Natural Kinds as Real Patterns: Or How to Solve the Commitment Problem for Perspectival Realism

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Abstract

Perspectival realism aims to reconcile the practice and the history of science with the realist commitment to mind-independent things such as natural kinds (Massimi 2018a;b, Teller 2011, Giere 2006). Yet an unambiguous realist commitment, particularly to natural kinds, is still missing from most perspectival realists' accounts (Creţu forthcoming,b, Morrison 2011, Chakravartty 2010). The problem of integrating the two commitments is identified as 'the commitment problem'. Taking inspiration from another weak realist position, structural realism (Ladyman and Ross 2007), a new account – natural kinds as real patterns – is developed as a solution to the commitment problem for perspectival realism. The natural kinds as real patterns account combines four main ingredients. First, a notion of 'perspective-independence', an empirically driven notion, different from mind-independence and objectivity. Second, a notion of 'real patterns', used to denote stable empirical regularities which science is in the business of tracking (Ladyman and Ross 2007, Dennett 1991). Third, a crucial distinction between 'research traditions' and 'perspectives' which is introduced to secure the legitimacy of perspective-independent real patterns (Laudan 1977). Fourth, a dual commitment to both real patterns (qua relations) and objects (qua relata).

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1 Introduction

What would a perspectival realist account of natural kinds look like? Perspectival realism is committed to the existence of mind-independent things and to the historical and cultural situatedness of scientific knowledge (Massimi 2018a;b, Teller 2011, Giere 2006). The first is the realist commitment and the latter is the perspectivalist commitment. A perspectival realist account of natural kinds would, accordingly, have to successfully integrate both of these commitments. However, as a weak realist position, perspectival realism is susceptible to a common worry raised against other weak realist positions such as structural realism. The worry is that within such weak realist positions there is no scope for a substantial ontological commitment to anything (see Ladyman 2016, Psillos 2001). Whilst many arguments have been articulated in support of the perspectivalist commitment, the realist commitment remains largely unsupported (Creţu forthcoming,b). Thus, integrating the two commitments within a perspectival realist account of natural kinds brings forth a particularly fraught problem for perspectival realism, let us call it the commitment problem.

Strong realist views, such as 'essentialism' (Ellis 2001) or 'homeostatic property cluster kinds' (Boyd 1991), incorporate a realist commitment, but are not sufficiently

perspectival (Giere 2006) for two main reasons. First, such views are not sufficiently practice-relative. To be precise, such views either deny the role which theoretical interests and assumptions play in scientific classifications or they only apply to some sciences but not to others (Slater 2017; 2015, Khalidi 2016b, Ereshefsky and Reydon 2015, Kendig 2015, Magnus 2014; 2012, Massimi 2014, Craver 2009 etc.). For example, essentialism doesn't work very well for biology (Ellis 2001, Okasha 2002) and the homeostatic property cluster kinds does not apply to physics (Khalidi 2016b). Second, strong realist views are not ontologically scale-relative (Bursten 2016, Ladyman and Ross 2007). That is, they tend to ignore that what may exist on a particular spatiotemporal or energetic scale may not exist on a different scale. Thus, solving the commitment problem for perspectival realism calls for a new strategy.

The new strategy, call it 'the real patterns strategy', is an elaboration of certain key insights of structural realism. In particular, the real patterns strategy presupposes the improvement and development of Ladyman and Ross' suggestion that a weak realist position can be practice- and scale-relative whilst also being ontologically committed to 'real patterns'. Ladyman and Ross' real patterns strategy will be ultimately found to be unsatisfactory to resolve the commitment problem for perspectival realism. However, certain key insights will be retained and developed into a new account – *natural kinds as real patterns* – which can successfully integrate the realist and perspectivalist commitments. In the new account, *natural kinds are real patterns, where real patterns are robust relations amongst entities exhibited by any two given entities with sufficient regularity on any given scale.*

The natural kinds as real patterns account is built upon four core conceptual ingredients: first, a notion of 'perspective-independence' which is an empirically driven notion, different from the 'God's eye view' metaphysical notion of mind-independence and from the methodological notion of objectivity. Second, a notion of 'real patterns', which is used to denote stable empirical regularities which science is in the business of tracking (Dennett 1991, Ladyman and Ross 2007). Third, the crucial distinction between 'research traditions' and 'perspectives'. Following Laudan (1977), a research tradition is understood

as "a set of assumptions: assumptions about the basic kinds of entities in the world, assumptions about how those entities interact, assumptions about the proper methods to use for constructing and testing theories about those entities" (p. 97). In contrast, the notion of 'perspective' is used to mean a sophisticated theoretical framework that encompasses the set of theoretical interests and background theoretical knowledge that a researcher or group of researchers can be said to hold at any given time.[1]

It will be argued that real patterns are 'authenticated' prior to the development of perspectives on their nature. Authentication refers to the identification and validation of a particular empirical phenomena as well established and genuine. Thus a research tradition affords the authentication of empirically genuine real patterns, whilst perspectives are subsequently developed to study their nature. It is worth noting that perspectives may not lead to understanding the nature of the authenticated real patterns and thus fail. Yet, when they do fail, the authenticated real patterns remain authenticated. Hence, the ontological commitments warranted by the research tradition can be retained even when perspectives are abandoned. To the extent to which the distinction between research traditions and perspectives is accepted, it will be argued that real patterns are perspective-independent empirical phenomena. As authenticated phenomena, independent of perspectives, the commitment to real patterns thus constitutes a legitimate ontological commitment. Therefore, with authentication in hand, a more convincing general strategy for resolving the commitment problem for perspectival realism can be developed.

In the true spirit of perspectival realism, a further novel development of the real patterns strategy consists in drawing important lessons from the history and philosophy of science. In particular, insights from Whewell's philosophy of classificatory sciences (Whewell 1840a;b) are used to remedy further problems with Ladyman and Ross's (2007) account. For Ladyman and Ross, a natural kind is a real pattern of 'high indexical redundancy', where indexical redundancy concerns the measurability of patterns. A pattern that can only be measured at one point in time and space by one individual has very low indexical redundancy. In contrast, a pattern that can be measured from multiple per-

[1]This is similar to Laudan's 'theory'. On a different notion of 'perspective', closer to Laudan's research tradition, see Massimi (2018a).

spectives has high indexical redundancy. According to Ladyman and Ross, "[t]here are no things" (p. 130) and "[s]tructure is all there is" (id.), and hence only real patterns are ontologically subsistent. However, if we follow Whewell, we must surely accept that any scientific classification is inherently tied to the ideas of likeness and difference. Yet, these ideas can only be applied once several objects are compared to one another and their relations of likeness and difference are identified between them. The process of identifying relations of likeness and difference lies at the heart of distinguishing between kinds of objects, which in turn lies at the heart of any account of natural kinds.

It is worth noting, however, that these ideas are not, in and of themselves, inherently tied to projectibility,[2] nor do they need to be, since projectibility does not constitute the sole aim of all scientific classifications. As Okasha (2002) points out, assuming that the primary purpose of any scientific classification is that of 'facilitating causal generalisations', "is not necessarily appropriate to all sciences" (p. 210). In particular, an account which assumes that the point of classification is identifying projectible kinds will have little applicability to evolutionary biology, where the point of classification is to identify the units that play a fundamental role in the evolutionary process.

Ideas such as likeness and difference are simply used to identify relations between objects. The nature of the relevant relations, once authenticated, is subject to discipline specific investigations into their nature. Distinguishing kinds of objects presupposes the identification of both objects and relations among them. Thus, the real patterns solution to the commitment problem for perspectival realism involves both real patterns (qua relations) and objects (qua relata). Since natural kinds are inherently tied to the ideas of likeness and difference which require for their application the existence of objects, contra Ladyman and Ross, at least some things must stay.

The paper is structured as follows: section 2 establishes a principled distinction between perspective-independence, mind-independence, and objectivity, thus clarifying what kind of ontological commitment is available to the perspectival realist. Section 3

[2]Projectibility refers to projectibility judgments which can be understood as hypotheses from actual evidence about certain phenomena to future inductive inferences about same kinds of phenomena. In making projectible judgments, one makes use of predicates that are entrenched where the entrenchment of a predicate, following Goodman, "depends upon frequency of projections" Goodman (1983), p. 97.

critically evaluates Ladyman and Ross' real patterns strategy. Their strategy is found unsatisfactory and an improvement is proposed based on Laudan's framework. In Section 4 the improved strategy is developed into a new account of natural kinds – natural kinds as real patterns – that resolves the commitment problem for perspectival realism and that qualifies as a perspectival realist account of natural kinds. Section 5 considers objections and replies.

2 Perspective-Independence vs. Mind-Independence

Perspectival realism can be characterised positively by its commitment to epistemic pluralism – the idea that there are multiple ways of acquiring knowledge about the world and multiple different descriptions of mind-independent entities. This commitment extends to both the history of science and to current scientific practices. Negatively, perspectival realism can be characterised by its rejection of the realists' epistemic commitment to ultimate, objectively true pictures of the world. Perspectival realists are nevertheless committed to mind-independent entities, which in the case of natural kinds are traditionally taken to be 'objective, mind-independent' entities (Khalidi 2016a). Thus, the first step in understanding the kind of ontological commitment available to the perspectival realist is to establish a principled distinction between mind-independence and objectivity.

It is standardly assumed that a natural classification must be mind-independent and objective. However, objectivity is often conflated with mind-independence. It is not surprising that the two notions are conflated, since objectivity is necessary, but not sufficient for mind-independence, yet, at the same time, mind-independence is not necessary for objectivity. To get a clear grasp on objectivity and mind-independence, a few distinctions are in order.[3]

A classification can be said to be objective when it is unambiguous and intersubjec-

[3]See also Khalidi (2016a)'s paper for a four-tier distinction between types of mind-dependence, as well as Franklin-Hall (2015)'s paper, who distinguishes between 'fully objective' and 'fully mind-independent kinds'.

tively well-founded.[4] Objectivity is a methodological notion, pertaining to the practice of science and not to the nature of the world. As Daston and Galison (2007) note "[t]o be objective is to aspire to knowledge that bears no trace of the knower – knowledge unmarked by prejudice or skill, fantasy or judgement, wishing or striving. Objectivity is blind sight, seeing without inference, interpretation, or intelligence" (p. 17). A classification can be objective without being mind-independent, for example the classification of flags. Flags, and what they represent in different circumstances, are human constructs whose ongoing existence and function is dependent upon humans maintaining such constructs and their ongoing performance (Thomasson 2014). Although objectivity is an important notion for the philosophical analysis of science, since it is a methodological rather than ontological notion, it is not directly relevant to the commitment problem.

A classification is standardly assumed to be mind-independent when it is independent of human thought.[5] Yet, complete independence from human thought resembles a form of God's eye view, impossible to attain. Mind-independence, in the strong realist's sense, is not only unattainable, it is incompatible with scientific practice. No inquiry can proceed without at least some theoretical assumptions about the nature of the world (see Haslanger 2015, Kendig 2015). For example, the most common assumptions in connection to natural kinds are that the world is structured, that it is stable enough, that there are hierarchies of objects etc.[6] General methodological assumptions such as these are inevitable components of any research tradition. Thus, there can be no natural kinds classifications that are mind-independent in the strong realist's sense.

Within a research tradition, however, 'perspective-independence' can be obtained.[7] A perspective is an evolving theoretical outlook that offers a particularised ontology. In the context of real patterns, a perspective is an interpretation of the nature of authenticated real patterns. The real patterns themselves are authenticated prior to the development

[4] Giere (2006) similarly defines objectivity as "reliable intersubjective agreement", p. 34.

[5] This notion of mind-independence has already been criticised by perspectival realists, see Giere 2006, Massimi 2018a;b.

[6] A similar point about assumptions is extensively made by Kant (1781), see especially the Appendix pp. 590 - 604 , and also by Whewell (1840a), see especially pp. 18 - 41.

[7] Massimi (2018b) also talks about perspective-independent things, though endorsing "the realist metaphysical tenet about a mind-independent (and perspective-independent) world" (p.170). See also fn. 1 above.

of perspectives. Things that are perspective-independent will still be mind-independent in virtue of their dependence on the research tradition. For example, within the research tradition of relativistic quantum mechanics, positrons were authenticated independently of perspectives on their nature (Creţu forthcoming,a). As authenticated real patterns, positrons were studied further by a hole-theoretic perspective and a field-theoretic perspective (Roqué 1997). The hole-theoretic perspective was later abandoned, but positrons remained authenticated (Creţu forthcoming,a, Pashby 2012). Thus, positrons are perspective-independent real patterns. Like positrons, real patterns that are authenticated within a scientific research tradition, are empirically-driven, perspective-independent phenomena. Perspective-independent real patterns thus constitute a legitimate realist commitment, worthy of any respectable realist account.

The question of realism and mind-(in)dependence has recently been taken up by Ereshefsky (2018) and Khalidi (2016a). Khalidi (2016a) argues that "mind-independence ... is irrelevant to realism about [a] phenomenon" (p. 225), because if it is used as a criterion for the reality of kinds, a lot of kinds in the domain of natural sciences would be excluded. He proposes instead to "discern real or natural kinds" (p. 242) by using a "causal criterion of reality" according to which a kind exists if "it has instances that share causal properties" (p. 243). Ereshefsky (2018) thinks Khalidi places "too much emphasis on causality" (p. 854) thus excluding a variety of astrophysical, microbiological, and physical kinds that are not defined causally. Insofar as Khalidi rejects the strong realists' notion of mind-independence as irrelevant to realism about kinds, his account is a promising avenue for solving the commitment problem for perspectival realism. But, if Ereshefsky is right, Khalidi's account will be insufficiently practice-relative since many areas of natural science (in particular modern physics) appear to operate without reference to causes.

As regards Ereshefsky's (2018) account, he thinks we should focus on the 'defeasibility' of kinds, a provision according to which "the relations asserted by a classification should not be true by definition and could be defeated by empirical evidence" (p. 850). Any account that claims to be practice-relative should incorporate Ereshefsky' naturalistic suggestion, already implicit in Whewell (1840a)'s considerations on classificatory sciences.

Beyond defeasibility, it is not however clear to what extent Ereshefsky commits to the realist commitment of perspectival realism, and thus his account does not constitute a viable solution to the commitment problem.[8]

Finally, a classification that is empirically driven by observations of perspective-independent entities can be said to be a natural classification. Making sure that the study of nature is done by systematic and objective means whilst being heeded by empirical phenomena is all we can expect from perspective-independence, and hence from a natural classification or system.

3 The Real Patterns Strategy

Originally proposed by Dennett (1991), in a now classic article 'Real Patterns', the real patterns strategy has been developed in most detail thus far by Ladyman and Ross (2007) in their iconoclastic 'Every Thing Must Go'.[9] In this section it will be shown that Ladyman and Ross' strategy is, despite several merits, unsuccessful in providing a clear-cut ontological commitment to perspective-independent real patterns. Partly because of this and partly for other reasons which will be discussed in the next section, Ladyman and Ross' strategy cannot in its current form be used to solve the commitment problem for perspectival realism.

Ladyman and Ross (2007) argue that science is in the business of tracking stable empirical regularities: 'real patterns'. Their starting point is the assumption that without stable regularities there can be no predictions. Without predictions, there can be no science. Hence, one needs to take real patterns seriously. Proceeding from observations regarding the objects of study of both physics and the special sciences, Ladyman and Ross argue that folk-metaphysics misleads in characterising the objects of science as self-

[8] See Kendig and Grey's (2019) and Lemeire's (2018) recent papers which express general scepticism regarding the ability of purely epistemic accounts to secure the naturalness of kinds independently of metaphysical considerations.

[9] Ross (1995) and Wallace (2010) also applied the real patterns strategy to ontological problems, but only Ladyman and Ross (2007) have developed it in connection to natural kinds. It is for this reason that their view takes centre stage here. Häggqvist (2005) also gestures at the possibility of developing a natural kinds account based on Dennett's 'real patterns'.

subsistent individuals.[10] In physics, in particular, in light of developments in quantum mechanics and general relativity, parochial metaphysical concepts such as intrinsic natures, identity, persistence, causation, and cohesion break down. In their survey of physics and the special sciences, Ladyman and Ross, also note, crucially, that we are now in a position to study events on previously unimaginable spatiotemporal and energetic scales. Physics, for example, studies phenomena that last from anywhere around a tiny fraction of a second to years and decades and can also focus on spatial scales infinitely smaller than the "spatial scales of a millimetre to a few thousand miles" which "are all that have concerned us until recently" (p. 11); astrophysics studies phenomena that similarly can last from a fraction of a second to millions of years; whilst geology "require[s] us to adopt time scales that make all of human history seem like a vanishingly brief event" (p. 11). What these examples point to is the scale-relativity of ontology, where,

> [s]cale relativity of ontology is the more daring hypothesis that claims about what (really, mind-independently) exists should be relativized to (real, mind-independent) scales at which nature is measurable (p. 200).

For Ladyman and Ross, "from the metaphysical point of view, what exists, are just real patterns" (p. 121), where a pattern is real if and only if it is projectible under "at least one physically possible perspective" and encodes information about other patterns. To be precise, Ladyman and Ross define real patterns as follows:

> To be is to be a real pattern; and a pattern x → y is real iff
>
> (i) it is projectible; and
>
> (ii) it has a model that carries information about at least one pattern P in an encoding that has logical depth less than the bit-map encoding of P, and where P is not projectible by a physically possible device computing information about another real pattern of lower logical depth than x → y" (p. 233).

Nature can be studied by identifying and measuring real patterns. Real patterns are measured by indicating their locators. A locator is an "index relative to an address

[10] By self-subsistent individuals Ladyman and Ross (2007) can be interpreted to mean objects with transcendental individuality. See points (1) to (3) on p. 134.

system" where "operations of fixing, stabilizing, and maintaining salience of some data from one measurement operation to another" (p. 121) have been performed. Locators presuppose some background theory; so "[h]ow precisely a given locator, in the context of a given theoretical structure, tells us to focus our measurements varies with the refinement of empirical theory" (p. 122). Thus, that one can take multiple measurements at multiple locators and those measurements can be repeated by different observers is what makes the real patterns strategy comply with objectivity demands. It is worth noting that real patterns can have high or low indexicality, which depends not on the level of refinement of theory, but on the relative distribution and measurability of patterns across the universe. Electrons, for example, can be measured at nearly any locator in the universe and thus have high-indexicality. Biological patterns such as giant pandas are measurable only from certain small regions of the universe, and thus have lower indexicality than physical patterns. But, biological patterns can still be said to have high-indexicality compared with tables and chairs since measurements of biological patterns can be taken on more scales and at more locators than tables and chairs inhabit. Though tables and chairs have low-indexicality, they are still real patterns on the view espoused by Ladyman and Ross.

Real patterns thus defined, are at the core of the authors '*ontic structural realism*'.[11] In a nutshell, ontic structural realism denies the existence of metaphysically fundamental individuals whilst embracing relational structure as ontologically fundamental. In doing this, ontic structural realism dispenses with traditional objects in favour of real patterns. As a consequence, much about the orthodoxy of science is reevaluated and ends up being constrained by physics. Given physics's maximum level of generality and therefore its primacy over other sciences,[12] concepts such as cohesion and causation lose some of their metaphysical shine even in the special sciences. But cohesion and causation are still very useful principles for understanding the phenomena of the special sciences, though not necessarily for understanding their ontology.

What Ladyman and Ross take themselves to provide is a way of making the ontology

[11]For a general overview of structural realism see Ladyman (2016). For a recent critical overview of ontic structural realism see McKenzie (2017).

[12]See Ladyman and Ross (2007), p. 44 for a precise formulation of the Primacy of Physics principle.

of science compatible and continuous with recent developments in a variety of scientific practices. In this respect, their view can be said to fulfil the practice-relativity requirement. Their view also promises a commitment to perspective-independent real patterns, which can be said to underpin projectible generalisations and explanations in science generally. However, by making real patterns dependent on a "physically possible perspective", where such a perspective is constrained by what "physics tells us could be physically occupied" (p. 236), they invite a reading of perspective that is at the same time too restrictive and too liberal. It is too restrictive because it unduly restricts possibilities to what may be compatible with the "best physics". Yet, the best physics may both exclude possibilities that may turn out to track real patterns[13], or may fail to contemplate *unconceived alternatives* (see Stanford 2006). It is too liberal because it blurs the distinction between paradigmatic human constructs such as tables and chairs, and perspective-independent scientific objects such as positrons and other empirically authenticated kinds.

As it stands Ladyman and Ross' real patterns account does not provide a clear cut commitment to perspective-independent real patterns. Thus, both of the above criticisms underwrite a more serious challenge, namely that Ladyman and Ross' ontological commitment to perspective-independent real patterns is insubstantial. In sum, whilst Ladyman and Ross' view delivers practice-relativity and scientific objectivity, it does not deliver an ontological commitment to perspective-independent entities, and thus in its current form cannot constitute a solution to the commitment problem for perspectival realism. If the real patterns strategy can indeed be used to tackle ontological problems, in particular the commitment problem for perspectival realism, real patterns need to be shown to be perspective-independent.

The distinction between research traditions and perspectives helps us understand that there are different stages of theory development which play different roles in investigating natural phenomena. In the first instance, one has to ensure that the relevant phenomena are genuine (Laudan 1977, p. 18). To be precise, phenomena, which include

[13]The existence of antimatter was initially regarded as an impossibility by the "best physics" at the time, even after Dirac's prediction of it. For details see Creţu forthcoming,a, Pashby 2012, Roqué 1997, Darrigol 1988, Hanson 1961; 1962.

real patterns, must first be authenticated within a research tradition. A research tradition, is understood as "a set of assumptions: assumptions about the basic kinds of entities in the world, assumptions about how those entities interact, assumptions about the proper methods to use for constructing and testing theories about those entities" (p. 97). Authentication is necessary in order to eliminate, insofar as it is possible, potential errors due to experimentation, measurements, or "freak results" (p. 18). Though the process of authentication can take considerable time it ultimately establishes real patterns as genuine and worthy of being studied further. Real patterns are studied further within perspectives sponsored by the research tradition.

A perspective was defined as a sophisticated theoretical framework that encompasses the set of theoretical interests and background theoretical knowledge that a researcher or group of researchers can be said to hold at any given time. Real patterns are not authenticated as having a certain nature – that is, as being of a certain kind, having a certain origin, or being constituted in a particular way. Real patterns are authenticated as being genuine phenomena prior to the development of particular perspectives. For this reason, real patterns are perspective-independent. For example, positrons can be identified as genuine phenomena in cloud chamber photographs in the absence of perspectives on their nature, that is independently of hole-theoretic or field-theoretic perspectives on their nature (Roqué 1997). However, positrons cannot be identified as new phenomena independently of any assumptions about particles or cloud chambers, and thus they are not mind-independent in the strong realist's sense. Yet, insofar as they are authenticated, positrons can be said to be perspective-independent.

The real patterns strategy, let us recall, was introduced to deliver an ontological commitment to something in the world. Any ontological commitment worthy of the name ought to be to something independent of us, of our knowledge, and of our ways of thinking about the world. It was shown that complete independence from human thought is both unattainable and undesirable. It was, however, shown that authentication secures an ontological commitment to genuine empirical phenomena, albeit of the perspective-independent type. Perspective-independence is, nevertheless, a virtue of the proposed

framework for two reasons. First, because perspectives, and not research traditions, particularise the ontology of nature. Second, because perspectives can only "particularise the ontology of the research tradition" (p. 81) after the authentication of genuine phenomena. Perspectives interpret the nature of authenticated empirical phenomena.

To sum up, the real patterns strategy has been examined as a potential means of solving the commitment problem for natural kinds. A critical assessment of Ladyman and Ross' implementation of the real patterns strategy pointed to the lack of a substantial ontological commitment. It has been shown that this weakness derives primarily from a dangerous dependence of real patterns upon perspectives. The distinction between research traditions and perspectives shows how we can understand real patterns as perspective-independent entities. On the present account, real patterns are authenticated within a research tradition and this is what makes them real. Real patterns are further studied from within a perspective, which preserves the ontological commitments of the research tradition. Perspectives allow one to understand the nature of real patterns. However, when a perspective is abandoned, one need not also abandon the ontological commitments warranted by the research tradition. Having shown how the real patterns strategy can be improved in general terms, the commitment problem for perspectival relism is resolved in the next section by a novel approach.

4 Natural Kinds as Real Patterns

The original proposal for natural kinds as real patterns is due to Ladyman and Ross. It will be argued that whilst Ladyman and Ross are right to suggest that natural kinds are real patterns, their view cannot in fact support this claim. Since natural kinds are inherently tied to the ideas of likeness and difference which require for their application the existence of objects, contra Ladyman and Ross, at least some things must stay. In particular, it will be argued that their view must be modified to include a dual commitment to real patterns (qua relations) and objects (qua relata) to be applicable to natural kinds. The novel view, with a dual commitment to perspective-independent entities, provides a solution to the commitment problem for perspectival realism.

According to Ladyman and Ross, natural kinds are nothing but scale-relative real patterns of "high-indexical redundancy".[14] Indexical redundancy concerns the relative distribution and measurability of real patterns in the universe. The more real patterns of a certain kind there are, the more measurements we can take. The more measurements we can take, the more objective real patterns are. What this means for natural kinds is that by being of high-indexical redundancy, they are objective. That real patterns are scale-relative means that what real patterns exist on a particular scale may not exist on a different scale. For example, as Ladyman and Ross note "at the quantum scale there are no cats; at scales appropriate for astrophysics there are no mountains" (p. 199). A variation of scale, either temporal, spatial or energetic, may result in yet different real patterns being observed. For example, when a transition from a larger to a smaller temporal scale has been taken into account, it will not be surprising that certain patterns no longer exist even if the spatial scale remains fixed. A case in point here comes from biology, where "in histories of lineages at small enough temporal scales there is no natural selection, because natural selection requires a substantial minimum number of reproductive events" (p. 203). There is, however, an extra dimension to scale-relativity, call it numerosity.[15] The basic idea behind numerosity is that "more is different" (Anderson 1972). Sometimes "mere numerosity makes a dramatic difference" (Ladyman and Wiesner 2018, p. 56). To say that real patterns are numerosity relative is to say that some real patterns are only visible with an increase in quantity. For example, "there are no cross-elasticities of demand in a two-person economy" (Ladyman and Ross 2007, p. 199).

Numerosity is particularly relevant to natural kinds for two reasons: first, because to talk of kinds of objects, one must be able to compare individual objects; and second, because likeness and difference can modify with the number of things, both synchronically and diachronically. The first point is constitutive of the idea of kinds, whilst the second concerns the evolution of kinds. Concerning the first point, Whewell (1840a) notes in 'The Philosophy of the Inductive Sciences' that " ... before we can attend to several things as

[14] " 'Natural kind' is a more elegant phrase than 'real pattern of high indexical redundancy' (...)" Ladyman and Ross (2007), p. 297

[15] Ladyman and Wiesner 2018 introduce numerosity in complex science. The concept is borrowed without assuming that kinds are complex systems.

like or unlike, we must be able to apprehend each of these by itself as *one thing*" (p. 449). To use Whewell's example, the basic idea here is that to be able to talk about a tree, in a forest of trees, we must apprehend the tree as one unit, with its own trunk, branches, leaves and so on. Only once we have thus singled out each tree, we can attend to what is alike and what is different amongst the trees. Having thus authenticated likenesses and differences – i.e., relations – amongst various trees, we can formulate perspectives about the most effective way of systematising said relations to enhance exactness, precision, and empirical adequacy.

It is true that both of these acts – of singling out one entity and of finding relations amongst many – are 'operations of the mind'. Thus, it would seem that any result of these operations would itself be an operation of the mind. To the extent to which one accepts perspective-independence, one would, however, not draw such a parochial conclusion. Instead, one would see that neither operation is purely an operation of the mind. Both operations are grounded in repeated observations of empirical regularities. On the one hand, repeated observations of trees in forests, and in isolation, warrant the belief that "assertions concerning the object shall be possible" (p. 452). On the other hand, repeated observations of trees would eventually lead one to notice that likeness in the shape of leaves is far more common than likeness in the shape of the branches. Thus, on the basis of such observations, the belief that "general assertions shall be possible" (p. 454) is also warranted. Both of these assumptions are warranted to the same degree as induction is warranted. Moreover, though these two operations are assumptions, they are at the same time based on "[t]he unitermitting stream of experience [which] supplies us with an incalculable amount of such observed connexions" (p. 455).

Singling out objects, comparing them, grading observed likeness and differences is a laborious process that involves on the one hand assumptions and on the other hand unremitting observations of empirical regularities. The more objects and relations are observed the more laborious the process of organising likenesses and differences in a way that is exact, precise, and empirically adequate. The more laborious the organisation, the more contrived it seems. However, the process is always the same, involving assumptions

and objects and relations equally. As more observations become available, the same process is carried out at increasingly larger scales. Just as Whewell notes, the process repeats itself as follows: "[a]s individuals by their resemblances form kinds, so kinds of things, though different, may resemble each other so as to be again associated in a higher class; and there may be several successive steps of such a classification" (p. 457). To the extent to which this way of understanding classifications is correct, it is unclear how one can proceed without objects. If, as Ladyman and Ross argue, "[t]here are no things" (p. 130) and "[s]tructure is all there is" (id.), it is hard to imagine how one can talk about classifications at all. For Ladyman and Ross to preserve their commitment to practice-relativity they must also acknowledge that classification is part and parcel of the scientific practice. Since classification, as shown, is based on a distinction between objects and relations, Ladyman and Ross must make room for objects in their ontology.

The structural realist could accept perspective-independence whilst resisting the reintroduction of objects and thus insist that there are 'real patterns all the way down'. The structural realist could argue that all the operations described earlier for objects, can be similarly carried out, without loss, just with real patterns, in informational terms.Thanks Joe Dewhurst, Bryan Roberts, and Neil Dewar for raising and discussing this point. Whilst this option may be plausible for some contemporary practices, and would perhaps be particularly suitable to situations in which all the members of a kind are identical, situations which originally motivated ontic structural realism,[16] it still remains unclear how eliminating objects from other practices would preserve both practice- and scale-relativity. If the structural realist takes seriously classificatory practices, synchronically and diachronically, as well as scale-relativity, there are practices in which both objects and relations are equally important (for example, botany). Unless the structural realist shows for each practice that only relations are fundamental, the motivation to do away with objects quickly dissipates.

As regards perspectival realism, even without reintroducing objects, the real patterns strategy can still provide a legitimate commitment to natural kinds via real patterns.

[16]Thanks to Richard Dawid for raising and discussing this point.

But whilst this would make perspectival realism compatible with some practices, such as physics, it would threaten perspectival realism's commitment to epistemic pluralism and thus risk once again one of its core commitments. Thus, a perspectival realist account of natural kinds, must be committed to both objects (qua relata) and to real patterns (qua relations) to qualify, by its own lights, as sufficiently perspectival.

The commitment problem for perspectival realism, let us recall, is the problem of successfully integrating the perspectivalist commitment and the realist commitment within an account of natural kinds. Does the natural kinds as real patterns account successfully integrate the two commitments? On the view proposed here a perspectival realist natural kinds account would be committed to perspective-independent natural kinds as real patterns. That is, it would be committed to perspective-independent objects and real patterns, where real patterns are robust relations amongst entities exhibited by any two given entities with sufficient regularity on any given scale. This is the ontological commitment. The perspectival realist account proposed is also committed to practice- and scale-relativity. Consider each commitment in turn.

It has been argued that there are two important stages of classification, and that it is in the first stage – i.e., the authentication stage – that the ontological commitment to natural kinds is secured. Authentication involves nothing over and above identifying, measuring, and maintaining the salience of empirical phenomena. Since at this stage what is at stake is validating empirical phenomena as genuine so as to further investigate them in order to understand their nature, the authentication process does not rely on perspectives regarding the nature of the phenomena. Thus, the process of authentication, by involving few, if any, assumptions about the nature of the authenticated phenomena, and by not prescribing any specific ontology for the relevant phenomena, can be taken to secure an ontological commitment to perspective-independent real patterns. Thus, to the extent to which the distinction between research traditions and perspectives is accepted, the resulting commitment to perspective-independent natural kinds as real patterns can be taken as a genuine ontological commitment, worthy of any realist account of natural kinds. In the true spirit of perspectival realism, let us now briefly turn to three examples,

taken from both contemporary scientific practice and history of science.

Modern astrophysical classifications proceeded by first identifying, measuring, and cataloguing relations of likeness and difference as revealed in the spectra of stars. Fat, thin, and fluted patterns on the spectroscopic photographs were authenticated without prior knowledge of the information contained within them. Both Edward C. Pickering and Henry Norris Russell, argued that the classifications should be based solely on the authenticated spectra, in the absence of any perspectives regarding their nature (see Cannon and Pickering 1901, Hoffleit 1991). Authenticated patterns revealed in the spectra of stars constituted the basis of the first three instalments of the The Henry Draper Catalogue, the third instalment being internationally adopted in 1910. With some modifications, due in part to changes in the numerosity scale and in the spatiotemporal scale, the third instalment of The Henry Draper Catalogue is still in use today. What this example shows is that the practice of classifying stars is based on the authentication of their spectral characteristics and on the systematisation of relations between stars as revealed by their spectra. Authenticated real patterns are later investigated through the development of perspectives on their origin, evolution, constitution etc.

The natural kinds as real patterns framework does not apply only to astrophysics, but also to particle physics. For example, the classification of the positron involved its authentication first, which was a complicated experimental and theoretical process (Creţu forthcoming,a, Roqué 1997, Darrigol 1988, Hanson 1961; 1962). The nature of the positron was subsequently investigated by emerging perspectives (Roqué 1997). Whilst multiple perspectives on the nature of the positron begun to emerge towards the end of 1933, it was the successful authentication of the positron which warranted a commitment to a new type of perspective-independent kind, common to all relevant emerging perspectives (Creţu forthcoming,a). This example shows that one can obtain an ontological commitment to perspective-independent natural kinds as real patterns in the absence of perspectives regarding their nature.

Let us now turn to the novel account's applicability in biochemistry, focussing on the classification of proteins. According to Havstad (2015; 2017), there are two stages to

protein classification: the first stage concerns the *individuation* of proteins, whilst the second stage involves the *organisation* of proteins. Havstad claims that "there simply isn't a plurality of ways to individuate proteins in scientific practice" (Havstad 2015, p. 76) since "everyone agrees on the individuation of the basic entities being sorted" (id.). It is worth noting that the individuation of proteins involves not only the identification of protein tokens, but also the individuation of protein types. So it is both *relata* and *relations* that are individuated prior to the development of various taxonomic perspectives. It is further worth noting, that the individuation of relations and relata, as well as the development of perspectives regarding their nature, are activities that take place "within the relevant scientific field" (Havstad 2015, p. 76). To put it differently, both the individuation of token and type proteins and the emergence of taxonomic perspectives involving authenticated relations and relata fall within the purview of the same research tradition. What this example shows is that an ontological commitment to perspective-independent real patterns can be secured independently of perspectives regarding their nature.

Summing up, the natural kinds as real patterns account has been shown to resolve the commitment problem for perspectival realism by securing a commitment to perspective-independent relations and relata and by being applicable to contemporary and historical scientific practices within astrophysics, particles physics, and biochemistry.

5 Objections and Replies

Before concluding, there are two objections which need to be addressed. The first objection concerns the naturalness of natural kinds as real patterns. What has been shown is that one can be ontologically committed to perspective-independent natural kinds as real patterns. But one can be equally ontologically committed to tables and chairs and to positrons and other scientific kinds. What makes the latter different from the former? There are two main distinguishing features. Unlike tables and chairs, positrons and other scientific kinds are empirically authenticated phenomena and they have high-indexicality. In contrast to positrons and other scientific kinds, tables and chairs have low-indexicality and they exist only due to human's collective intentions to bring them about for their use and comfort.

Thus, we can say that kinds are natural insofar as they are authenticated within a research tradition in the natural sciences.

Finally, the second objection concerns the relative priority between relations and relata. One might be concerned that the lack of commitment regarding their relative fundamentality[17] is a weakness of the natural kinds as real patterns view. However, since on the natural kinds as real patterns view, both relations and relata are authenticated and not prescribed, the lack of a pronouncement on this issue is a strength, rather than a weakness. Insofar as both relations and relata are authenticated, the natural kinds as real patterns view can be said to be compatible with three distinct views concerning the relative priority of relations and relata: a) a view on which relations are primary and things are secondary, see Stachel's (2006); b) a view on which things are primary and relations are secondary, see Russell (1911); and c) a view on which neither things nor relations are primary, see Esfeld and Lam 2008, Pooley 2006. Thus, regardless of a pronouncement on the fundamentality of either relations or relata, what matters is that there is an ontological commitment to both.

6 Conclusion

Perspectival realism has two core commitments: the perspectivalist commitment to the situatedness of knowledge and the realist commitment to things in the world. Contemporary perspectival realists accounts lack a substantial realist commitment, a problem that has been identified as 'the commitment problem'. A new account – the natural kinds as real patterns view – has been proposed as a solution to the commitment problem for perspectival realism. Natural kinds as real patterns is the view according to which natural kinds are real patterns, where real patterns are robust relations amongst entities exhibited by any two given entities with sufficient regularity on any given scale. It has been argued that what entities exist on a particular spatiotemporal or energetic scale and how many entities there are on any spatiotemporal or energetic scale determine the natural evolution of the relations that hold between entities at any relevant scale. It was fur-

[17]For fundamentality overviews see Stachel (2006) and McKenzie (2013).)

ther shown that a research tradition affords the authentication of objects and relations, whose nature is then explored through various perspectives sponsored by the research tradition. The perspectives can be short lived, but when they go, the commitment to the entities and relations authenticated within the research tradition remains. It is in this sense that natural kinds as real patterns can be said to be perspective-independent, and thus through them that the perspectivalist can secure a realist commitment. The natural kinds as real patterns view has also been shown to apply to examples from astrophysics, particle physics, and biochemistry.

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