

## Pattern Ontologies At Work

H.K. Andersen  
Philosophy, Simon Fraser University  
handerse@sfu.ca

**Abstract:** Patterns and pattern ontologies are a powerful way for pragmatists to address metaphysical issues by rejecting a false dichotomy between pluralism and realism. However, there is a common misconception about patterns that I call the philosophically perverse patterns (PPP) problem. Here, critics of patterns invent perverse examples that meet the metaphysical criteria to count as patterns. I defuse this concern by showing how PPP misunderstands what the pragmatist metaphysics of patterns is supposed to accomplish: the bare definition should not rule out, or in, substantive examples of patterns that instead should involve methodological considerations. I use this response to the PPP problem to show how the metaphysical definition of 'pattern' allows the pragmatist to capture the rich intricacies of ontologies in the sciences and yields two illustrative norms by which methodology can be guided in developing or refining ontologies: cohesion and coherence.

**Keywords:** patterns, pragmatism, cohesion, coherence, realism, pluralism

### 1. Pluralism, Realism, and Pragmatism

Growing attention is being paid to patterns (Dennett 1991) as a way to accommodate a plurality of ontologies from various sciences. Rather than considering the world as composed from only items on a single list of entities and/or processes, such that higher level sciences like biology must ultimately reduce their ontological units to those of physics, pluralism allows for multiple such ontologies tailored to different fields, such that the ontology for ecosystems need not be justified by showing how each item can be reduced to something in the particle physics ontology. Pluralism about ontologies resists the urge to come up with One Right Answer for the furniture of the world, and makes sense of different kinds of ontological practices in the sciences.

This inevitably raises the question about how those pluralistic ontologies relate to one another, often in the form of a challenge to pragmatism, or in the misapprehension that pragmatism is anti-realist. What do they have in common such that they all count as ontologies? Does pluralism involve the rejection of realism, or can the pluralities of ontologies also accompany some version of realism? How do they fit together given that we presume it is one world that they each concern some portion of? A unificationist metaphysics would proceed on the principle that there must be some underlying unity to all those ontologies, such that a plurality of ontologies still makes sense as separate perspectives on a single reality. This need not be especially pragmatist – for example, one could presume that there is one 'right' or 'natural' ontology, and continue using the others for simplicity's sake. But it could also be pragmatist: there could be pluralism with respect to ontologies, and criteria for connecting without reducing ontologies, while also committing to the underlying unity of the world. The pragmatist can thus reject this challenge as a false dichotomy: it need not be that either

there is One Right Ontology to rule all the pluralities, or one hereby rejects realism. Pragmatist realism is a middle way between these the horns of this false dichotomy.

There is a common misunderstanding of pragmatism where it supposedly allows that there are different ontologies for different purposes, and that the philosophical objective in relating these ontologies should be to ascertain which ontologies should be used for which purposes, and not to attempt further to unify them with empirically vague and potentially meaningless analysis. This way of applying pragmatism, though, is more Carnapian logical empiricism than pragmatism. It implicitly relies on a sharp divide between internal questions, asked of and only answerable with respect to individual ontologies, and external questions, about the usefulness or fruitfulness of relying on one versus another ontology. It buys into the same false dichotomy and just chooses the other horn than the metaphysical One Right Answer.

There is a long tradition of presupposing that pragmatism is anti-realist and/or anti-metaphysical. This presupposition is shared by critics as well as by adherents; Rorty's style of pragmatism is anti-realist. Pihlström (2007) has a good discussion of this presupposition and also offers a Jamesian pragmatist metaphysics. In that regard, I share with Pihlström the idea that pragmatism is sufficiently broad that pragmatists don't have to sign on for one position on the issue of anti/realism, and can develop different versions of realism that still fall under the pragmatist umbrella. Pihlström's approach is historically situated. I will offer something similar in high-level motivation - a broadly Jamesian style of pragmatist metaphysics - but will do so with more contemporary pragmatist materials, using a version of Dennett's patterns.

In this paper I lay out a middle way by examining how patterns facilitate a pluralism for ontologies with the underlying unity of the world. It is not just that there are different ontologies, in the sense of lists of what there is, in various sciences and subfields. There are further *metaphysical* principles that patterns bring concerning the criteria by which ontologies are constructed. Pragmatist metaphysics is not merely lists of patterns, labeled ontologies. It is also these criteria for inclusion on such a list, principles by to organize those ontologies, inferential connections among patterns in an ontology, the regimes or domains (such as high energy, low temperature, indefinite population size, etc.) within which many patterns are defined and for which ontologies involve inferential connections. And, also, pragmatist pluralism with underlying unity includes the parts of science that support but which are not themselves ontologies: specific experimental techniques, practices for using instrumentation, exemplars or prototypes by which students can come to see how to use these patterns in practice. Thus, pragmatism has a path forward that is realist, in endorsing the unity of the underlying world, without getting skewered on the horns offered by this misunderstanding, either having to reduce all ontologies to One Right ontology, or having to say that any ontology is just as fine as any other and allow them to proliferate without ontic or metaphysical checks.

The following patterns-based pragmatist view is *metaphysical* in the sense that it goes beyond or foundationally supports the various ontologies to show how they coordinate as collectively providing a detailed view of what the world is like, similarly to Sellar's (1967) stereoscopic view or Mitchell's integration (2023) and fractured looking glass (2000), rather than a single simplistically coordinated unified picture. I've argued elsewhere (Andersen 2023) that pragmatism involves inextricable intertwinement of epistemology and metaphysics. This means also that doing pragmatist metaphysics incurs obligations to explicitly connect that metaphysics to epistemological issues. The way pragmatist realism avoids the uniqueness versus anti-realism dilemma horns is with invoking the

connection to methodological considerations and interconnections (not reductions) that coordinate disparate ontologies via at least two norms, coherence and cohesion.

Section 2 offers a slightly updated characterization of Dennett's (1991) definition of 'pattern' and illustrates how pattern ontologies work. Section 3 outlines a frequently encountered concern about patterns, what I call the problem of philosophical perversity, then shows how it is misguided and how a pragmatist can respond. Section 4 details the positive view and shows how interconnections among patterns, and among ontologies, and their embeddedness in practices yields two norms, coherence and cohesion. Section 5 brings these together into a full picture of how patterns provide a pragmatist foundation for unification of disparate ontologies in the sciences, highlight this unificatory strategy as historically pragmatist with a contemporary polish.

## 2. Defining Patterns

Dennett's (1991) work on patterns was groundbreaking in a number of ways. He was an early adopter of using ideas drawn from computer science to provide a new perspective on philosophical problems. His insight about real patterns stemmed from considerations of Conway's Game of Life, and how patterns can be identified with as much objectivity as one could ask for, but without having to be fundamental joints. His initial goal was to develop patterns as a way of elaborating how intentionality can be a feature of the world that is displayed on its surface, in a manner of speaking. Beliefs, and intentional behavior, are directly observable like other non-mental entities. They need not involve hidden internal states that cannot be verified by science. Intentionality involves patterns are more complex than but not different in principle from other kinds of patterns studied by science. This way of using patterns is useful for vastly more than just intentional beliefs, of course.

Dennett's motivation for his definition of a pattern is that "in the root case a pattern is 'by definition' a candidate for pattern *recognition*" (32). He wanted to accommodate the role of perspectives, while also insisting that patterns are not merely what humans are able to identify. It is not merely our own subjective view as to what patterns are identifiable in some bit of data or part of the world; there may be patterns which no humans are able to discern. This sounded very counterintuitive in 1991, it should be noted, and is now so commonplace as to be trivial. With the advent of extensive data mining, and growing popular understanding of these practices, there is no longer anything particularly counterintuitive about insisting that patterns are really and can be detected even though humans might be even in principle unable to discern them without computer assistance. Instead, there is a new range of misunderstandings of the view that swing the other direction: that of course there are patterns, but they somehow are in, or must be found in, data only. This way of thinking about patterns comes from the ubiquity of pattern recognition in software contexts, where it is applied to data only. And it also is heightened as a misunderstanding of how he used the Game of Life example to illustrate the idea of patterns and pixels. Using patterns for ontology is sometimes done by treating the entire world as if it were a kind of Game of Life, where the world has some pixelated feature at a microphysical level, akin to sense data (e.g. Millhouse 2020).

The original view of patterns, and part that I want to put back into the spotlight, is that we *can* find patterns in data, but patterns *need not* just be in data. Patterns are also a way of talking about phenomena in the world. Dennett's original application of patterns as a way to use intentionality in psychology and cognitive science is not about patterns 'just' in data, it is about patterns in the world.

There is a long tradition of using patterns as one wants to, by offering updates to Dennett's original definition (inter alia, Wallace XX, French and Ladyman, Petersen 2018, Millhouse 2020, Seifert 2023). But, perhaps also in the spirit of pragmatism, none of these other definitions quite nail what I take to be some of the centrally important features of patterns, especially when using 'pattern' for analyzing ontologies. So who am I to break with this tradition? Here is Dennett's characterization of a pattern, as a starting point for an update. There are two parts to it: a requirement involving compressibility, and another involve recognition or identifiability. The compressibility definition is this:

A pattern exists in some data--is real--if there is a description of the data that is more efficient than the bit map, whether or not anyone can concoct it. Compression algorithms, as general-purpose pattern describers, are efficient ways of transmitting exact copies of frames, such as A-F, from one place to another, but our interests often favor a somewhat different goal: transmitting inexact copies that nevertheless preserve "the" pattern that is important to us. (1991, 34)

This use of data compression helps us identify when a pattern of some sort must be present, but does not go far enough to capture the usage of patterns in contemporary pattern recognition. To be very clear, this is not a criticism of Dennett's description, per se. It was the part that seemed most important to emphasize, at a time before anyone outside of computing science had much, if any, understanding of compression.

The issue with this part of Dennett's characterization is that it is not a definition, it is a diagnostic indicator. Compressibility is not required for patterns: there could be patterns that are incompressible, but which are still identifiable given their identification conditions and which can recur more than once, just incompressibly so. Patterns can be like fingerprints: specified completely, down to the individual pixel equivalent. There may be patterns which are uncompressed though compressible. In fact, some bar codes function like this, one of the very examples on which Dennett draws. Compressibility is a useful clue if one is resistant to the idea that any pattern exists in any data or part of the world (e.g. McAllister 1997). Having a compressible description *ensures* that there is at least some pattern being compressed, but it is not *required* for a pattern to exist. As such, his focus on compressibility is useful as a diagnostic, but is not what constitutes a pattern as such.

Consider Dennett's illustration of the other part of the definition of patterns, for identifiability. Compare two different patterns, A and B, where A is highly compact as a description but also noisy, with a 20% error rate; B is a much less compact description with only a 5% error rate. They are both identifiable in the same area; in other words, they are carving up overlapping but non-identical tokens as instances of different phenomena. Which one is the 'right' pattern? According to Dennett, if one person bets on Pattern A, and someone else bets on Pattern B, they may both make money over pure chance in the long run. (35) This is sufficient, on Dennett's view, to justify the claim that each are equally (and, to be sure, mildly) real. This emphasis on betting is helpful: this pluralism with respect to the existence of overlapping, equally real, patterns is not a *merely* philosophical question about ontology. It is a question with genuine consequences that can be tracked in measurable ways, including ways like making money in betting strategies.

This paves the way to refine the definition of a pattern. The goal is to walk the fine line of making it as spare and general as possible, while also not being trivial or vacuous. It ought to have enough substance to be capable of being put to use. It needs to answer the metaphysical question of what it

is to be a pattern - not what any specific pattern is or should be. But it also does need to be clear enough that it can be used to identify specific patterns, such that they could be checked against the world. It's important to keep these questions distinct: what is it to be a pattern at all, such that what actual patterns there are, are *patterns*.

I propose the following definition:

DF: A pattern is constituted by its identification conditions and noise/error tolerance. A pattern is something that can be checked for and return in at least some case a determinate yes/no answer.

This definition involves two important elements. The first is that every pattern must involve specification of identification conditions for that pattern. These identification conditions individuate an extension for the set of instances of that pattern. Changing the identification conditions changes the profile of the pattern, the set of instances in the world in which the pattern locates a given instance as an instance of the same pattern. These identification conditions are just what one would check for, in some given region of the world, to see if there is, or is not, an instance of this pattern. It is more general than, and covers as a specific case, examples like specifying causal variables: the variables have to be given identification conditions, including the values or range of values they can take, such that we know what it means for there to be an instance of a variable taking one of its values.

The second important element of the definition is that all identification conditions must also specify some noise/error tolerance range. Patterns, in data or as ways of picking out phenomena, inevitably involve some noise in the way the pattern is instantiated, or error in the measurement process by which it is checked as an instance of that pattern. Changing only the noise or error tolerance also changes the profile of the pattern. Keeping the identification conditions fixed, it will increase the set of instances to raise the threshold for noise/error, and will decrease the set of instances (sometimes to the null set) with a lower tolerance threshold to count as an instance of that pattern.

Phenomena themselves can be noisy. This is a way of talking about the same kinds of issues that sometimes go under the heading of idealizations. We can identify instances of frictionless force exchange on planes, like roller skaters pushing off one another, despite there being no examples of genuinely frictionless planes. They merely need to be frictionless, to a specified noise tolerance. Another example is a box of a particular cereal with a bar code printed on the side. It is the 'same' bar code as the other boxes of the same size of the same cereal have; there is one pattern, for that kind of cereal, and multiple patterns, where each box is printed with its own instance of the bar code. Each can have *noise* in the sense that the printing is not perfect, one got smudged a bit, there are tiny variations in any physical product. The bar code only needs to be good enough, below a fairly high noise tolerance level, to be read by the scanner. The scanner introduces *error*, as well: there may be something about the scanning process where the device can't scan about 1% of the boxes of this cereal. We can differentiate between noise in the phenomenon itself (so, a smudged box) and error in the measurement (when the scanner isn't working well enough). But usually, in practice, there is no clear line between these. The reason to lump these together as a noise/error tolerance is that the comparative contributions of each will differ based on highly context-sensitive features of specific patterns and specific conditions for identification, and often we may not be in an epistemic position to clearly delineate the separate contributions of noise versus error.

Pattern identification rules can be recovered in an explicit format from non-linguistic practices: for example, an implicitly followed set of rules for a game can be used to recover an explicit set of identification conditions being used. A well-defined pattern is such that instances of it that can be identified by those conditions (even if no instances of it actually occur), in a manner analogous to how, having generated a consistent set of explicit rules for the game, one can then say what would happen in some set of circumstances that one has never actually observed during the implicit-rule-governed play. A pattern just is something that of which tokens can be identified, and which can be at least potentially re-identified. Even if there are utterly unique patterns, in that they only occur once, by defining their identification conditions we have defined a possible type - these conditions can be used to 'check' for other instances. Even if the checks all turn up negative - in other words, the pattern does not occur again - it is the possibility of determinate checkability that renders it a pattern type.

In this way, the concept 'pattern' is stereoscopic between types and tokens: one box with a bar code has a different pattern, in the sense of tokens, than every other such box, even while every such box has the same bar code pattern in the sense of types. Individual patterns are constituted by their identification conditions; defining a pattern means providing sufficient information to identify tokens of it as occurring or not occurring. This is a fruitful ambiguity, allowing us to connect types (that can include variables in interventionism) as giving pattern identification conditions, with the tokens (instances of such variables) as instances in which the identification conditions are satisfied.

### 3. Patterns and the Problem of Philosophical Perversity

Why haven't patterns been adopted more widely, then? In deploying patterns applied to the causal nexus (Andersen 2017), it turns out that many people still want patterns to be sparse, and unique, with a single uniquely best way to carve up the causal nexus. When this fails, they take it as fatal for patterns. Here I will respond with a pragmatist challenge: the issue with patterns has been atomism, considering just one pattern in isolation. If we take patterns, the holism that is central to pragmatism, and how patterns get *used* in practice, the perverse pattern problem dissolves.

In principle, one can define a single lone pattern; nothing in the idea of patterns or pattern ontologies prevents it. This has led some to what I will call the problem of philosophical perversity for patterns. This perversity will be familiar to philosophers, but there is a version of it specific to patterns that many have taken to be fatal for pattern ontologies. The *philosophically perverse patterns problem* (PPP problem) is a way of taking the basic definition for patterns, and showing that one can do bad things with it, following those rules. There are sub-variants of the PPP problem that take different angles at constructing perverse patterns, so I will take a common objection and walk through that as an exemplar of the PPP problem. The pay-off of using pattern ontologies is worth the effort to recover from the impulse towards philosophical perversity.

Consider an interlocutor who claims the following: If I adopt a pattern ontology, what is stop me from coming up with a pattern that is just something like, every third car that drives past a given intersection, or the tip of my nose and that mountain over there? What if I choose grue and bleen instead of blue and green? What is to stop me doing this? If we only need identification conditions and noise tolerance specifications, what if I turn my noise tolerance up to 100%? The idea seems to be that the given example patterns are clearly perverse, and something we oughtn't use. Yet, it is technically allowed to count as a pattern, by the definition. Thus, the PPP problem concludes,

patterns won't work because there is too much "anything goes". The presupposition behind this is, of course, that some patterns would be the 'right' ones, and some are bad patterns, and we need more to discern between the right and wrong patterns. The buried presupposition underneath this is that the definition of a pattern, on its own, must be held accountable for what we do with it. Somehow, by the lights of the PPP problem, the very definition of a pattern should only allow 'good' patterns to count (for whichever realist metric of evaluation one is using). Thus, pattern ontologies lack some key resource by allowing perverse patterns to count as patterns.

The PPP problem has consequences for views that invoke patterns. For patterns as a basis for picking out causal relata (e.g. Andersen 2017), the PPP problem is taken to imply that such patterns are obviously not possible causal relata, since so many awful and clearly not causally efficacious patterns can be generated perversely. This alone has been taken to reductio away any such view of causation. Even in cases where authors are endorsing patterns, they assume that just being able to identify a pattern surely shouldn't be enough to count as pattern, because then there would be such a multitude of patterns containing ones that are surely perverse (e.g. Ladyman, Ross, Spurrett, and Collier 2007, p. 205, parenthetical aside in particular). At least once, the bullet has been bitten as thoroughly as a bullet could be bit: McAllister (1997) endorses the idea that every pattern is present, perverse and otherwise, with a 100% noise tolerance level.

The PPP interlocutor proposes obviously perverse patterns with what I will argue is the mistaken understanding of pattern metaphysics that it must bake into the very idea of a pattern some way to prevent such perverse usage. If there is no in-principle reason why they can't use a perverse pattern - in other words, if it is not ruled out a priori by the rules of the pattern game - then it somehow counts as a legitimate pattern and, *thereby*, as a counterexample to use of pattern ontologies. Thus, the apparent challenge from philosophical perversity is how to 'rule out' such perverse pattern formation. Can patterns prevent philosophical perversity?

Sadly, there is nothing that can prevent genuinely determined acts of philosophical perversity. In this, patterns, pattern ontologies, and pattern ontologists are no exception. More optimistically, though, the pragmatist does have a lot of flexibility for response to the PPP problem, and these responses serve to both deflate the apparent devastatingness of the problem and also allows for a positive articulation of further ways in which pattern ontologies can help us understand various parts of the sciences without having to invent wholly new conceptual apparatus just for this purpose. Thus, my response to the PPP problem serves as a springboard to articulate a good way to think about how different ontologies connect to one another that allows for pluralism in the sciences with an underlying commitment to the unity of the world thus studied, and shows how those ontologies can relate without either reduction or unchecked proliferation.

The first response to this challenge from philosophical perversity is to reject the requirement that somehow patterns, the use of patterns, or pattern ontologies bear responsibility to prevent philosophical perversity. As noted, there is no resource yet discovered that can prevent genuinely determined acts of philosophical intransigence. Yet also, there is no special reason that pattern ontologies have to accomplish this. Someone who is sufficiently determined to put together perverse patterns is not going to find anything in the nature of patterns, or pattern ontologies, that prevents it. This style of perversity might be a fine rhetorical move when arguing against something like a proposal for what counts as fundamental, or for essence, etc., where being able to produce a clearly unsuitable example according to the rules means that the rules themselves are flawed. In this case, though, the bare definition of a pattern, or the idea of a pattern ontology, need not do so, just as it is

not the job of the rules of the road alone to force people to adhere to them, nor of the rules of chess to force people to play a good game if they are determined to lose on purpose. The case of perverse patterns is more like someone learning chess and pointing out that there is nothing in the rules that prevents them from deliberating losing the game. True, one might say with a bit of bemusement, there is nothing in the rules to stop you from such perversity. But also, that is not an objection to or problem with the rules. It is your poor usage of them, or your dubious choice of goals to accomplish with them. It is not the job of the rules of chess to keep you honest, as it were, nor is it the job of patterns to ensure you use them responsibly.

In this regard, a pragmatist metaphysician should lean on the interconnection between metaphysical and methodological considerations and, even before answering the PPP problem more substantively, point out that this is not a role that should be assigned to the bare metaphysics of patternhood. The metaphysical definition of patterns is required for the whole picture to hang together and work, but we should not expect the pure metaphysics of pattern to be as load-bearing as it would have to be in order to stop perverse patterns before they even happen. Something stops philosophical perversity with patterns; it just isn't the definition itself.

This leads to the second response to this challenge to patterns from philosophical perversity, the one that leads to a positive articulation of how to use patterns effectively. This response calls the interlocutor's bluff. To a perverse pattern choice, the pattern pragmatist can say: go for it. Pick that pattern. Let's see how that actually goes. More on this in the next section; the short version is that the pragmatist does not merely propose patterns at random, or because they find them non-perverse. Patterns have to *do* things, and perverse patterns fail almost immediately in doing any of these things. The metaphysics of patternhood transitions smoothly into methodological applications that the perverse patterns are completely unable to handle. We can choose useless patterns; but if we do so in something like a scientific context, then we *are* doing it wrong, not because of the bare rules for patterns but because of what these patterns are used for.

It is extremely hard it is to put together anything resembling an ontology when using perverse patterns, without being parasitic on some other, non-perverse, pattern ontology. Coming up with even one genuine alternative ontology to compete with something already developed in the sciences is so difficult as to be minorly miraculous. At best, a full ontology of perverse patterns can be generated through systematic modification of an existing ontology: one could formulate a recipe to 'grue' everything in it, thus ensuring that the result covers all and only the same cases, but gruesomely rather than wholesomely. This does not count as genuine construction of an alternative ontology, though. It is completely parasitic on some other existing ontology to which the grue recipe (or some other similarly parasitic algorithm) can be applied. As such, it is more like a 'filter' applied to a pre-existing photo. It requires the pre-existence of something substantive in order to then distort it in systematic ways. It cannot serve as an alternative to that which it parasitizes.

There are ill-definedly large numbers of very unsuitable patterns that meet the minimum criteria to be patterns. But we aren't coming up with random haphazard ontologies in the sciences; they serve a variety of different purposes, and those purposes connect and constrain what patterns could fulfill those goals. Randomly chosen patterns serve poorly at this. One could pick a terrible pattern but very rapidly be unable to go on settling any more patterns to go with the perverse choice. Patterns have roles to play in coordinating a lot of extremely sophisticated inferential, instrumental, mathematical, observational, experimental, conceptual, and linguistic work, especially in the sciences. As such, a patterns pragmatist can say, what are you going to *do* with that perverse pattern? The



existence of bad pattern choices doesn't tell against using patterns, just like poor implementation of otherwise justified modelling practices don't give reason to think all models are useless. It means we have to draw on what we want to *do* with those patterns, or models, in order to use that as guidance; it requires connecting metaphysics to methodology.

#### 4. Using Patterns: interconnected embedded ontologies

Patterns provide a way to put together ontologies, inside scientific and theoretical settings but also in ways that cross out of those settings into other uses of scientifically developed knowledge. In a big-picture, broad-sweep, hand-wavy way, patterns are a new iteration of a long discussion from Plato and Aristotle about how to construe the linguistic (including formal) resources we use to get a handle on the world. Offering a pragmatist pattern foundation for ontology is thus not about changing details about scientific practice, for example, by butting into a lab group and 'correcting' them about how they were using the term 'virus' right there.

The pay-off of thinking in terms of patterns is how this brings along with it the ways in which patterns connect to one another across different epistemic contexts. It can be easy to think of science as giving us a furniture list of what there is in the world, a laundry list of items that count as the ontology to which any particular science (or model, or theory, etc) is committed to. This is what some contemporary metaphysics of science work is focused on: finding the right list of items that a particular theory or domain is committed to, and 'reading off' that as metaphysics from the theoretical commitments of the science in question (for a more plausible version of the reading-off approach, see Humphreys 2013; for effective criticisms of less plausible versions of 'reading-off' in metaphysics of science, see, inter alia, Guay and Pradeu 2020, Saatsi 2017, and Chakravartty 2013).

Patterns help us see that ontologies in the sciences in ways don't just list line items. They aren't a kind of glorified grocery list. Instead, parts of an ontology come knit together in a huge variety of ways. Some of these ways of knitting are inferential: they facilitate the inference of the existence of one item from the measurement of a different item. And they do so in the context of providing identification conditions that can ineliminably include specifications that guide measurement. The identification conditions for selenium atoms are going to involve highly technical specifications, for example, while the identification conditions for quartz are much more accessible. Some of these ways that patterns are knit together into ontologies are methodological. Identification conditions for one pattern will often involve another pattern that is related in systematic ways to it, such as Chang's (2007) nomic measurement, where we measure changes in temperature by measuring other changes, in volume for example, that are nomically related to the quantity we want to measure. Patterns also connect via direct measurements: identification of superconduction, for example, may require also identifying the existence of the Meissner effect, in that superconduction is differentiated from other forms of enhanced conduction its very definition by the presence of this effect. Superconduction and the Meissner effect are not two separate patterns, each atomistically isolatable. They are inextricably connected in the ontology in which they appear.

Thinking in terms of patterns also helps us track the behavior of patterns that appear across a wide variety of settings. Some, like 'bosons', only appear in technical contexts, and were invented for exactly those contexts, such that any usage of this term elsewhere must be drawing on that background. Other patterns, such as 'velocity', have a wide and busy social life across a huge variety of contexts, and may actually have different identification conditions in different settings or

theoretical contexts. Someone might use velocity in a conversational context where the direction does not matter - "your velocity was over the speed limit" does not require specifying both direction and speed. But in physics, you would be doing it incorrectly if you conflated speed and velocity.

The usage of patterns, in using a general term, kind, quantity, variable, etc. to identify a particular instance in a particular case of that term, draws attention to differences in identification conditions across settings, and highlights how these terms often have usage outside of science. Someone might claim to have a virus that is making them sick, and a friend might reasonably point out that what they have is actually bacterial, not viral, and encourage them to go to the doctor and consider taking some antibiotics that would not work if it were a virus. These are scientific terms in the way Putnam (1975) noted, for terms like jade, beech, or elm. Science has claim to the expertise involved in specifying what the actual identification conditions and noise/error tolerance range are. But they don't have exclusive usage rights to them: other people can draw on what they learn in science and put it to lots of other uses in non-scientific contexts. Thinking about these in terms of patterns helps situate these different usages, which overlap, cross, interfere or reinforce at boundaries, overlay one another, and more. It highlights the part of pragmatism that involves expressivism about meaning and discourses: it is the nexus of usages, inferences in which it figures, etc. (e.g. Price 2007). Yet it does so in a way that highlights how we cannot *just* talk about language without also hewing closely to that to which we apply the language, where and how we use it with other practices that are not linguistic (like learning how to pipette properly).

There are constraints on what can count as an ontology that come from the basic notion of what a pattern is; there are further constraints in specific ontologies based on the features of specified individual patterns, but here what I mean is that the very idea of a pattern in use carries with it the ways in which this pattern connects to other patterns, in ways that form, loosely or more tightly, ontologies. – not what a particular pattern is, but what it means to be a pattern at all.

Ontologies do not have to be tightly constructed logically closed system. These are not Carnapian frameworks with precise operationalizations or precise divisions between directly observable and theoretical terms. Many terms appear across a range of ontologies, inside and outside of the sciences; sometimes the sciences have claim to be the relevant experts on defining the term, and sometimes terms end up with more free play among different usages. These ontologies of patterns are loosely connected among one another, and interconnected with the richness of natural language, for the most part, as well as tied to formal language when they figure in mathematical models or equations. In scientific settings, a pattern might begin as an ordinary term, and then go through a process of iterative refinement to end up with a different meaning (magnetism is a good example of this). And some patterns might be introduced for technical reasons, because natural language had no use for such a term before (for example, the Hamiltonian).

Some patterns appear in many different ontologies. These tend to be of especial interest, for several reasons. One is that these patterns, or, what is getting identified as instances within a given tolerance range, must be useful in different domains or different kinds of application in language, such that they appear in multiple ways. These are more likely to be patterns we think of as forming the core of what a realist would commit to. One might even draw a connection between the ubiquity of a given pattern across different kinds of ontologies, and its status as a natural kind. This is similar in some ways to the proposal in Khalidi (2018), especially with a pattern ontology for causation such as Andersen 2017. It would differ from Chakravartty (2023) by treating this as mild or deflationary realism, rather than conventionalism, but is otherwise similar in spirit. The pragmatist aspects of the

view here would reject his dichotomy of either a robust, natural kinds-supporting realism, or mere conventionalism or operationalism.

The norms around pattern development, ontology construction, and usage of patterns and pattern ontologies are neither just methodological or epistemological norms, nor bare metaphysical principles. They are fusion norms, norms which can be more methodological or more metaphysical depending on how they are used in particular contexts. They don't have some fixed internal essence such that they 'really' are one or the other type of norm. They are needed for the very idea of an ontology using patterns, but also look clearly like what it takes to apply the bare conceptual metaphysical apparatus to the world via empirical work in science. These are neither subjective nor objective on the usual ways of using those terms. I draw instead on Chang's (2023) way of differentiating mind-framed and mind-determined. He effectively highlights how these are constraints based on how we use *any* linguistic structure, including formal languages like math, to talk about the world. This accommodates the dual understanding that there is no way to talk about the world except by *talking* about it, which means, this is not 'just' us projecting our way of speaking, and the world may be so complex and complicated that there is no one single right way to talk about it. The world may in fact be so dense with structure that we will never exhaust it, which means we could have better or worse ways of developing ontologies, but never read some uniquely privileged complete and correct ontology (e.g. Andersen forthcoming).

There isn't space to do full justice to the ways in which norms about usage and practice shape patterns individually and how they connect to different patterns in ontologies, and how a single pattern can connect different ontologies by appearing in multiple ones with overlapping though perhaps not identical identification conditions or noise tolerance. A brief discussion can illustrate.

The first such norm for ontologies is *cohesion*: an ontology cannot be some mere collection of patterns, but must provide or at least aim for a kind of exhaustive and exclusive coverage of the relevant terrain with the list of items in the ontology such that the patterns interrelate in order to achieve that coverage. The patterns in the ontology must 'fit' together, extensionally and inferentially, rather than being separate line items on a list. I am calling this fitting-together of individual patterns into an ontology cohesion; it is semi-internal to such an ontology, even while recognizing that ontologies don't have air-tight boundaries.

For example, the notion of a niche, populations, and predator-prey relationships, exhibit this inferential connectedness in the study of ecosystems. They don't merely identify freestanding phenomena; they also provide conceptual connections between them such that they fill out the ontology with ways to infer between them, such as the Lotka-Volterra equations. Cohesion is not as strong as logical consistency; pattern ontologies can meet coherence requirements without meeting the strict logical consistency requirements of a Carnapian language, for instance. But some degree of cohesion, and a commitment towards increasing that cohesion, is required for something to even count as an ontology in the first place. Patterns allow us to capture both the linguistic and representational parts of scientific knowledge products and methods, and the relevant differences in parts of the world picked out by those linguistic and other devices. This coordinating aspect of patterns achieves the fit of a pattern ontology as a tool for studying a domain, not just an isolated phenomenon. Cohesion is thus a term for how patterns can fit together that is a new way to capture what philosophers of science have long pointed out about systematicity and interconnections using theories or models.

The second norm on patterns and pattern ontologies is *coherence*: this is a relation between apparently different pattern ontologies focused on potentially overlapping but non-identical targets of investigation in the world. Ontologies cannot be utterly unconnected to one another, and there are constraints that each ontology places on other ontologies such that we, as researchers and knowers, must be at least in principle capable of tracing out inferential paths between such distinct ontologies. This is not the same as reduction, since coherence between ontologies can be accomplished without presuming a hierarchical structure such that one ontology is more real, fundamental, or otherwise privileged than another. Coherence is neither an entirely Carnapian internal question, nor purely external, though it might be mistaken for something akin to external questions. This norm of coherence captures the commitment to a single unified world studies through various diverse methods that cannot help but each shape the view they give as a result. An example can be found in Chua's (2021) discussion of the two definitions of entropy. This can be understood as a way in which there are two overlapping but non-identical pattern ontologies, such that entropy figures as a pattern in each, but where there may be further issues or differences in the way in which it is defined. These are fruitful points of friction and contact to explore for rectification of these different perspectives from the different definitions.

Coherence also tracks the ways in which a single term might be deployed with different meanings, or, in other words, with different identification conditions for the pattern, in different contexts. Pattern ontologies don't automatically guarantee that an apparently single pattern that appears in more than one theoretical context is actually being used consistently across those contexts. We can use the idea of a pattern to keep track of useful features of scientific change over time and difference between settings or contexts.

## **5. Conclusion: Patterns, pluralism, and pragmatist unification**

One misapprehension about pragmatism is that it requires commitment to a kind of pluralism that cannot be unified. The misapprehension about patterns is similar: that one can proliferate patterns yet always fail to find the Right Patterns. I've made the case that patterns and pattern ontologies can remain both pluralistic while also involving underlying unity through norms such as coherence and cohesion. This coherence but not reduction of pattern ontologies means we have to take a more synoptic view of how these ontologies fit together as investigations into one underlying real world.

Sellars (1962) offers a helpful way to think about unification in a pragmatist setting. Philosophy is the field, according to him, that specializes in knowing its way about all the other subjects, including the sciences. In order to know one's way around, one has to take a sufficiently synoptic view of how the different fields hang together, without thereby having to either impose enforced unification onto those fields, or be beholden to wait till such unity appears. He uses the manifest and scientific images to illustrate this. The unification of the two images does not occur because one displaces the other. It occurs in the manner of two perspectives that unify into a stereoscopic view of the whole. The manifest and the scientific image are not in competition so much as they provide different perspectives on the same array of topics, and from such slightly different perspectives, it is possible to see how they all hang together in a three dimensional way.

This stereoscopic vision is already suggestive of the use of patterns. Finding our way around the scientific image involves knowing that the various ontologies at use are, and how to navigate between them. This does not mean reducing one to the other, or having neat and tidy pathways that

lead without bumps from patterns used in biochemistry to patterns used in particles physics, for example. We can know our way around a landscape that remains fractured and somewhat disparate; we need not connect every pattern in one ontology to every pattern in another. We need to know when to use one ontology, and when to switch to a different one, and maybe how to smooth the rough parts for the cases where either ontology could apply, imperfectly.

This circles back to the issue of philosophical perversity. The creation of perverse patterns, as we've seen, doesn't get one very far. If one is seriously committed to the bit, with a perverse set of patterns, it might be possible to construct a tortured but complete ontology or some sort. But, one doesn't do science, or use patterns, all by one's self. The PPP problem is driven by atomism about meaning: it requires keeping a pattern separate from any of the inferential, methodological, etc. connections that place it in a nexus with other patterns. This kind of atomism has been consistently rejected by pragmatists; it is arguably one of the most defining and consistent features of pragmatism since the beginning of the 20th century.

Putnam (1975) reminds us that the meanings of words are not just in our heads, nor just in the world. Language is a tool, but not like a hammer or a screwdriver. It is a tool like a ship, that requires a whole crew of people in order to be successfully used. So, perverse patterns are not ruled out in principle, and even especially determined and clever patterns sets with some coherence and cohesion are not ruled out as intrinsically incorrect. They are just deeply unusable; they are clunky and ungainly, existing only to make a tedious point. One can decide to walk across a tiled floor by only stepping on every third tile and moving one to the left each time. There is nothing impossible about this. If you really want to do this every time you cross that room, ok. But what doesn't thereby happen is that you have given any reason for other people to cross the room that way.

That it is *possible* to do so is not a good *reason* to do so. One can develop perverse patterns, and even perverse pattern ontologies; but there is little one can really do with them, and one does it alone, so they still don't act as counterexample to the fruitfulness of thinking in terms of patterns. Patterns and pattern ontologies are another way of talking about what we do with language in coordinating activities in the sciences.

**Acknowledgements:** The ideas here were developed over a wide range of talks given over many years (since 2014, in my work on patterns in causation), so thanks to all the people who listened to talk about patterns over that time and asked great questions about patterns, perverse and otherwise. Thanks to participants at the Santa Fe Institute workshop "Real Patterns in Science and Cognition" (2022), organized by Tyler Millhouse, Steve Petersen, Daniel Dennett, and Don Ross. And thanks to Sandra D. Mitchell for collaboration and ongoing discussion around pragmatist metaphysics, and participants in the Pragmatism, Metaphysics, and Philosophy of Science workshops (2014, 2015, 2017).

#### **References:**

Aames, J. 2019. "Patternhood and generality." *European Journal of Pragmatism and American Philosophy* XI:2, . <https://doi.org/10.4000/ejpap.1640>

- Andersen, H. K., and S. D. Mitchell, eds. 2023. *The pragmatist challenge: Pragmatist metaphysics for philosophy of science*. Oxford University Press.
- Andersen, H.K. forthcoming. "The Density of Structure". *Synthese*.
- Andersen, H.K. 2017. "Patterns, Information, and Causation." *Journal of Philosophy*
- Bogen, J., and Woodward, J. (1988). "Saving the phenomena." *The Philosophical Review* 97(3): 303-352.
- Chakravartty, A. 2023. "Last Chance Saloons for natural kind realism." *American Philosophical Quarterly* 60(1): 63–81. <https://doi.org/10.5406/21521123.60.1.06>
- Chakravartty, A. 2013. "Naturalized metaphysics." *Scientific metaphysics*, eds. Ross, Ladyman, and Kincaid, 27-50. Oxford University Press.
- Chang, H., 2022. *Realism for realistic people*. Cambridge University Press.
- Chua, E. Y. 2021. "Does von Neumann entropy correspond to thermodynamic entropy?" *Philosophy of Science*, 88(1), 145-168.
- Conway, J. (1970). "The game of life." *Scientific American*, 223(4): 4.
- Dennett, D. 1991. "Real Patterns." *The Journal of Philosophy* 88(1): 27-5.
- Guay, A., & Pradeu, T. 2020. "Right out of the box: How to situate metaphysics of science in relation to other metaphysical approaches." *Synthese*, 197(5), 1847-1866.
- Humphreys, P. 2013. "Speculative Ontology." In *Scientific metaphysics*, eds. Ross, Ladyman, and Kincaid, 51-64. Oxford University Press.
- Khalidi, M. A. 2018. "Natural kinds as nodes in causal networks." *Synthese* 195: 1379-1396. <https://doi.org/10.1007/s11229-015-0841-y>
- Ladyman, J., Ross, D., Spurrett, D., and Collier, J. 2007. "Rainforest Realism and the Unity of Science", *Every Thing Must Go: Metaphysics Naturalized* Oxford University Press, 190-257. <https://doi.org/10.1093/acprof:oso/9780199276196.003.0004>
- McAllister, J.W., 1997. "Phenomena and patterns in data sets." *Erkenntnis*, 47(2), pp.217-228.
- Millhouse, T. 2020. "Really real patterns." *Australasian Journal of Philosophy* 100(4): 664–678. <https://doi.org/10.1080/00048402.2021.1941153>
- Mitchell, S. D. 2020. "Through the fractured looking glass." *Philosophy of Science*, 87(5), 771-792.
- Mitchell, S. D. 2023. "The landscape of integrative pluralism." *Theoria: An International Journal for Theory, History and Foundations of Science*, 38(3), 261-297.
- Pihlström, S., 2007. "Metaphysics with a human face: William James and the prospects of pragmatist metaphysics." *William James Studies*, 2.
- Petersen, S. 2019. "Composition as pattern." *Philosophical Studies* 176, 1119-1139. <https://doi.org/10.1007/s11098-018-1050-6>
- Pihlström, S. 2009. *Pragmatist metaphysics: An essay on the ethical grounds of ontology*. Bloomsbury Publishing.
- Putnam, H. 1975. "The meaning of 'meaning'." *Philosophical Papers, Mind, Language, and Reality*, V2, 215-271.

Saatsi, J. 2017. *Explanation and explanationism in science and metaphysics*. Oxford: Oxford University Press.

Sellars, W. 1962. "Philosophy and the scientific image of man." *Frontiers of science and philosophy* 1: 35-78.

Siefert, V. 2023. "The chemical bond is a real pattern." *Philosophy of Science* 90(2): 269-287.  
<https://doi.org/10.1017/psa.2022.17>