Hypothesis-Space Constraints in the Historical Sciences

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Phil Andrews (philandrews04@gmail.com)

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Abstract

The historical sciences research into the deep past differs fundamentally from the experimental sciences because it reconstructs past causes from present evidence rather than directly observing or reproducing the events under investigation. Because the historical sciences rely primarily on abductive inference among competing explanations, they require inferential openness, which in turn requires avoiding hypothesis-space constraints that lack independent methodological justification. The general principle of causation is ontologically non-specific and therefore does not itself warrant restricting admissible causes to natural ones. The important methodological question is not whether a cause is natural or non-natural*. It is whether the causal hypothesis is sufficiently constrained to participate in reliable comparative inference. Because explanatory success is achieved under different epistemic conditions in the two domains, the success of methodological naturalism in the experimental sciences does not, by itself, justify imposing an a priori ontological restriction on admissible explanations in the historical sciences. Thus, in the historical sciences, and using Darwin as a case in point, the methodological analysis of ontological categories shows which ones have justification for inclusion in the hypothesis space. This framework distinguishes methodological practice from metaphysical commitment, arguing that determination of whether an ontological category can be formulated in a methodologically constrained way is the criteria for admitting the resulting hypotheses into the hypothesis space.

Keywords: inference to the best explanation; historical sciences; predictive sciences; scientific method; methodological neutrality, non-natural*.

With the recent publications by philosophers of science such as Cleland (2001, 2002, 2011), Popper (1959, 1978), Turner (2005, 2007), Jeffares (2008), Sober (2008), Currie and Turner (2016), Currie (2017, 2018), Page (2021) and others, about the historical sciences we find they argue that the historical sciences differ methodologically from the predictive/experimental sciences.

The historical sciences research into the deep past faces a distinctive methodological challenge: unlike experimental sciences, it cannot directly observe or reproduce the events it seeks to explain. Instead, it reconstructs causal histories from present evidence.

They also present the problem of underdetermination in the historical sciences and address it by emphasising that the methodology enables common cause explanation and inference to the best explanation (IBE) (Lipton 2004; Sober 2008).

This reality, that comparison of competing causal explanations is a key methodological feature in the historical sciences, immediately raises a question that these philosophers of science have not yet addressed: on what basis can any cause be excluded?

Scientific inquiry should maximize epistemic completeness, but of course absolute epistemic completeness is impossible because it is inefficient to include literally every conceivable causal category. However, the historical sciences should avoid premature closure of the hypothesis space: hypotheses should be excluded only where their inclusion is incompatible with the methodological aims or evidential standards of the inquiry. The purpose of historical inference is to discover which admissible explanation best accounts for the evidence, so excluding potentially true hypotheses without methodological justification undermines that epistemic goal. Nevertheless, disagreement remains and it appears to be associated with the current debates over methodological naturalism as a research strategy and metaphysical naturalism as a claim about reality.

Ruse (2001) explicitly discusses the distinction between methodological and metaphysical naturalism, including whether methodological naturalism entails metaphysical naturalism. Similarly, Halvorson (2016) argues for methodological naturalism while distinguishing it from metaphysical naturalism. His argument is that restricting scientific inquiry to the natural world is a methodological strategy rather than necessarily a metaphysical conclusion.

Interestingly, the debate between science and religion does not generally note the distinctions of the historical sciences. While commonly structured around four models: conflict, independence, dialogue, and integration (Barbour 1990), these frameworks typically assume that science is a unified methodological enterprise governed by methodological naturalism, while religion involves commitments to supernatural agency.

If we wish for increased clarity in the debate, there is opportunity if we separate the methodology for the predictive/experimental sciences from the historical sciences and then ask whether methodological naturalism should apply identically to both.

The advantage gained by this separation is that it reveals that the historical sciences depend primarily on inference rather than experimental manipulation.

Secondly, we must define ‘non-natural’ because the term itself is too broad. It includes almost anything someone could imagine, which is why the hypothesis class becomes under constrained.

Therefore, from here on out the term non-natural* (with the * for clarity) cause is defined as: A causal agent capable of suspending stable physical regularities over a finite interval in the past, intervening such that there is trace evidence that temporary physical incompatibility occurred.

This definition is used so that the scope of non-natural* causes is a bounded intervention category. This is a stipulative research definition, not a claim that all possible non-natural* causes must behave this way. This paper investigates a particular constrained class of non-natural* hypotheses, but not that they are all necessarily like this.

Similarly, clarity regarding the term “natural” is warranted: It is generally used in three contexts:

1. Naturalism as metaphysical thesis
2. Methodological naturalism as scientific practice
3. Natural hypotheses as individual causal explanations

Thus, when the term natural is used in this paper the context shall be explicit.

Now the question becomes: How can a constrained non-natural* hypothesis be evidentially distinguished from an as-yet-undiscovered natural explanation without simply treating anomaly as evidence of intervention?

The definition of non-natural* enables us to start answering this question. By constraining the hypothesis space, where a non-natural* cause hypothesis about past events now makes a risky claim: that the non-natural* cause altered the normal operation of physical regularities. This produces genuine evidential constraints and evidential expectations, in that somewhere in the evidence there should exist traces of:

- Temporary past departures from ordinary regularities, and more specifically evidence of temporary physical incompatibility, the non-natural* hypothesis claims that it is more likely that a past temporary inconsistency with known regularities of nature occurred rather than the best available natural explanations
- sharply bounded deviations, (the hypothesis must clearly establish the natural state before and after the departure so that uniformitarianism can be utilized before and after the non-natural* events)
- evidence of subsequent return to ordinary regularities,
- effects that are difficult to generate by extending known physical processes.

Logic presents us with the well-known law of cause and effect. The general principle of causation is ontologically non-specific. By itself, it does not distinguish between natural and non-natural* causes, and therefore cannot alone justify restricting admissible explanations to natural ones.

Delfino (2011) in his discussion of Methodological Neutralism said: "scientists should simply search for causes without setting any a priori conditions on what ontological status those causes must have."

Thus, the non-specificity of causation establishes that any exclusion of an entire ontological category must be justified by methodological considerations beyond the concept of causation itself. Ontological category does not itself constitute sufficient grounds for exclusion; methodological constraints determine admissibility. The burden therefore shifts to identifying and defending those additional methodological principles if such exclusions are to be maintained.

In the predictive sciences, methodological naturalism is epistemically justified because experimental testing relies on natural, manipulable causes to generate predictions that are bounded, repeatable, and open to public empirical audit. Because non-natural* causes lack experimental manipulability and operational invariance, they are methodologically inoperative in predictive domains and legitimately set aside.

Moving then to the world of the past and deep past, where direct manipulation and controlled observation are no longer possible, for some reason we humans have the ability to imagine all sorts of causes that are non-natural. Are our imaginations leading us towards or away from truth and how can we determine reality from imagination?

The principle of causation is itself ontologically underdetermined/non-specific, so the admissibility of an ontological causal category depends upon its methodological justification for inclusion in the hypothesis space. This can be called the principle of methodological neutrality and from here on out when used in this paper it means; ontological neutrality at hypothesis-space construction, subject to methodological admissibility constraints.

Methodological admissibility is therefore a gatekeeping condition, not an evidential conclusion: a hypothesis may be admitted to the hypothesis space without thereby receiving a high prior probability or any positive evidential support.

When logic alone does not determine admissibility, admissibility should be governed by methodological performance rather than antecedent ontological commitments. The epistemic goal is comparative explanation of historical evidence, so an ontological category should not be excluded unless its inclusion prevents reliable comparative inference.

Methodology analysis tells us which causes science investigates and pragmatics explains why a particular methodology is adopted. Suppose the true cause of a deep past unique event was non-natural*. If we exclude non-natural* hypotheses a priori, then an excluded hypothesis cannot be evaluated against the evidence. That is a remarkable result. A priori exclusion prevents describing any evidence as supporting that category within the initial inferential framework, thereby making the category unavailable for comparative evaluation until the methodological restriction itself is first revised.

If the epistemic objective is to discover which member of a set of methodologically admissible hypotheses best explains the evidence, then excluding a potentially true admissible category requires justification because comparison cannot recover hypotheses already excluded.

Laudan (1983) argues that attempts to define science via rigid methodological demarcation criteria have largely failed, however he is relatively silent on the distinction between the historical and predictive sciences. Plantinga (1996; 2001) argues that methodological naturalism is not a neutral methodological constraint but a substantive restriction on permissible explanations, but again the affect of acknowledging the methodological differences between the historical and predictive sciences is undeveloped.

Integration of the current distinct methodology in the historical sciences with the logic of methodological neutrality unveils a potential improved method for the historical sciences that avoids premature closure on possible ontological categories.

Dawes and Smith (2018) argue that scientific naturalism is not merely an arbitrary methodological restriction, but its success is reflected in the historical character of scientific practice which has progressively demonstrated that natural explanations are the ones that work. In other words, over the history (scientific revolution) of the predictive sciences we see that initially there were forms of methodological neutrality and then over time the superior effectiveness of naturalistic methodologies has established that methodological naturalism is indeed the only epistemology that ensures reliability in the predictive sciences.

However, looking at the progression in the historical sciences we see that it is not so clear cut, the research space continues to be awash with contradictory theories like theistic evolution, dissent from Darwinism, worldwide flood geology, creationism, young earthers, intelligent design etc... So, it is fair to say that many researchers are still in the space of methodological neutrality and I suggest it is because we have not had a formal way to determine the correct methodology. The delay in achieving this formality is likely due to the slow progress in acknowledging the distinction between the historical sciences and the predictive sciences.

Once it is recognized that the historical sciences operate under a different epistemic structure, then the formal analysis of the appropriate methodology can follow. Note firstly then that this process requires us to take a step back initially and recognise that the success in the predictive sciences does not automatically establish identical hypothesis-space restrictions in the historical sciences.

The predictive sciences derive much of their reliability from experimental intervention, controlled observation, and the independent constraint of competing causal hypotheses. The historical sciences generally lack these forms of control and instead evaluate competing explanations abductively according to explanatory scope, causal adequacy, coherence with established knowledge, and, where applicable, predictive or retrodictive success. Consequently, the practical success of methodological naturalism in experimental science cannot, by itself, justify excluding non-natural* causes from the historical sciences.

So, causation does not justify naturalism, and the predictive science's methodology does not automatically justify naturalism in historical science.

Historical science could have its own independent methodological reason for restricting the hypothesis space to natural causes. Whether historical science should impose such a restriction must therefore be determined by analysis of the epistemic conditions and methodological aims of historical inquiry.

Independent analysis of the epistemological conditions in the historical sciences is the only way to determine what ontological categories are permitted in the hypothesis space. The methodology of the historical sciences is tabulated along with 3 generalised ontological categories.

Methodology in the Historical Sciences Criterion	Natural	Non-natural and other unconstrained[1]	Non-natural* (constrained)
Can be formulated as a constrained hypothesis	☑ Yes	☐ No	☑ Yes
Can specify observable consequences	☑ Yes	☐ No	☑ Yes
Specify the characteristics of the cause (ontological specification of the agent)[2]	☑ Yes	☐ No	☐ No
Specifies the causal intervention sufficiently to determine observable consequences	☑ Yes	☐ No	☑ Yes
Permits natural regularities to constrain the pre- and post-intervention periods	☑ Yes	☐ No	☑ Yes
Can be comparatively evaluated	☑ Yes	☐ No	☑ Yes
Can generate discriminating expectations	☑ Yes	☐ No	☑ Yes
Can avoid unlimited ad hoc flexibility	☑ Yes	☐ No	☑ Yes

1. Note: "Other unconstrained ontological categories" includes hypotheses such as simulation hypotheses, Cartesian demons, Boltzmann brains.
2. Non-natural* "causal adequacy": The difficulty of defining the characteristics of the cause need not be a roadblock, it refers to phenomenological sufficiency (the hypothesis specifies an intervention sufficient to generate the observed kind and magnitude of effect). However, it is possible that if evidence of non-natural* intervention is found, then that evidence may also tell us something of the characteristics of the agent, for example the evidence may point towards the agent having intention, intelligence, purposefulness and engineering expertise.

Based on this analysis it appears that non-natural* causes are permitted in the hypothesis space of the historical sciences. In summary a non-natural* hypothesis is admissible only if it predicts evidence of temporally bounded past manipulation, suspension, or selection of otherwise stable natural regularities, where those effects are independently identifiable (the traces must be identifiable without first assuming the truth of the non-natural* hypothesis).

Then such hypotheses can be compared with competing natural hypotheses to see which one aligns with the evidence better. If any non-natural* hypothesis is found to be weak and unsupported by the evidence, it can be excluded or at least set aside until evidence discovered in the future justifies revisiting it.

Next, we must use pragmatism to guide the analysis (just like it has done in the predictive sciences over the centuries since the scientific revolution). The methodological distinction

between predictive and historical science follows from their different epistemic goals. Predictive science aims to generate reliable forecasts and support intervention in the natural world. Its success is measured by the ability to predict, manipulate, and control phenomena under repeatable conditions. If a causal factor cannot be relied upon to produce stable, repeatable outcomes under controlled conditions, it cannot serve as a dependable basis for predictive intervention. For this reason, predictive science appropriately restricts itself to using the regularities of nature. Predictions or designs that invoke irregular or unconstrained causal factors cannot provide the reliability required for engineering, medicine, or other applications where human safety depends upon accurate prediction.

The historical sciences, by contrast, write narratives about past events from present evidence. Its primary objective is explanatory adequacy rather than predictive control. Although historical reconstructions should be as accurate as possible, they are generally not used directly to design bridges, aircraft, medical practice, or other technologies whose safe operation depends upon the repeatability of natural laws. Consequently, the pragmatic justification for restricting explanations exclusively to regular natural causes is less direct than it is in predictive science.

Constraining the definition of non-natural* to include “over a finite interval in the past”, also has pragmatic reasons because sometimes the historical sciences are involved in predictive models (e.g., historical geology predicting earthquakes, historical climatology modelling future climate change, evolutionary history predicting viral mutation patterns in epidemiology).

Granted, the process of pure retrodiction (narrative) cannot generate the discovery of new continuing physical regularities of nature. Generally, it is the physical observation and testing in the predictive sciences that enables us to discover the regularities of nature. However, models of the past actions of the regularities of nature are then used to predict the future and sometimes used in applied science. The distinction then is that the methodological requirements for a historically bounded reconstruction are not identical to those for a model intended to support repeatable applied science. Thus, there is no danger that a wrong non-natural* hypothesis will ever be used in applied predictive science.

However, a past intervention can change initial conditions and thereby affect future events without itself continuing. So, the intervention itself does not need to continue for its effects to propagate into the future. But the non-natural* hypothesis does not posit an ongoing non-natural* causal regime or continuing suspension of regularities. Therefore, models that predict the future need not incorporate any continuing non-natural* aspects, they are only built on the regularities of nature ensuring their reliability.

This then is pragmatic support for methodological neutrality in the historical sciences and builds on the previous analysis of the methodologies in the historical sciences. These provide a justification that non-natural* hypotheses are admissible in the hypothesis space until evidence eliminates them.

A priori exclusion of a causal category requires an independent methodological reason. The distinctive epistemic conditions of the historical sciences do not provide such a reason against constrained non-natural* hypotheses. Therefore, their exclusion is not methodologically justified at the hypothesis-space construction stage.

This difference to the predictive sciences does not imply that historical explanations may be arbitrary or that accuracy is unimportant. Rather, it reflects the fact that the historical sciences operate under different epistemic conditions. Past events cannot ordinarily be repeated or

directly observed, and competing explanations must therefore be evaluated primarily through inference to the best explanation. However, the historical sciences must be careful because their narratives can be speculative regarding proposed pre-historic chains of events. Some historical science narratives admit this difficulty for example,

- Odenwald (2022, 23) recently published a summary of the state of play regarding the origins of the universe and concluded: "Of course, this entire story is highly speculative, even fanciful."
- Carlos Frenk (2004, 1750): "We don't understand how a single star forms, yet we want to understand how 10 billion stars form."
- Blum et al. (2017, S755): "The processes that led to the formation of the planetary bodies in the Solar system are still not fully understood."
- Ijjas, Steinhardt and Loeb (2017, 39) said: "Today we are fortunate to have sharp, fundamental questions imposed on us by observations. The fact that our leading ideas have not worked out is a historic opportunity for a theoretical breakthrough."

With this analysis of the hypothesis space constraints in the historical sciences it now clarifies that much of the contemporary debate over methodological naturalism can be understood as a disagreement about whether historical inquiry should adopt such methodological neutrality. The central disagreement is not over the success of predictive sciences, but over whether the historical sciences should begin by presupposing divine agency as an available explanatory category or by excluding non-natural* causes from consideration. Although opposite in content, they are methodologically similar because both specify a priori hypothesis-space constraints before the methodological justification begins. A potential correction for both unfolds when the logic of methodological neutrality is also integrated with the distinct methodology for the historical sciences.

Sadly, some investigations in the historical sciences are biased by prior commitments. For example, some take their religious book as saying God created in the beginning and then go about looking for evidence that supports their conclusion, classic confirmation bias.

The debate is clarified by taking a step back and "doubting all things" (Descartes, 1644) and then conducting a methodological neutrality analysis of the historical sciences. This distinguishes methodological practice from prior metaphysical commitment. Methodological justification determines which categories of explanation, if any, remain warranted for inclusion in the hypothesis space.

An objection to this will likely take the form of stating it is a problem to allow non-natural* ontological categories because it changes the rules of science.

In response the proposal does not change anything regarding experimental/predictive science. Rather, it is just recognising the previously published distinctions in the historical sciences and developing the logical consequences of them. The appropriate principle in the historical sciences is therefore not that every causal category is equally justified for inclusion in the hypothesis space, but that every cause should earn its place through methodological justification rather than being accepted or rejected by prior commitment.

Historical science is strongest when it allows reality, as revealed through evidence, to determine the boundaries of explanation. Even if non-natural* causes in the past turn out to be highly improbable, this approach does allow us to discover that reality if it exists. And thankfully this approach does not undermine the success of naturalism in the predictive sciences.

A disciplined historical science that finds justification for inclusion of non-natural* causes in the hypothesis space then requires:

1. Clearly identifying the evidence.
2. Formulating competing explanations.
3. Evaluating what each explanation predicts or accounts for.
4. Avoiding assumptions that determine the conclusion before the evidence is considered.

This brings us full circle to the philosophers of science who have described the distinctions in the historical sciences and now with methodological neutrality integrated in it is necessary to test the proposal. Admissibility does not confer evidential support. It merely makes comparative evaluation possible.

Case in point: Charles Darwin's *On the Origin of Species by Means of Natural Selection*

Darwin included a causal hypothesis of a different ontological type from natural selection in his hypothesis space and compared it to the natural hypothesis using a form of inference to the best explanation. Darwin repeatedly treats the view that species were independently created as an alternative explanation of the facts he is trying to explain: The following quotes are examples of Darwin comparing the competing natural and non-natural origins theories of his time and working towards the best explanation. These are quoted from the 5th edition published in 1869.

"The great majority of naturalists have believed that species were immutable productions and have been separately created." (Preface, p. v)

"Let us now see whether the several facts and rules relating to the geological succession of organic beings, better accord with the common view of the immutability of species, or with that of their slow and gradual modification, through descent and natural selection." (p. 273)

"In the following remarks I shall not confine myself to the mere question of dispersal; but shall consider some other facts, which bear on the truth of the two theories of independent creation and of descent with modification." (p. 339)

"How inexplicable on the theory of creation is the occasional appearance of stripes on the shoulder and legs of the several species of the horse-genus and in their hybrids!" (p. 411)

"Why, it may be asked, have nearly all the most eminent living naturalists and geologists rejected this view of the [im]mutability of species? It cannot be asserted that organic beings in a state of nature are subject to no variation; it cannot be proved that the amount of variation in the course of long ages is a limited quantity." (p. 417)

Darwin provides a historical example in which a non-natural causal proposal was explicitly treated as an explanatory alternative and evaluated comparatively against a naturalistic account.

In other words, Darwin did not simply exclude non-natural causation a priori. Darwin doesn't say something like: "Supernatural causes are impossible; therefore, I shall only consider natural selection." Instead, he argues comparatively against special creation.

His argument is that common descent + modification by natural selection produces a much more unified explanation of these otherwise disparate facts. This is effectively a form of abductive reasoning and inference to the best explanation.

Darwin's special-creation hypothesis is much less mechanistically specified than his natural-selection hypothesis and is part of Darwin's criticism of the non-natural hypothesis of the immutability of the species.

His presentation is of a continuously operating causal process that predicts/explains a vast number of otherwise puzzling facts. He compares creation/immutability of species with the fact that species aren't merely sitting there; they have a historical distribution, variation, inheritance, competition, selection, extinction, geographical isolation relationships, etc.

What we see him doing then is noting the hypothesis that explains the greatest number of independent facts with the fewest special assumptions, a form of consilience and explanatory unification. He presents the phenomena and then a causal hypothesis grounded in processes we know to occur. He compares it to the alternative creation/immutability and describes its lack of explanatory power and consilience with the evidence. This reveals that the two hypotheses are not equally developed causal models which leads him to his conclusion supporting the substantially stronger argument.

Thus, we can see clearly that Darwin's argument did not depend on the premise that non-natural* explanations are illegitimate (should be excluded from the hypothesis space). He treated creation/immutability as an explanatory alternative and argued that natural selection was preferable because it provided a natural law governed, unified causal explanation of a much larger body of evidence.

It is obvious, but it must be noted again that Darwin’s methodology occurs in a hypothesis space limited to the historical sciences.

This is why it is coherent. In experimental/applied predictive science, you can intervene directly, but the historical sciences cannot do that with the deep past events being reconstructed. What past causal process would best explain the evidence becomes the question at hand. Darwin's argument is in the historical-science setting and gives Darwin a legitimate reason to review hypotheses that differ in causal type.

Darwin's argument is consistent with a methodology that does not impose strong Methodological Naturalism as a prior exclusion rule. But he does not give the non-natural* hypothesis a free pass either. It is subject to the same explanatory/evidential discipline as the natural hypothesis.

Darwin is an illustrative case that shows treatment of non-natural* explanations as competitors for comparative assessment pragmatically works, but it shouldn’t be taken to prove the validity of methodological neutrality, the logic presented earlier is still required.

Lastly regarding Darwin's hypothesis of creation/immutability we must note that it does not technically fit the above definition of non-natural* hypothesis. He describes it as species being independently created, without specifying that physical laws were temporarily suspended. And his reference to immutability of species indicates that the hypothesis does not provide a return to/resumption of ordinary regularities like mutation and selection. So, strictly speaking, Darwin's special creation hypothesis is not a direct instance of the non-natural* hypothesis

category defined earlier. However, Darwin demonstrates that historical science can compare causal hypotheses of different ontological types.

Careful Application

While inference itself remains entirely conventional, the appropriate initial boundary of the historical sciences hypothesis space is methodological constraint, not ontological category, then the practical implementation of methodological neutrality in the historical sciences needs careful management. The novelty lies in the construction of the hypothesis space. Methodological neutrality requires that all hypotheses satisfying the methodological admissibility criteria remain available for comparative evaluation. Thereafter inference to the best explanation, determines which hypothesis is best supported by the total partitioned evidence.

However, even though non-natural* causes are allowed in the hypothesis space, the issue quickly becomes that non-natural* hypothesis's evidential criteria are under constrained.

Firstly, all natural and non-natural* hypotheses in the space must adhere to an equal scientific standard, they must: explain evidence; have causal adequacy; be coherent; generate discriminating expectations and survive comparison.

Secondly, non-natural* hypotheses must specify the causal intervention and observable consequences claims (ontological specification of the agent is not required). It is analogous to requiring a gravitational hypothesis to specify gravitational consequences. To achieve this the following conditions of evidential support should be implemented by theorists:

> Non-natural* hypothesis must
>
> - explain the evidence (the relevant traces must be identifiable without first assuming the truth of the non-natural* hypothesis)
> - have greater likelihood than relevant competitors that observed traces occurrence is substantially more expected under the non-natural* hypothesis
> - provide greater explanatory scope/power over relevant competitors (evaluated jointly with coherence, simplicity/auxiliary assumptions, causal adequacy, and discriminating evidential expectations)
> - show substantially higher evidential support (not just anomalies, rather evidence that physical regularities over a finite interval in the past were interfered with such that there is trace evidence that temporary physical incompatibility occurred and then ordinary regularities resumed)
> - make explicit predictions about what artifacts should be found in the future that are not predicted by competing natural hypotheses (a prediction about presently unknown evidence concerning the past, not a prediction that the non-natural* intervention will recur in the future)
> - not, by any means, generate new continuing physical regularities of nature (The category is intended to explain historically bounded interventions, not to replace natural law with an alternative ongoing system of lawlike behaviour.)

These constraints are necessary because without them the category would remain sufficiently flexible to accommodate almost any historical outcome, preventing meaningful comparative evaluation.

Note that there is no requirement to describe the characteristics of the non-natural* cause, the requirements are all helping determine if the cause has left observable traces in the natural world.

Epistemic Dilemma 1: Trace Evidence vs. Natural Regularities

In the modern era of strict methodological naturalism trace evidence of temporary physical incompatibility is identified as an incompletely understood natural phenomenon driving the expansion or revision of natural laws. A non-natural* explanation is not available as a candidate regardless of how poorly the current natural explanations perform. The methodological framework therefore prevents the anomaly from directly entering a comparative natural-versus-non-natural* evaluation.

To avoid begging the question, some effort must at least be expended in the domain of the hypothesis space and at least allow for the possibility that physical regularities over a finite interval in the past could be interfered with leaving trace evidence that temporary physical incompatibility occurred. Furthermore, if nothing else, this approach allows extensive review of ad hoc adjustments made to naturalistic models of deep past events. This extra attention will build those adjustments from ad hoc to viable and reliable theories.

Sometimes models of deep past events have proposed regularities of nature or physical properties inserted in that are currently unknown i.e. have not been directly observed in the present. This exposes a key methodological tension, because these proposals sometimes introduce an unverified auxiliary hypothesis… leaving us wondering, is it just to preserve naturalism?

It is possible that omissions play a significant role too (this is where further research is required beyond the scope of this paper). One could leave out a key regularity of nature from a model so that it produces what we see around us (i.e. the omission is not for modelling idealization for simpler computation).

So yes, naturalistic hypotheses are permitted to introduce auxiliary hypotheses when those auxiliaries are independently justified, testable, or otherwise methodologically warranted.

The presence of auxiliary assumptions is not itself a defect. The methodological issue is whether they are independently justified and whether their introduction is constrained by evidence. And the historical sciences should be treated analogously: their admission cannot be rejected merely because they depart from established regularities; rather, they must satisfy their own evidential constraints.

Auxiliary assumptions and omitted constraints must be made explicit and independently assessed regardless of whether the hypothesis is natural or non-natural.* This should avoid any accusation of a methodological/structural double standard. Of course, inserting unobserved regularities or omitting critical ones that conflict with evidence might be viewed by many as standard scientific practice and epistemic conservatism. Science prefers to present alignment with the principle of nomological invariance, but is this a presentation of reality? The other

danger is that when those assumptions become permanent ad hoc fixtures without independent verification, they have become non-falsifiable placeholders. The best way to avoid this is to have a potential rival theory, thus if for no other reason, non-natural* hypothesis should be allowed in the hypothesis space just to ensure that anomalous evidence can be evaluated against genuinely competing causal explanations rather than being forced into an indefinitely extensible naturalistic framework. And vice versa, the introduction of the non-natural* theories are falsifiable from the outset because of the existing viable natural theories.

When naturalistic models omit or modify known regularities to fit anomalies, they are practicing standard scientific fallibilism and "epistemic conservatism"—holding out for a better natural model. Many view that invoking a non-natural* cause is giving up and stopping science. The reality is the opposite, as can be seen above, the process of analysing a non-natural* theory will take exponentially more effort.

If naturalistic models can introduce auxiliary assumptions to preserve explanatory adequacy, then those assumptions must be independently justified and transparently identified; similarly, non-natural hypotheses must meet explicit evidential constraints. This paper does not advocate jumping to a non-natural* conclusion whenever a natural model faces an anomaly, rather, it argues that with non-natural* causes in the hypothesis space it improves science and increases reliability of conclusions drawn.

Natural and non-natural* hypotheses can both contain unobserved historical assumptions, although non-natural* hypotheses additionally posit a bounded departure from ordinary regularities. But, both classes should be evaluated by the same standards governing auxiliary assumptions. Then, we will benefit from a framework that can manage this situation and provide further incentive to improve ad hoc auxiliary hypotheses in all causes admitted to the hypothesis space.

Epistemic Dilemma 2: Evaluation of Non-natural* Trace Evidence

The following 5-step process is a possible starting point for this new field of science:

1. Establish Bounded Anomaly Traces (Local Incompatibility).
    a. Identify physical evidence that shows a sharp, localized departure from expected regularities over a finite past interval.
    b. Confirm that the anomaly is bracketed by clear "before" and "after" states where standard, uniformitarian physical laws operated normally.
2. Identify Phenomenological Sufficiency Without Continuous Mechanisms
    a. Demonstrate that the trace evidence requires a cause with sufficient capacity to produce the observed effect (phenomenological sufficiency), yet lacks any continuous physical mechanism already expressed in the established regularities of nature.
3. Verify Physical Incompatibility and Law-Invariance
    a. Demonstrate evidence of temporary physical incompatibility, that there is a high likelihood that it was an occurrence inconsistent with known regularities of nature that produced the trace. It must provide evidence for the intervention itself, not merely evidence against the natural alternatives.
    b. Demonstrate that the observed trace is not explained by currently postulated ad hoc/new natural phenomena because that ad hoc phenomena theoretically

would break the stability of surrounding, verified physical laws. It is recognized that this is an outlier case, in that many proposed ad hoc phenomena are shown to be compatible with the current established regularities of nature.

c. It must be noted here that future new discoveries could reduce the likelihood of the non-natural* cause and could even reduce that likelihood to zero in line with the principle of fallibilism and scientific tentativeness.

4. Evaluation of Evidence of High Specificity/Complexity/Intention.
    a. It is possible that the above evidence in Step 3 of incompatibility with nature demonstrates a low likelihood that natural random processes of self-organization generated the trace evidence and thus;
    b. Symmetrically, this evidence is thus telling us something of the characteristics of the agent, for example if the evidence reflects a highly improbable (naturalistically) configuration containing complex symbolic information, semiotic codes, deliberate semantic structures or complex/specified information, then it infers an agent having intention, intelligence, purposefulness and engineering expertise.
    c. It must be noted here explicitly that this is only a possible downstream inference about agent characteristics, not part of the admissibility or intervention-detection criteria. This does not alter the admissibility criteria presented earlier, for admissibility in the hypothesis space the characteristics of the agent do not need to be specified, but it is a possibility that we need to prepare for that downstream inference/evaluation might begin to reveal some characteristics of the agent.

5. Evaluate Comparatively/IBE
    a. Formulate specific retrodictive expectations: show that the non-natural* hypothesis predicts unique, auxiliary trace artifacts that competing naturalistic models (including ad-hoc auxiliary hypotheses) specifically predict should not exist.
    b. Evaluate the hypotheses comparatively using likelihood; which hypothesis is more likely regardless of if it is natural or non-natural*?

This process highlights even further that the earlier use of Darwin is barely an illustrative analogy. Special creation/immutability as Darwin evaluated it is far from the criteria above. Darwin was not comparing common descent against semiotic codes, complex/specified information, or physical law-breakage. So yes, it is noted that Darwin's case study does not match the criteria above. However, what Darwin does demonstrate is that even slightly/poorly constrained non-natural* hypotheses can still be in the hypothesis space.

In summary there are at least four stages to the process:

Stage 1 — Ontological possibility: answering the question: Could this type of cause exist?

Stage 2 — Hypothesis-space construction with methodological neutrality enables us to answer if a causal category is sufficiently constrained to be methodologically admissible.

Stage 3 — Hypothesis specification: The non-natural* hypothesis constraints enable us to answer what exactly the hypothesis claims happened, and what evidence distinguishes it from competitors.

Stage 4 — Comparative inference and IBE allow us to assess which admissible hypothesis best explains the evidence.

Conclusion

In light of the distinctions between the historical and experimental/predictive sciences, the methodological assumptions appropriate to the predictive sciences cannot simply be transferred to the historical sciences without independent justification. Although both domains employ scientific reasoning, they pursue different epistemic goals and consequently employ different methodological constraints. Thus, a review of hypothesis-space construction in the historical sciences is warranted. The principle of causation is ontologically non-specific; thus, we must turn to methodological analysis of ontological categories to determine which ones are permitted in the hypothesis space. The important methodological question is not whether a cause is natural or non-natural*, it is constrained vs unconstrained causal hypotheses. So non-natural* hypotheses need to be sufficiently constrained to participate in a reliable comparative inferential hypothesis space. This is a methodologically neutral principle governing the initial construction of the hypothesis space determining which categories can be admitted in sufficiently constrained form.

Not all hypotheses are equally plausible or equally supported. Admissibility is only the beginning of inquiry. Both natural and non-natural* hypotheses remain subject to the same evidential standards, including explanatory scope, explanatory power, internal coherence, evidential consistency, predictive success regarding future discoveries, comparative evaluation, and susceptibility to falsification. Hypotheses that fail these criteria are rejected irrespective of their ontological category. Whereas, excluding any coherent class of causal hypotheses from historical inquiry requires an independent justification grounded in the epistemic aims of that discipline. Each proposed causal category must satisfy the methodological conditions for admissibility, while exclusion of an otherwise admissible category requires an independent methodological justification. The particular constrained class defined as non-natural* shows potential that it can be formulated in a methodologically assessable manner. Arguably it is only in this case then that the epistemically appropriate methodology is one of methodological neutrality, allowing methodological constraint and effectiveness —not prior ontological commitment—to determine which ontological categories are permitted in the hypothesis space.

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