distinguished from their rivals because of the banal fact that these languages are good ways for us to achieve our purposes.[14]

Explosive realism is not merely the view that there are fundamental kinds like 'proton' or 'neutron' as well as kinds for composite things such as trees and tall ships, but what explosive realism holds is that there is also such a thing as the single composite entity that is comprised of *HMS Victory*, my left thumb and James Joyce's second pair of glasses. According to explosive realism, there is no natural reason to think that 'tree' is a kind, but the seemingly outlandish composite entity is not. That the objects used in our example do not spatiotemporally coexist is no problem according to Kitcher, since he believes that contemporary physics does not necessarily require that things have to be locally connected to be one thing.[15]

Explosive realism rests on what we could call the "principle of free combinability" (PFC):

> Any composition of objects into composite objects is admissible, unrestricted by spatiotemporal or causal connectedness. All of the resulting compositions are "equally good from the perspective of nature itself".

However, according to the proponents of explosive realism, this view does not entail constructivism: we cannot make up any old kind by just wishing it was there. That is to say that explosive realism does not commit us to the view that there are ghosts, witches or a molecular memory of water. There is nothing in nature that would correspond to these kinds. Modest realism is lenient regarding grain: whether we use a very fine-grained language like the predicates of fundamental physics, or a coarse-grained one when we want to talk about tall ships, is up to us. Modest realism is not only about scale, however: as we have seen, it allows for seemingly outlandish and saptiotemporally unconnected objects.

According to explosive realism, the view applies well to scientific practice: our scientific disciplines are modeled after their intended uses, and so are their respective vocabularies. There is no single correct vocabulary: sometimes we want to talk about fundamental physical phenomena, then we need a language that can refer to the kinds of objects we are interested in. We do not need terms like "elephant" "malaria" or "demand" to talk about α-radiation. And sometimes we want to talk about population dynamics,

[14]Kitcher (2001), 46

[15]Kitcher (2001), 47. I will discuss below that contemporary physics cannot be used to justify this claim quite so nonchalantly.

and then it would be foolish to try to apply the language of fundamental physics.

Explosive realism, as advertised by Dupré and Kitcher, is much more than just a theory of kinds. It is a view that is supposed to tread a middle path between scientific realism and antirealism. The view regarding natural kinds is only the backdrop to a realist pluralism. According to this view, there are multiple possible representations of reality, i.e. not only vocabularies, but *theories* formulated in these vocabularies. These representations are held to be partly overlapping, non-reducible, but jointly consistent.[16] According to explosive realism, the different representational systems that "conform to nature" are jointly consistent. That means that any two representational systems, formulated in different vocabularies, do not contradict each other as long as they represent nature correctly. The pluralism that Dupré and Kitcher propose holds that the various representational systems that we get when we select a certain set of vocabularies are not only jointly consistent, at least as long as they accurately depict reality, but also non-reducible to one another. So evolutionary biology and its language are jointly consistent with e.g. chemistry and fundamental physics and their respective languages, but not reducible to these more fundamental representational systems.[17]

One can easily see why this view is attractive to anyone who tries to give an account of special science laws. It provides an ontology of kinds that treats the different classifications of nature seriously, just as BBSA takes the different sets of laws the special sciences offer seriously, without the demand that neither kinds nor laws can be subsumed under one single unified ontology. So BBSA and explosive realism seem to be a perfect match, with the explosive realism providing a pluralist account of kinds that BBSA requires so that the various languages in which the best systems are formulated are equally valid and non-reducible.

However, explosive realism has a number of problems. We will turn to these issues now.

4. Problems of Explosive Realism

In this section, I will first discuss a some issues that explosive realism has independent from its application in the BBSA, and then some problems it generates for this particular view on laws of nature. While the issues explosive realism has on its own are enough to reject it as a basis for an account of laws, it also generates specific problems for a best system view. Explosive realism is designed to keep a middle ground between classical realism regarding natural kinds and constructivism, so perhaps unsurprisingly, it has been criticised by both sides as either being too realist[18] or not realist enough. I

[16] Kitcher (2002), 570

[17] Against this, I will argue below that the resulting theories are at least mutually exclusive.

[18] see e.g. Longino (2002b), and Longino (2002c)

will focus on the realists' objections, since they prepare the ground for my reasons to reject it as a basis for an account of laws.

Independent Problems. First, there is the worry that explosive realism is really just that: ordinary, run-of-the-mill realism. The worry is founded in Dupré's and Kitcher's attempts to show that their views do not entail constructivism. In order to defend themselves against the charge that in their view, it is possible to just make up any sort of kind as we please, they both have the same answer: In their view, reality is an unstructured mess, but the structure that we carve out of it, and the multiple different the classifications that we draw, are not of our making, but do refer to something real. The manuscript of *Finnegans Wake*, Queen Victoria, and the number two, all exist as single objects, but also as a composite object. We choose to use a classification that only treats these things as separate instead of a system in which they form a composite object, but that does not entail that these different competing classifications are man-made. Hence, Julia Göhner and Markus Seidel claim, Kitcher and Dupré are in danger of simply proposing a realist natural kinds view, with the simple addition that they hold that there are an awful lot more natural kinds than realists concerning natural kinds typically hold. Explosive realism comes down to a view that there are fundamental natural kinds, and any combination of these natural kinds also form natural kinds.[19] I disagree. As we will see below, this will only be unproblematic if the resulting vocabularies do not give rise to equally valid scientific theories that are not mutually exclusive. Below, I will argue that explosive realism and PFC will lead to mutually exclusive and equally valid theories, which renders the view relativistic. I will argue that the resulting theories are, however, not equally valid, which cannot be accommodated by explosive realism.

This leads us to the second realist challenge to explosive realism, i.e. that the view is not realistic enough. Kitcher often claims that modest realism reflects our common sense view of the world. However, Friederike Göhner and Markus Seidel claim that, while Kitcher refers to common sense when he defends realism against relativism and constructivism, his own view fails to be commonsensical. It is highly questionable whether it is compatible with common sense that there is such a thing as a single composite entity that consists e.g. of the manuscript of *Finnegans Wake*, Queen Victoria, and the number two.[20]

I have to agree: the intuitively common sense response if someone tried to convince you that these three very different and spatiotemporally unconnected things should be treated as one single object, should be one of disbelief. It also does not help that Kitcher invokes modern physics to justify spatiotemporally unconnected composite objects. Granted, modern physics does not always require spatiotemporal connectedness in order to classify

[19]Göhner and Seidel (2013), 121

[20]Göhner and Seidel (2013), 125-126

something as one single thing, event, or process.[21] But instead of allowing for *any* spatiotemporally unconnected things to be interpreted as single composite objects, when physicists claim that spatiotemporally unconnected objects should really be treated as one single object, they do not do so because they happened to have chosen a language in which this is possible. They do so because it has been empirically discovered that e.g. in entanglement phenomena, several spatiotemporally unconnected objects can be described as one single physical system, which in turn explains its entangled behaviour. We have *empirical* reason to classify two photons that are in an entangled state as one object, so we have no choice but to do so. The same does not apply to the manuscript of *Finnegans Wake*, Queen Victoria, and the number two. We cannot make up composite objects such as this simply in accordance to our preferences, as explosive realism and PFC allow. In the sciences, we accept kinds because they feature in projectible and successful theories. We successfully land probes on comets, cure illnesses, and build ever smarter computers. It would, to mirror the no-miracle-argument,[22] be miraculous if theories that are built on a language that contains only outlandish composite predicates were that successful. It is highly questionable whether there are projectible laws that describe the causal antics of the single thing that is the manuscript of *Finnegans Wake*, Queen Victoria, and the number two, and give us the possibility to make predictions and manipulate nature.

Note that the arguments against explosive realism presented here should not be misconstrued as arguments against composite kinds: a sulphuric acid molecule, made up of a hierarchy of ever smaller objects, is not an individual object just because we happen to use a language that treats it as one. We have to accept that being a sulphuric acid molecule is a kind because our best theories treat it as such. For explosive realism to fall under the category of scientific realism, it has to contain some sort of claim that at least our best scientific theories get some of the ontology at least partially right, which explains why our best theories are successful. This is a minimal requirement for a theory to be called "realist". But if one accepts that, one has to also accept that at least some of the categories that science use actually refer successfully.[23] So far the proponents of explosive realism would probably agree. But what about the above-mentioned outlandish composite kinds? For them to be harmless from a realist perspective, treating them as one single object should not contradict our best scientific theories. According to Kitcher, this is the case: the infinitely many representational systems that are the consequence of explosive realism are supposed to be non-contradictory.[24]

[21]Kitcher (2001), 47

[22]Cf. e.g. Boyd (1989), 7-9.

[23]Unless one wanted to propose some variant of structural realism of course.

[24]Kitcher (2002), 570

Against this I argue that the resulting representational systems are at least mutually exclusive, which entails that they cannot both be true. Granted, we treat elementary particles, molecules, cells, and rabbits as equally real kinds and the according theories or scientific disciplines as equally valid, even though reduction might not be possible. We do so because this all fits into the same scientific picture. That there are such things as rabbits does not contradict our best scientific theories, which, while maybe non-reducible to a fundamental theory, are complementary.[25] But a theory that posits outlandish composite kinds is not complementary to our best scientific theories, but an alternative, a rival.

Take entanglement phenomena as an example. According to explosive realism, which compositions of smaller objects are treated as single composite objects and which are not is a matter of preference. However, physics tells us an elaborate story why we should treat entangled objects as single physical systems. There is no such story for every of the possibly infinite number of composite objects of the sort explosive realism permits. A theory that holds that there are more composite objects than our best scientific theories hold there are entails that our best scientific theories are *wrong* about how they carve up reality. We would need a different set of laws to make sense of a reality that had outlandish composite objects but no rabbits. These sets of laws would be rivals, mutually exclusive. Entanglement phenomena are a wonderful example: that these phenomena are a consequence of quantum mechanics was once seen as a *reductio*, because they are inconsistent with locality.[26] The two different representational systems under which e.g. two photons, emitted from the same light source at the same time, moving in opposite directions, are either entangled and hence seen as a composite object, or not entangled, and hence seen as two different objects, are mutually exclusive. They cannot both be right. According to explosive realism's principle of free combinability (PFC), however, there is no reason to privilege the view that these two particle form a composite object over one where they do not, apart from our preferences. But it is not a matter of mere whim that we choose the one over the other: entanglement phenomena are an indisputable part of our reality, and we cannot choose to ignore them. These phenomena are inconsistent with 19th century Newtonian mechanics, which is one of the reasons why we had to let Newtonian mechanics go. We cannot just choose to treat entangled objects as separate because we feel like it and with that move save locality from being false.

Explosive realism, PFC, and the best system analysis can easily tempt one into a simplified view of scientific practice. These views, especially when combined, can give one the impression that scientific practice runs somehow like this: We first agree on a set of predicates according to our preferences, and then we go about building a best system with them. According to

[25]At least, if there is a contradiction, this is seen as a defect.

[26]Einstein et al. (1935)

PFC, any recombination of smaller objects into larger objects is admissible, and the resulting best systems are then incomparable according to Cohen and Callender's problem of immanent comparisons. In reality, however, the sets of kinds that the special sciences use are not a matter of more or less arbitrary choice and in any way prior to the science's effort to build a set of laws with them. To the contrary, the sets of predicates that the sciences use are a result of their effort to build projectible theories, which allow us to manipulate nature. Any different choice of predicates gives rise to different theories, and it would be a miracle if they were all equally projectible. In the case of entanglement phenomena, we replaced one way to carve up nature with another one, the pair of them mutually exclusive. But that mutual exclusivity does not only contradict PFC, but the two rival theories, QM and 19th century Newtonian mechanics, are also not equally well projectible: Newtonian mechanics cannot make sense of entanglement phenomena for example. The two alternative ways to view entangled systems, either as one composite, or as two distinct systems, are not "equally good from the perspective of nature itself".

Problems for the BBSA. Apart from these issues that explosive realism has independently, it generates two problems for the BBSA: The first problem is that it implies relativism with regard to natural laws. The second problem is that it remains unclear how there could be a way in which the various best systems for the special sciences share a certain core vocabulary or whether it would be possible that one best system can make use of the vocabulary of another system, which seems necessary for our scientific endeavour.

Applied to the BBSA, explosive realism implies relativism, in the sense that it gives rise to mutually exclusive but equally valid sets of best systems. It is not only impossible to compare the best systems of different special sciences, but there is also no way to decide between rival best systems for one single particular field of enquiry, if these rival best systems are formulated in different vocabularies. If there really are possibly infinitely many best systems which use different sets of predicates, each "equally good from the perspective of nature itself", and which hence are incomparable, then it is impossible to rationally decide between them.[27] But if there is no language-independent criterion of deciding between rival best systems, we would have to accept them as equally valid. As noted above, this equal validity claim can be seen as the central tenet of relativism. If we build a theory of laws of nature upon explosive realism, we get a host of mutually exclusive but supposedly equally valid laws. But the decision between relativism and realism should be independent of which theory natural laws one proposes.

The second problem that explosive realism generates for the BBSA is that it becomes unclear how the different best systems can consistently refer to one another. Let me elaborate. Remember that the core idea of the BBSA

[27]Cohen and Callender (2009): 31

is this: you get a number of best systems, each for one special science, which furnish us with the laws of that particular special science. Each of these best systems is formulated in the vocabulary of that particular special science. However, the special sciences do not exist completely independent of and oblivious to other scientific disciplines. Chemistry needs physics, molecular biology needs chemistry, economics needs psychology, and so forth. However diverse the vocabulary of these special sciences are, there should at least in principle exist the possibility that they are compatible with one another. One of the reasons we know why chemistry works is that it is compatible with physics. We know what chemical phenomena look like on a more fundamental level, and that would not be the case if physics were completely on the wrong track with e.g. its models of fundamental particles. It would not be possible to keep our chemistry as we use it today and combine it with fundamental physics which do not treat any of the fundamental particles as individual entities. That there is such a kind as 'proton' or other fundamental particles does not preclude that there is such a kind as 'gold'. We can talk about gold without talking about fundamental particles. But if we needed to, it would be possible. Gold e.g. has 79 as atomic number and an atomic mass of 196,97, so it is an element with 79 protons and 118 neutrons. If we wanted to explain some of the chemical properties of gold we could refer to our knowledge of its physical make up. That would not be possible if physics did not use 'proton' or 'neutron' as kinds, but 'this proton, all neutrons ever, and the my first gin and tonic on the noteworthy day that was the 9th of January, 2015'. A physics that used different, but according to PFC equally admissible, kinds would *not* be compatible with our current best chemistry.

I do not wish to propose any sort of unificationist or reductionist approach here. I do not claim that all best systems, all predicates, should supervene on those of fundamental physics. But if we had two scientific disciplines as fundamental as physics and chemistry which were not compatible, would we not perceive this as a scientific scandal, as an issue which *must* be resolved? In explosive realism, incompatible best systems would be based on vocabularies that are the respective alternatives to ones in the same field which would give rise to compatible best systems. But these vocabularies are "equally good from the perspective of nature itself" in explosive realism: there is no independent criterion that could favour one over the other. But to a realist, that should not be acceptable. It should not be a matter of *choice* that fundamental physics and chemistry use compatible vocabularies. Again, this antirealist consequence disappeared if we could only restrict the pool of predicates further than explosive realism allows. In the next section, I will argue that naturalism regarding natural kinds does just that.

What does that leave us with? As we have seen above, the BBSA is a laudable amendment to the original BSA in the sense that it finally provides us with a way to accommodate special science laws. However, since it is based on explosive realism, it would allow languages, and with them rival

theories, which would contradict modern science, with, at least according to the proponents of BBSA, no language-independent criterion to decide between rival incompatible systems. Explosive realism seems attractive on two counts: it does away with the weighty metaphysics that essentialism about kinds brought with it, and it allows us to take higher-order kinds seriously. However, the advantages are offset by the fact that although explosive realism allows for composite kinds which are irreducible to the fundamental ones, it does allow for too many kinds. So what we need is a way to further restrict the pool of eligible predicates in order to solve the problems that explosive realism generates for the BBSA, but without falling into the essentialist trap of requiring but ultimately failing to provide a set of necessary and jointly sufficient properties for each kind. There is an obvious alternative to explosive realism that could provide us with the same advantages, but without the drawbacks: naturalism about kinds. In the following, I will give a brief outline of the view and how it fits in the BBSA.

5. Naturalism about Kinds Makes the Better Best System Account even Better

Naturalism is the view that the scientific categorisations *do* reflect a real order in nature, but without the metaphysical claim that the resulting kinds are individuated by an essence, a set of necessary and jointly sufficient properties that this kind possesses in every metaphysically possible world. According to naturalism, the success of our sciences is partly due to the fact that science is at least approximately right about the entities it proposes. Naturalism regarding kinds is most thoroughly defended by Muhammad Khalidi,[28] but aspects of it are also held by scientific realists like Richard Boyd.[29]

While naturalists like Khalidi are sceptical about the notion of essence, naturalism still holds that kinds have a characteristic cluster of properties, but which do not necessarily have to be instantiated in every individual. However, although this set of kinds is not necessary and jointly sufficient as it would be, were it taken to be an essence, it is nonetheless not up to our mere whim which properties belong to the cluster. Theses kinds and their respective sets of properties are up to science to discover. Science can also revise our categorisation of which properties we hold to be important for the membership of an individual to a certain kind. In this regard, it is stricter than explosive realism, especially Dupré's, who argued that our everyday categorisations are as good from the perspective of nature itself as our scientific ones. He complained e.g. that the scientific classification of whales as mammals is not any more natural than to classify whales as fish. According to him, we simply had different interests according to which we

[28] cf. e.g. Khalidi (2013) and Khalidi (2015).

[29] cf. e.g. Boyd (1991), Boyd (1999a), and Boyd (1999b).

classify whales as fish in our everyday life than we would have when science classifies them as mammals.[30]

According to Khalidis's naturalism about kinds, there can be several possible equally good classifications of nature. But the number of different alternative sets of kinds is much smaller as it would be in explosive realism. Khalidi holds that in science, we value epistemic criteria such as projectibility above everything else in our choice of kinds. A kind that does not lend itself to being projected and does not figure in any successful scientific theory gets replaced by one that does. And so the kind 'whale as a fish' gets replaced by the kind 'whale as a mammal'. Likewise, the language that treated entangled objects as completely distinct gets replaced by a language that treats them as a composite entangled entity.

In the way that we chose which properties belong to the cluster of properties that are associated with being of a certain kind, Khalidi's view is reflective of Richard Boyd's theory of natural kinds as "homeostatic property clusters" (HPC). According to Boyd's view, kinds are individuated by a cluster of properties none of which are necessary or sufficient for kind membership, not in isolation nor in conjunction. That is to say that not every member of a kind has to instantiate the complete cluster to belong to a kind. But according to Boyd, the cluster of properties that individuate a kind is not just a loose collection of properties. In this view, a (set of) causal mechanism(s) is responsible for the cluster of properties, which are causally related to one another through the causal mechanisms that account for their presence. The causal mechanism holds the cluster of properties in homeostasis. It is possible that a member of a kind does not share all of the properties of its according property cluster, but then there must be a difference in the causal mechanism that can account for this. A member of a kind with an incomplete property cluster is called to be in imperfect property homeostasis.[31]

The lesson to take away from Boyd's account is that causation plays a crucial role to see if one's categorisation refers to kinds. What differentiates this account from the pluralism discussed above is that kinds are only accepted if they are inductively successful (which the kind 'manuscript of *Finnegan's Wake*, Queen Victoria and the number two' wouldn't be). We know that a kind will be inductively successful when it correctly represents the causal structure of our world. The outlandish kinds repeated once too many already in this paper do not. Khalidi argues that the causal structure of nature is more complex and diverse that the HPC-account can accustom. There simply might not always be a clear-cut causal mechanism which can account for the distribution of properties that allow us to identify kinds.

[30]Dupré (1993), 29. Interestingly, it seems that since Dupré made that point, it has become commonplace to call whales mammals even in everyday life. So in contrast to Dupré's view, we have revised our everyday classification according to the scientific one.

[31]Boyd (1999a), 166

Nevertheless, they are inductively successful because they correctly accommodate the causal structure of our world:

> If natural kinds are to play a role in inductive inference and serve the purposes of science, then they will be implicated in causal processes. Instead of a model whereby kind K is simply associated with some set of properties $P_1, \ldots, P_n$ we need to articulate an account according to which the projectibility of kind K is due to its figuring in certain causal relationships. However, that does not mean that there will always be some causal mechanism that holds the properties in the cluster together, or even that those properties are held together in a state of homeostasis.[32]

This account of natural kinds delivers exactly those desiderata that we needed in order to alleviate the worries that explosive realism generated for the BBSA.

Let us recapitulate what the problems explosive realism had on its own or in application for the BBSA, and how naturalism concerning natural kinds can help us to solve them. Firstly, naturalism is, in contrast to explosive realism, thoroughly realist. If a kind does not help to capture the causal structure of nature and is not projectible in the application of scientific theories, we will discard it. Explosive realism with its PFC did not allow for this. There, any recombination of kinds can give rise to composite kinds, irrespective of their projectibility or possibility to be used in causal modeling. Secondly, naturalism does provide us with non-fundamental kinds, as we need them in the special sciences, without resulting in an unwanted proliferation of outlandish kinds, since these outlandish kinds would not figure in the causal structure of our world as science reveals it to us.

Similarly, if we apply naturalism regarding natural kinds to the BBSA, we can solve the problems that explosive realism generated there. Firstly, the resulting view of laws is not relativist. Only the kinds which the sciences propose in their representation of the causal structure of reality may be used in order to formulate best systems for the special sciences. So the problem does not arise that there are automatically many competing best systems for the same scientific discipline that are not, in the words of Cohen and Callender, immanently comparable, because they are formulated in different languages. This reflects scientific practice much better than the original idea to pair the BBSA with explosive realism. The organisation of our knowledge of the world in deductively closed best systems is an idealised scenario anyway, so we should not expect it to happen with any old categorisation that one could come up with from the armchair. Organising our knowledge into a deductively closed system is an ambitious scientific project, and it should happen in the actual vocabulary the sciences actually

[32]Khalidi (2013), 131

use. Secondly, it becomes apparent that the vocabularies that e.g. chemistry and fundamental physics use are compatible. As mentioned above, a rejection of explosive realism does not entail that there are no macro-kinds. But, if we take naturalism seriously, there exist only those macro-kinds that the sciences claim there exist.

Lastly, a commitment to naturalism regarding natural kinds also helps us to argue against spurious science which might use a vocabulary that might otherwise be hard to argue against in the framework of explosive realism. Naturalism, according to Ladyman, Ross, et al., includes a commitment to the conviction that fundamental physics, being our best current science, serves as a sort of litmus test. Ladyman, Ross, et al. call this conviction the "primacy of physics constraint" (PPC), which amounts to the view that the "[. . .] failure of an interpretation of special science generalizations to respect negative implications of physical theory is grounds for rejecting such generalizations."[33] This is exactly which, without any explicit endorsement of unificationism, ensures that the special sciences are compatible with one another. Chemistry in its current form does not violate PPC, while a spurious science which used a vocabulary which is not compatible with fundamental physics would. Naturalism, in contrast to explosive realism, would ensure we have a fairly consistent set of special sciences and would see any case of inconsistent vocabulary as an anomaly which has to be resolved.

To sum up, all we wanted from our theory of kinds for the BBSA was to arrive at a realist view that treats macro-kinds seriously, so that we can build multiple best systems, one for each special science, without a proliferation that would lead to relativism. Naturalism provides these desiderata and makes the better best systems account *even better*.

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[33]Ladyman et al. (2007), 190

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