

## Analogy and Pursuitworthiness

### 1. Introduction

One of the main debates today concerning analogies in science is between formal and material approaches to analogical reasoning.

According to the material view, defended most prominently by John Norton, analogical inferences are warranted by concrete empirical knowledge about the specific domain in which they are applied. Nothing interesting depends on formal similarities between analogical inferences used in different scientific domains. Proponents of the material view argue that attempts at formulating universally applicable formal inference schemas are either (a) too vague to distinguish between good and bad analogical inferences or (b) rely so heavily on context-dependent empirical information that the formal aspects become irrelevant.<sup>1</sup>

One response to this challenge, recommended by Paul Bartha, is to meet it head-on and defend an inference schema which avoids these objections. As he points out, although some aspects of analogical inference might depend on material background assumptions, there is no reason not to explore how much can be captured by formal schemata.<sup>2</sup> Below I will look specifically at Bartha's own proposed two-dimensional inference-schema for analogical reasoning.<sup>3</sup>

The aim of this paper is to highlight a lacuna in the debate. Both sides in this debate focus on analogies as a means to justify *accepting* a hypothesis to some degree or other. I argue that analogies in science in science play another important role, namely to justify *pursuing* hypotheses. I'll argue that both Norton's and Bartha's account, as they stand, do not give us a plausible account of how analogies justify pursuit. I then present my own account of

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1 Norton (*manuscript*); cf. Norton (2003) and Brigandt (2010).

2 Bartha (2013, §2.4).

3 Bartha (2010).

how analogies justify pursuit, and show how analogies on this account can justify pursuit independently of whether they can also justify acceptance.

## 2. Acceptance and Pursuit

Let me start by explaining how I see the difference between acceptance and pursuit.<sup>4</sup> By “accepting a hypothesis”, I simply mean to have some positive epistemic attitude towards it. Acceptance comes in different forms and degrees, depending on the specific epistemic attitude. So one can accept it as *true*, as *empirically adequate*, as *the most likely*, or merely as *plausible*. Common to these is that in order to justify accepting a hypothesis in any of these ways, one has to reason about what to believe about the world (or the *observable* world, if you're an empiricist).

To pursue a hypothesis, on the other hand, is to do things like (i) *testing and refining it empirically*; (ii) *developing it theoretically*; (iii) *exploring its possible uses and applications*. The important point here is that justifying the pursuit of one hypothesis rather than another involves *practical reasoning* about which course of action to follow.

It is important to distinguish efforts to justify pursuit from the so-called “context of discovery”. The latter is typically taken to regard the question of how to “discover” or generate hypotheses for scientific research, prior to any efforts at justifying them. The problem in justifying pursuit, by contrast, concerns how to best prioritise the limited resources available for scientific research. Such choices both can and ought to be justified. Like justification for acceptance, this presupposes that one has thought of candidate hypotheses for pursuit in the first place. I'll return to this conception of justification for pursuit below.

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4 The distinction between acceptance and pursuit was formulated in those terms by Laudan (1977: 106-114). For more recent discussion see Whitt (1990) and Šešelja, Kosolovsky & Straßer (2012).

### 3. The Material View

Norton's material account of analogy is based on what he calls *facts of analogy*. These state that some specific similarity obtain between two kinds of phenomena, where the exact nature of the similarity is stated as part of the fact. *Analogical inferences* are then simply those inferences which rely on facts of analogy. A typical analogical inference may look like this:

(N1) Systems S1 and S2 have similarity *X*. [*Fact of analogy*].

(N2) S1 has property *a*.

*Therefore:*

(N3) S2 has property *a'*.

In some cases these premise will be strong enough to warrant a straightforward deductive inference. At other times we need to invoke further premises or make some sort of contextual judgement about whether it is reasonable to accept the conclusion in light of the premises. We may also only assert the fact of analogy with some degree of hesitation, e.g. as *likely* or *merely possible*, in which case we would typically carry this qualification on the to conclusion:

(N1\*) *It is likely that* systems S1 and S2 have similarity *X*.

(N2) S1 has property *a*.

*Therefore:*

(N3\*) *It is likely that* S2 has property *a'*.

The upshot of the material view is that all of this will depend on background knowledge about the specific domain where the inference is made. So we can explain why

any particular *individual* analogical inference is reasonable or not, by looking at the domain-specific background knowledge. But, argues Norton, there isn't going to be any practically usable *general* account of analogical reasoning which can distinguish between good and bad inferences across different scientific domains. Thus, these inferences aren't so much warranted by the *analogy* between the two systems, as simply the relevant pieces of background knowledge, some of which happens to be about facts of analogy.

For my purposes, however, the crucial point is that this account is focused on acceptance. Norton conceives of analogies as premises in inferences concerning what to believe about the world. But in many cases, analogies aren't used as premises at *end* of an investigation to infer conclusions about the target phenomenon. Rather, they are used as a *starting point* for the development and empirical testing of theories and models.

In fact, several of the cases Norton (*manuscript*, 4) cites as examples of how analogies have often “proven quite fertile in the history of science” seem to be of this type. Take for instance the development of the liquid drop model of the atomic nucleus in the 1930s. Physicists at this time faced the problem that the single-particle methods they had used so far were intractable for the many-body problem represented by heavy nuclei. As Norton describes the situation, the physicists noticed that the nucleons “seemed something like the many molecules clustered together in a liquid drop” (19). But this (fairly weak) observation did not in itself lead physicists to conclude anything about atomic nuclei. They did however try and apply the same modelling techniques as were typically used for liquid drops. In other words, the analogy here seems to have justified pursuing this modelling strategy. This is also reflected in how Norton describes the situation: “The *hope* was that the physics of drops *might* also coincide with *at least some* of the physics of nuclei” (*ibid.*, emphases added).

Norton does recognise that the inferences in many of the cases he analyses are at best very weak. He remarks that in some cases analogical facts “may be merely conjectured or,

better, may be explored empirically” (13) and that “If we doubt the strength of the inference and wish to refine our assessment, we ... [would] engage in empirical investigations of the fact of analogy” (14). One might read this as suggesting that our background knowledge in these cases only justify *conjecturing* a fact of analogy, which we can then pursue.

But this doesn't answer the question of why scientists should conjecture and investigate an *analogical* hypothesis instead of any other hypothesis we might think of.<sup>5</sup> In the cases Norton cites the analogy seems to have played an important role in justifying the pursuit of a particular line of investigation, but as it stands his account does not address this aspect of analogical reasoning.

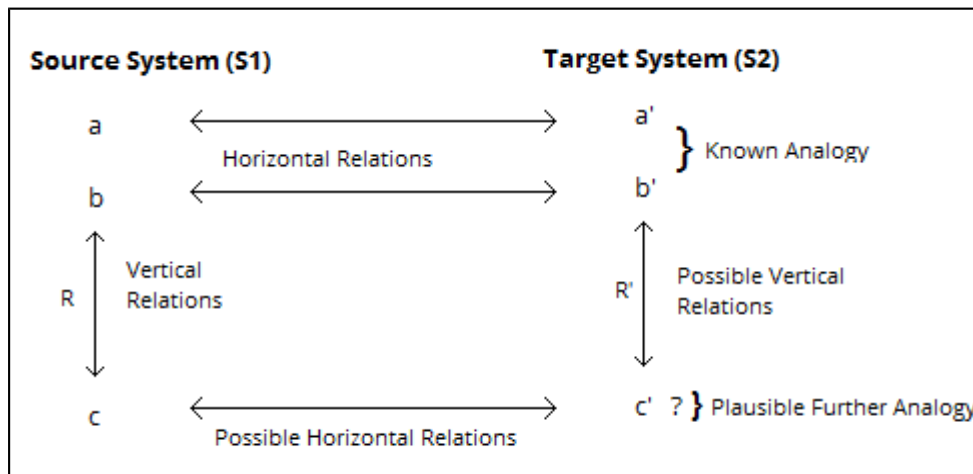
A possible reply might be our that our background knowledge suffices to show the analogy more *plausible*, and that this makes it reasonable to pursue it. However, the problem is that we are often *lacking* background knowledge about the domains we want to investigate. With background knowledge as sparse as in the case of the liquid drop model, it is doubtful that this suffices to show the analogy more plausible than the countless other hypotheses we might pursue. Furthermore, as I will argue later, plausibility on its own is not sufficient to justify pursuit.

#### **4. The Two-dimensional Account**

First, let me look at Bartha's account. This is based on the two-dimensional analysis of analogical inferences, first proposed by Mary Hesse (1963). The point here is that analogical inferences are not just based on the “horizontal relations”, i.e. the similarities and differences between the source and target system. They also depend on the “vertical relations”, consisting of the causal or explanatory relations, within the two domains (*fig. 1* below).

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5 A similar argument is made by the “Campbellian” in the opening dialogue of Hesse's in *Models and Analogies in Science* (1963: 37).



(Fig. 1, adapted with changes from Bartha 2010: 25)

Building on these this idea, Bartha defends an inference-schema which can be summarised as follows:

(B1) There is some causal or explanatory relation  $R(a, b, c, \dots)$  between features  $a, b, c \dots$  of S1. [*Prior association*]

(B2) S2 has one or more features  $a', b', c', \dots$  analogous to  $a, b, c, \dots$  [*Potential for generalisation*].

(B3) S2 does not have any features which would preclude  $R'$  (analogous to  $R$ ) from obtaining. [*No critical difference*].

Therefore:

(B4) It is *prima facie* plausible that  $R'(a', b', c', \dots)$  obtains for S2, and *a fortiori* that S2 has features  $a', b', c', \dots$

The first premise states that there is some “prior association” in the source system, in the form of some causal or explanatory relation between its features. Second, we look at whether there is a “potential for generalisation”, meaning that the target system has some features analogous

to those features involved in the prior association. Finally, we need to consider whether there are any “critical differences” between the two systems, i.e. whether S2 has any features which would preclude a relation analogous to the prior association from obtaining. Given these premises, Bartha argues, it is *prima facie* plausible to “transfer” the prior association to the target system, and thus infer that the relevant further analogical features.

As you can see, Bartha only claims that analogical inferences following this schema show a hypothesis *prima facie* plausible.<sup>6</sup> He takes this to mean (roughly): “There are sufficient grounds for taking *p* seriously” (2010: 16). This is partly an epistemic notion: A plausible hypothesis, for Bartha, “has epistemic support: we have some reason to believe it, even prior to testing” (2010: 15). (In probabilistic contexts, he explicates this as having a non-negligible prior probability). But Bartha also mentions that plausibility judgements have pragmatic connotations:

“To say that a hypothesis is plausible typically implies that we have good reason to investigate it (subject to the feasibility and value of investigation)” (*ibid.*).

So Bartha seems to think that analogies can be used to justify accepting hypotheses, in the weak sense of regarding it as plausible, but also recognises that they can justify pursuing it.

In practice, however he only focuses on acceptance. In a suggestive footnote (2010: 18, note 19) Bartha mentions that the point about pursuit depends on the acceptance-dimension “in a decision-theoretic sense” given “contextual information about costs and

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6 As an inspiration for this focus, Bartha cites N. R. Campbell's defence of analogies in science. Campbell argued that theories would be completely “valueless and unworthy of the name” (1920/1957: 129) without analogies, since only these distinguish theories “from the multitude of others [...] which might also be proposed to explain the same laws” (*ibid.*, 142). This is however almost certainly a misinterpretation of Campbell, who insisted that the value of analogies is a completely personal and arbitrary matter of what we happen to find intellectually satisfying. Although Campbell considered this kind of value very important, he nowhere connects it to plausibility or likeliness.

benefits”. He however goes on to say absent this information “the two points are at least partially independent”. As far as I can tell, Bartha does not expand on this connection elsewhere. As I am reading Bartha here, he seems to be assuming that the primary role of analogies in justifying pursuit is to show the hypothesis plausible. Once this is established, whether we are furthermore justified in pursuing it depends solely information about the feasibility, costs and value of doing so. He seems to regard this information as independent of the analogical inference itself, and thus in this sense “contextual”.

In my view, there two problems with this picture of how analogies justify pursuit. Firstly, I'm not convinced by Bartha's arguments that his inference-schema can generally justify regarding hypotheses as plausible. Secondly, I think analogies can play a role in justifying pursuit *even if* they don't make hypotheses any more plausible. I'm not going to argue the first point in much detail. I'll just look at one of Bartha's arguments, since it fits nicely into my account of justification for pursuit.

## **5. Analogies and Unification**

The argument I'm interested in is Bartha's (2010, ch. 7) argument that hypotheses based on analogy tends to promote many of the so-called “non-empirical theoretical virtues”, that is, things such as coherence, simplicity, and unification.<sup>7</sup> I'm just going to focus on unification here, which is also the one Bartha places the most weight on.

The form of unification Bartha is interested is Phillip Kitcher's (1989) notion, where we achieve more unification if we can explain many different phenomena using a few explanatory schemas. Let us return to Bartha's inference-schema. The first premise (prior association) states that we have a certain explanation of certain features of S1. The second premise (potential for generalisation) states that S2 has a number of analogous features. Since

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<sup>7</sup> That these theoretical virtues play an important role in theory choice was argued in Thomas Kuhn's (1977) influential essay. Bartha also draws on Wesley Salmon's (1990) Bayesian reconstruction of this point.



there is no critical difference (premise three), it seems possible to explain the features of S2 with the same explanatory schema as used in S1. So if we can indeed transfer this explanation from S1 to S2, we will have unified the two systems under a common explanatory schema. Thus, by adopting the hypothesis that the prior association can be transferred we will have increased the overall unification of our explanations, and the greater the potential for generalisation, the greater the gain in unification.

Now, in order for this to be an argument that analogies justify *acceptance* we have to furthermore assume that getting more unification gives us a good reason to think that a hypothesis is plausible. But this is a controversial assumption. In particular, a proponent of the material view would point out that we don't have any reason to think that the world is generally, across all scientific domains, unified in this sense. Whether any particular kind of unification gives us reason to accept a hypothesis will depend on our background knowledge about specific domains.

What I want to argue now is that, *even if* we don't think unification gives us a good reason to accept hypotheses, we can still use this line of argument to show that analogies justify *pursuit*.<sup>8</sup>

## **6. Unification and Justification for Pursuit**

To argue this, I need to introduce my preferred account of justification for pursuit. The basic idea is similar to what Bartha seems to have in mind: Justifying pursuit is basically a decision-theoretic problem where we have to figure out how to get the most out of the limited resources – time, money, equipment, etc. – available for doing science.<sup>9</sup>

More specifically, we should be weighing our hypotheses in terms of things like:

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- 8 Bartha at some points suggests that we can interpret this argument as only showing that the analogy gives us a reason to investigate a hypothesis further. Most of his discussion however clearly aims at showing that analogies can justify acceptance. As mentioned above, Bartha does not say very much about how he sees the relation between plausibility and having reasons for investigating a hypothesis.
- 9 This conception goes back to C. S. Peirce's writings on abduction. See McKaughan 2008 for a detailed argument that Peircean abduction is concerned with pursuit rather than acceptance.

- a) The expected *costs* of pursuing them.
- b) How *interesting* or *valuable* it would be to learn that the hypotheses are true or false.
- c) How likely we are to get *reliable evidence* for or against the hypotheses.
- d) How likely we are to get *misleading evidence*.
- e) How *plausible* we think the hypothesis is prior to pursuing it.
- f) *Other possible outcomes*, besides learning whether the hypothesis is true.

Looking at these factors, Bartha seems to be assuming that analogical inferences primarily justify pursuit through raising (e), the plausibility of the hypothesis. But on the conception advocated here, this is not the only way to justify pursuit. In many cases, my suspicion is that relying on analogies is primarily a way of reducing (a) the expected costs of pursuit: By pursuing a modelling strategy already known to work elsewhere we avoid having to develop new modelling techniques from scratch. But for the remainder of this section, I want instead to focus on (b), the value of learning whether the hypothesis is true or false.

There are of course many kinds of value with associated learning this, but let us focus on what can reasonably be called intellectual or cognitive value. So let us bracket things like purely moral, political, aesthetic, etc. value. Even then, we are arguably still concerned with more than merely truth and falsity. Here is how Kitcher (1993: 94) makes the point:

“Nobody is interested in the minutiae of the shapes and colors of the objects in your vicinity, the temperature fluctuations in your microenvironment, the infinite number of disjunctions you can generate with your favorite true statement as one disjunct, or the probabilities of the events in the many chance

setups you can contrive with objects in your vicinity. What we want is significant truth.”

In particular, Kitcher highlights unification as a cognitive value we should be concerned with beyond mere truth, in the same sense that Bartha appeals to in his argument above.

With this in mind, let us return to Bartha's argument from the last section, but interpret it as aiming to show that analogies can justify pursuit. Let accept Bartha's argument that analogies tend to promote unification, and furthermore assume, with Kitcher, that it is generally more valuable to know whether a unifying hypothesis is true. We can thus conclude that analogies tend to lead us to hypotheses that it would be more intellectually valuable to know whether are true. On my account of justification for pursuit, this is sufficient to show that analogies justify pursuit, independently of whether they also raises the plausibility of the hypothesis.<sup>10</sup>

## 7. Conclusion

My aim in this paper have been to argue that analogies often play the interesting and important role of justifying pursuit, and that this role need not dependent on whether analogical inferences *also* justify accepting a hypothesis to some degree or other. It is of course possible that they can also play the latter role, but it is a mistake to simply assume all uses of analogy in science aims to show a hypothesis more likely or plausible.

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10 This assumes that the analogy does not *lower* the plausibility of the hypothesis. In general, if a given inference changes our estimates of more than one of (a)-(f), whether it raises our justification for pursuit will depend on the details of how we weigh these factors against each other. Exploring these issues is beyond the scope of this paper.

## 8. Literature:

- Bartha, Paul (2010): *By Parallel Reasoning: The Construction and Evaluation of Analogical Arguments*, New York: Oxford University Press.
- Bartha, Paul (2013): "Analogy and Analogical Reasoning", *The Stanford Encyclopedia of Philosophy* (Fall 2013 Edition), Edward N. Zalta (ed.), <http://plato.stanford.edu/archives/fall2013/entries/reasoning-analogy/>.
- Brigandt (2010): "Scientific reasoning is material inference: combining confirmation, discovery, and explanation." *International Studies in the Philosophy of Science* 24: 31–43.
- Norton, John (2003): "A Material Theory of Induction", *Philosophy of Science* 70: 647-670.
- Norton, John (2010): "There Are No Universal Rules for Induction," *Philosophy of Science* 77: 765–777.
- Norton, John (*manuscript*): "Analogy", unpublished draft, available online: <http://www.pitt.edu/~jdnorton/papers/Analogy.pdf>.
- Kuhn, Thomas (1977): "Objectivity, Value Judgment, and Theory Choice." In *The Essential Tension* (pp. 320–39). Chicago: University of Chicago Press.
- Salmon, Wesley (1990): "Rationality and Objectivity in Science, or Tom Kuhn Meets Tom Bayes" In *Scientific Theories: Minnesota Studies in the Philosophy of Science*, vol. 14, ed.C. Wade Savage (pp. 175–204). Minneapolis: University of Minnesota Press.
- Kitcher, Philip (1989): "Explanatory Unification and the Causal Structure of the World." In *Scientific Explanation: Minnesota Studies in the Philosophy of Science*, vol. 13, ed. P. Kitcher and W. Salmon (pp. 410–505). Minneapolis: University of Minnesota Press.
- Kitcher, Philip (1993): *The Advancement of Science: Science Without Legend, Objectivity Without Illusions*. Oxford: Oxford University Press.
- Laudan, Larry (1977): *Progress and its Problems: Towards a Theory of Scientific Growth*. London: Routledge & Kegan Paul.
- Whitt, Laurie (1990): "Theory Pursuit: Between Discovery and Acceptance," *Proceedings of the Biennial Meetings of the Philosophy of Science Association, Volume One: Contributed Papers*, 467–483.
- Šešelja, Dunja, Kosolosky, Laszlo, & Straßer, Christian (2012): "The Rationality of Scientific Reasoning in the Context of Pursuit: Drawing Appropriate Distinctions", *Philosophica* 86: 51-82.