**Hempel’s Raven Revisited**

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**Introduction**

Reasoning from the particular to the general – reasoning by *induction* – certainly seems like a thing that we do, and an important one at that. We see some particular *x’*s, we note that they have a certain property *P* and take ourselves to have found evidence that, in general, *x’*sare *P.* Astraditional empiricist views have it, induction is central to scientific method and, more generally, is the primary means by which humans acquire empirical knowledge. This is why Hume’s problem of induction is such a big deal. If induction is as central to human knowledge acquisition as the standard empiricist story says it is, then, given Hume’s problem, skepticism follows.

 But, as my title indicates, I am here to talk about Hempel’s Problem, not Hume’s— though my analysis will have bearing on the latter as well. This problem is more local than Hume’s. Rather than a skeptical concern about induction in general, it is a problem that arises in attempting to formalize induction using the framework of predicate logic. When we do so, we get some rather counter-intuitive consequences. Consider the generalization “ravens are black” or, as it would be put in predicate logic:

∀x (Rx 🡪Bx)

On any inductive logic, what would count as evidence for the truth of this generalization are observations of particular black ravens. Applying a simple rule of inference, contraposition, we get:

∀x (~Bx 🡪~Rx)

This statement has the same “semantic content” as the first formalization—it differs only in logical form. So, whatever counts as evidence for this second statement should count also as evidence for the first. But, observations of white shoes would count as evidence for this second statement. We see a pair of shoes and notice that they are not black and not ravens—true antecedent, true consequent, therefore true conditional. However, it is odd to think that observations of white shoes should count as evidence for the generalization that ravens are black. Yet that is what our inductive logic seems to dictate.

In noting this clash between logic and intuition, you might think that we’re at least on the right track with our inductive logic and the fact that it clashes with our intuitions just means we need to shore up the logic. The goal, then, is to rework our system of inductive logic such that it no longer yields counter-intuitive results the likes of which Hempel put his finger on. That is, as Goodman might say, to solve the problem is to bring our system of inductive logic into “reflective equilibrium” with our intuitions regarding which inductive inferences we should license and which ones we shouldn’t.[[1]](#footnote-1) I am going to approach the paradox another way—by understanding the relevant intuitions. This “intuitions first” approach has a decided advantage over the “logic first,” reflective equilibrium approach that has been standard in philosophical commentary on Hempel’s Paradox. On the latter approach, the intuitions are left as a kind of black box and it is taken on faith that, whatever the structure of the intuitions inside that box might be, it is a structure for which we can construct an isomorphic formal edifice—a system of inductive logic. By popping open the box, we can see whether that faith is misplaced.

 Perhaps a word on this methodology is in order. In a sense, what I want to do here is nothing more than a bit of bog-standard empiricist philosophy. Just as Hume proposed to vet the idea of causation by interrogating the (supposed) character of our actual understanding of that relation, I propose to consider Hempel’s Paradox in a similar way, namely, by trying to understand how we actually understand generalizations like the ones that generate Hempel’s problem. In other words, my plan is to investigate the character of our intuitive, pre-theoretical understanding of statements like “ravens are black.” Understanding what this amounts to can give us a clearer understanding of Hempel’s Paradox. It enables us to say not just *that* the particular consequence that generates the paradox is counter-intuitive but, also, *why* it is so.

 Another methodological note: I take cases in which we come to terms with apparent *exceptions* to be particularly informative with respect to our pre-theoretical intuitive understanding of generalizations such as “ravens are black.” I consider a number of such cases throughout the paper. I’ve found it helpful to do so in light of two hypotheses regarding the structure of our intuitive understanding—a *taxonomic* and a *nomological* one. I tentatively distinguish these hypotheses at the outset of my inquiry and develop the distinction further as it proceeds. Roughly, the taxonomic hypothesis states that we pre-theoretically understand generalizations like “ravens are black” to specify a necessary condition on being a member of the raven category, namely, being black. The nomological hypothesis, on the other hand, has it that we intuitively understand “ravens are black” to state that a lawlike relation holds between being a raven and being black. Noting differences between how we *would* respond to apparent exceptions to generalizations if these hypotheses were true and how we *in fact* respond to such exceptions throws into relief our actual pre-theoretical understanding.

Rather than taxonomically or nomologically, my analysis suggests that we actually understand such generalizations *mechanically*. To foreshadow a bit, this mechanical understanding is “thick” in the same way that Nancy Cartwright argues our causal concepts are.[[2]](#footnote-2) And, just as Cartwright tells us that there are many distinct thick causal concepts, there are many distinct ways in which we pre-theoretically understand generalizations like the ones at hand *mechanically.* As my analysis suggests, we intuitively understand “ravens are black” to mean *ravens are black by some underspecific yet characteristic means.* Likewise, we intuitively understand “coal is black” to mean *coal is black by some underspecific yet characteristic means.* Underspecific though they may be, we understand the means by which ravens are black to be different from the means by which coal is black. This doesn’t bode well for the prospect of explicating induction in terms of a single monolithic formal system which depends upon abstracting away from just those differences. To appropriate the words of Nancy Cartwright, when we do “we . . . lose a vast amount of information that we otherwise possess.”[[3]](#footnote-3) But we don’t lose it entirely. In fact, we don’t really *lose* it at all. Rather, we decide not to countenance it in our formal theory. That we *retain* this information explains why we find certain consequences of formal theories of induction to be counter-intuitive.

 Sections I, II and III of the paper develop what is meant by “means,” “underspecific” and “characteristic” respectively. This, however, is just a matter of emphasis. The significance of each term can only be appreciated in light of the analysis running through the entire paper. In the final section, I spell out the relationships between the taxonomic, nomological and mechanical hypotheses and bring the analysis to bear on both Hempel’s problem and Hume’s.

Karl Popper famously “solved” the problem of induction by denying induction.[[4]](#footnote-4) My analysis has led me to a similar conclusion. Like Popper, I suggest that there is no such thing as induction—but I don’t go in for falsificationism. If there is no such thing as induction, then there is no problem of induction nor are there any of the “local” problems that attend attempts at formalizing induction—Hempel’s Paradox being a case in point.

**Section I: Ravens are**

**Black by some Underspecific yet Characteristic *Means***

Let’s begin our analysis by asking ourselves how a generalization like “ravens are black,” or in formal terms, “∀x (Rx 🡪Bx)” might be understood. Here are two possible ways:

1) *The taxonomic understanding*: The conditional specifies a necessary condition on being a member of the category *raven*, namely, being black.

2) *The nomological understanding*: The conditional states that a law-like relation holds between being a raven and being black*.*

At first blush, these may seem rather different. On the taxonomic understanding, “ravens are black” *defines* ravenhood partially in terms of blackness. On the nomological understanding, there is a notion of ravenhood defined independently of blackness and the generalization states that this prior notion is related to blackness by law. Perhaps the most important difference between these two ways of understanding the generalization is that only on the nomological understanding do we get Hempel’s Paradox. If the statement is a matter of definition, there is no question of evidence bearing on it in the first place and, hence, no paradox.

 Some readers may be doubting that these ways of understanding the generalization are really as different as I seem to be suggesting. After all, even if it is in some sense a matter of definition, as the taxonomic understanding would have it, that definition wasn’t just stipulated from the *armchair.* Rather, taxonomists of the biological world have painstakingly built their categories by following Linnaeus into the *field*. What is the difference, one may ask, between such taxonomic fieldwork, part of the goal of which would be to determine whether blackness is a necessary condition on being a member of the category “raven,” and that empirical activity the end of which is to determine whether ravenhood and blackness are nomologically related? *Evidence* in the form of observations of actual ravens seems to come into the picture in both cases.

 I sympathize. In fact, here are some further reasons why we might think that these two ways of understanding the generalization are not as different as they may seem on their faces.

* First, obviously, they both license the inference from “*x* is a raven” to “*x* is black.”
* Second, it seems, both ways of understanding the generalization support the corresponding counterfactual. That is, assuming that some particular *x* is in fact not a raven, it is true, in light of the truth of the generalization, that “if *x* were a raven, then it would be black.”
* Relatedly, third, both understandings take the universal generalization to be true without exception*.*
* Fourth, on neither understanding is it the case that one can know the truth of the generalization just by reflecting on the terms used in formulating it. To put this in terms of the other side of the same coin, no contradiction—like that involved in the idea of a married bachelor—is involved in the idea of a non-black raven (on neither understanding is the sentence “analytic”). This is a consequence of what I mentioned above, namely, that observations of actual ravens are relevant whether we’re trying to determine if blackness is a necessary condition on ravenhood or if ravenhood and blackness are nomologically related. Besides, Hempel’s Paradox is a problem for the justificatory status of *empirical* generalizations. Even if there were some way of understanding the sentence as analytic, it wouldn’t be relevant here.
* Fifth, confronting something that looks for all the world like a raven and yet isn’t black would require one of two responses similar across the taxonomic and nomological understanding. On the taxonomic understanding, we could: 1) stick to our category specification and argue that this white thing is not in fact a raven or, 2) we could modify our category specification to include the white thing within the raven category. The latter would require striking blackness from the list of necessary conditions for ravenhood. Either tack would likely necessitate some argument against, on the one hand, liberals who don’t think the category should discriminate on the basis of color and, on the other, conservatives who insist that blackness is of the essence of ravenhood and that the category must remain pure. Likewise, on the nomological understanding, in encountering a white raven, we could 1) hold fast to the truth of the law and argue that this white thing is not in fact a raven or, 2) we could acquiesce in the law’s falsity and modify it accordingly. One could wonder whether there is a substantive difference between holding fast to a category specification according to which blackness is a necessary condition on being a raven and holding fast to the truth of a universally binding law that says ravenhood and blackness are nomologically related. Likewise, one could wonder whether there is a difference between modifying the specification of the raven category and modifying the law to accommodate observations of white ravens.

I return to the question of how to differentiate the taxonomic and nomological hypothesis in section III. For now, note that regarding the last bullet point above, one may object that the strategies for coping with being confronted by a white raven are only as limited as I have made them out to be because I have unfairly characterized the taxonomic and nomological ways of understanding the generalization as implying that it is *exceptionless*. We simply do not—nor should we—understand it like this. Categories have vague boundaries and laws are always *ceteris paribus.* Think of it this way: imagine you enter a walk-in refrigerator with your little nephew. You hug your elbows, exaggerate a shiver, smile down at your nephew and say, “brrrr, it’s freezing in here!” Apparently annoyed, your nephew looks up at you and says, “freezing is 32 degrees Fahrenheit. It’s *not* freezing in here.” Understandably, you roll your eyes and reflect on how your nephew is turning into a little brat. Later that day, sitting at the table helping your niece with her homework she asks, “what color are ravens?” You respond, “ravens are black.” Just then your nephew walks in and says, “oh yeah, what about *albino* ravens?” Again, brat. The exceptionless ways of understanding “ravens are black” that I have characterized, goes the objection, make it out that your brat-of-a-nephew’s smarmy over-literality is paradigmatic of how such generalizations are understood. Yet, it is just his over-literality that is diagnostic of his being a brat. In fact, that we *don’t* understand such generalizations as statements of exceptionless fact is a precondition on his ability to exercise this particular form of bratty-ness. That we don’t intuitively understand them as exceptionless is precisely what affords him the opportunity to be a brat in this particular way.[[5]](#footnote-5)

Again, I sympathize. Pre-theoretically, we simply don’t understand these generalizations as stating exceptionless truths. In fact, the above example gives us a palpable sense of how far an exceptionless understanding of these generalizations departs from our intuitive understanding of them—precisely as far as your nephew’s comment reflects a smarmy deviation from norms of linguistic comprehension. This is significant for our understanding of Hempel’s paradox. In order to formulate the paradox, we must take our intuitive non-exceptionless understanding of “ravens are black,” formalize it as the exceptionless ∀x(Rx 🡪Bx) such that, by contraposition, ∀x(~Bx 🡪~Rx) is its semantic equivalent. This process involves a departure from our pre-theoretical, intuitive manner of understanding them although, perhaps, a less smarmy departure than your nephew’s.

So we don’t intuitively understand such generalizations as exceptionless. Here is another case to help us see another aspect of our intuitive understanding of such generalizations. Take this example: “objects fall”— ∀x(Ox🡪Fx). Now imagine you are walking in the park with a group of friends. You come around a corner and see a park bench floating unsupported above the ground. One of your group points to it and says, “welp, I guess that’s not an object” and continues along her merry way. Your friend’s reaction would be odd indeed, yet such a response would be just what we would expect if the relevant generalization were intuitively understood taxonomically as providing a partial specification of the category *object.* Equally strange would be for one’s response to this situation to consist in whatever simple act of mind is involved in acquiescing in the “law’s” falsity—“welp, I guess *that’s* false.”

Of course, any real person’s cognitive response to this situation would be more complex than either of these alternatives suggest. One natural response would be wonderment or perhaps horror, “*Oh. My. God*.”[[6]](#footnote-6) A less affective, more curious, response—one more relevant to our inquiry here—would be to investigate to the end of determining by what *means* this remarkable phenomenon is occurring, “*how in the world . . .?”* That is, a natural response would be to try and understand the relevant *mechanism.* This doesn’t involve denying that the bench is an object nor does it involve denying that objects fall toward Earth. In fact, recognizing that, in general, objects fall is crucial in attempting to construct a model of what is going on mechanically here. That seeking after the mechanism is the natural response to confronting such a phenomenon indicates that the generalization to which the phenomenon is an apparent exception is, correspondingly, understood with respect to mechanism rather than with respect to the sharply bounded categories into which the world breaks down or the exceptionless laws that govern it.[[7]](#footnote-7)

We can say more, however, regarding what it means to say that we understand generalizations like the ones in question “mechanically.” For help, let’s consider Michael Strevens’ recently developed view on the semantics of causal generalizations. His view is philosophically kindred to the one I am developing here. Like the view I am developing, his semantics has it that generalizations like the ones at hand are not understood as exceptionless. Further, on his view, there is a sense in which they are understood “mechanically.” His account, however, flirts with a serious difficulty that I call the *anamnesis problem*. In brief, Strevens’ exposition suggests a reading of his view on which we already know—albeit “opaquely”— specific details regarding the mechanism relating e.g. ravenhood to blackness. The empirical discovery of those details thus consists in making apparent what we already tacitly knew about that mechanism turning mechanistic inquiry into an exercise in anamnesis. Nonetheless, it is a helpful contribution and its shortcomings illuminate an important aspect of my approach.

**Section II: Ravens are Black by some *Underspecific* yet CharacteristicMeans**

 To illustrate his view, Strevens considers a situation comparable to our park bench anomaly.[[8]](#footnote-8) A group of scientists studying ravens—and believing that ravens are black—one day discovers a population of grey ravens. Sometime later, these scientists discover that the grey raven’s habitat contained a previously unknown industrial pollutant that blocks a certain metabolic pathway preventing the development of the raven’s normal black plumage. In such a case, says Strevens, the scientists will not simply regard their original hypothesis as false. Why? According to Strevens,

. . . they will regard themselves as having discovered that the grey ravens were all along irrelevant to the blackness hypothesis, because the blackness hypothesis was intended to describe the consequences of the natural coloration mechanism, and the grayness of the ravens was no more a product of that mechanism than the whiteness of bleached ravens . . . In other words, they will regard their hypothesis as having had an implicit rider saying, among other things, *Provided that there is no significant amount of ABC in the environment . . .* This is a rider that they were incapable of spelling out at the time; it therefore gave their hypothesis opaque content.

On Strevens’ account, generalizations like “ravens are black” generally hold only *ceteris paribus*. This is illustrated in the example. The scientists don’t take their discovery of grey ravens to falsify the generalization as they would if they took their generalization to be exceptionless. Rather, “*CP*-ravens are black” is what they meant all along. For Strevens, as alluded to in the example, a CP-clause renders a generalization non-exceptionless by introducing a reference to a particular mechanism. In the example above, the mechanism referred to is the “natural coloration mechanism” for raven plumage. Further, according to Strevens, the CP-clause refers to the conditions that enable the mechanism’s operation. This would be the broader system supporting the pathway from DNA transcription and ultimately, the expression of the black plumage phenotype. Finally, it states that the mechanism operates properly. That is, nothing interferes with the operation of the natural coloration mechanism itself. So, the truth conditions for “CP-ravens are black” are:

* *When condition O holds, then by way of the target mechanism M, the conditions Z and the property F bring about the property G[[9]](#footnote-9)*

where Z stands for e.g. the broader system supporting the pathway from genotype to phenotype (the enabling conditions), O is the condition specifying that the mechanism, *M*, itself operates properly, *F* is being a raven and *G* is having black plumage. These truth conditions purport to account for why the scientists don’t reject the generalization as false. Their discovery that ABC interfered with the proper operation of the natural coloration mechanism was tantamount to discovering that condition O didn’t hold. Thus, in the case of these scientists, this condition endowed the generalization with “opaque content” in the form of a rider – *unless there is a significant amount of ABC in the ravens’ environment.* It is the presence of such opaque content that renders generalizations like the ones at hand non-exceptionless.

Although Strevens’ analysis is aimed at the semantics of CP-hedged generalizations, he concludes his paper stating, “Does it matter whether or not a causal generalization is explicitly hedged? . . . Let me conclude by endorsing this view: the sole semantics for causal generalizations is the semantics I have given for hedged hypotheses.”[[10]](#footnote-10) Thus, even if not explicitly CP-hedged, *all* statements of empirical generalization like “ravens are black” involve a tacit *ceteris paribus* clause—laws are always *ceteris paribus.*

As I mentioned, I am largely sympathetic. In fact, though I’m not developing a semantic theory, there is considerable overlap between Strevens’ view and my own analysis as it has been developed so far. First, for Strevens, a proper account of the semantics of generalizations like the ones at hand shows them to be not a matter of category or law but a matter of *mechanism*. Second, Strevens doesn’t take such generalizations to be understood as statements of exceptionless truth. Finally, his view can be deployed to rationalize your reaction to your nephew’s smarmy comment in the example above. The existence of albino ravens doesn’t “falsify” the generalization “ravens are black” because, on Strevens’ view, that generalization has a tacit CP-clause endowing it with an opaque rider to the effect of, “*provided that there are no genetic defects that prevent the normal production of melanin.*”On Strevens’ understanding, that bit of content was not something “which [you] were capable of spelling out at the time” of your nephew’s smarminess—it was opaque; though you may become capable of articulating it by Googling “albinism” and learning a little about how the genetic disorder works. Nonetheless it was there, like a hole awaiting an appropriately shaped peg, prompting you to roll your eyes at your nephew’s over-literality and reach for your Googling device. Thus, although Strevens’ example involves scientists in practice, the fact that his semantics applies so readily to the case of the bratty nephew—a case illustrating our pre-theoretical, intuitive understanding of our generalizations—shows that his semantics square with our pre-theoretical, intuitive understanding as well. In fact, Strevens’ view could be taken as one possible answer to the question of what it means to say that we intuitively understand generalizations like “ravens are black” mechanically.[[11]](#footnote-11)

That said, let’s consider Strevens’ view more closely. There are two ways of understanding it, one much more plausible than the other. The implausible view goes like this. When the raven researchers discovered that the grey ravens inhabit an environment containing ABC and recognized that this pollutant inhibits the development of normal black plumage, they genuinely discovered something *about their understanding* of the generalization “ravens are black.” In other words, they found something that was, albeit tacitly, in their understanding all along, namely the bit of opaque content corresponding to the facts about the mechanism that they discovered. As I put it above, this content was always there like a hole into which only a *there-is-a-significant-amount-of-ABC-in-the-grey-ravens’-environment-*shaped peg could fit. The researchers’ discovery consisted in finding this peg and, simultaneously, realizing that there was a hole in their understanding of the generalization into which, uncannily, this peg, and only this peg, fits. Discovering the peg and the hole and inserting the former into the latter is the act by which the generalization is saved from falsification upon the discovery of grey ravens. This way of spelling out the view suggests that there are many more bits of content—many more “holes”—scattered opaquely throughout the semantics of the generalization, waiting to be brought to light as the scientists discover further exceptions, and come to understand why they are exceptions, in the course of empirical inquiry. You don’t have to be tryptophobic to find this view aversive. The fact that it turns mechanistic inquiry into an exercise in anamnesis is enough.[[12]](#footnote-12)

That said, the passage quoted above suggests that a more plausible version may be in the offing. The passage reads that the scientists “. . . *will regard themselves* as having discovered that the grey ravens were all along irrelevant to the blackness hypothesis . . . [and] *they will* *regard their hypothesis* as having an implicit rider . . .” (my emphasis). The implausible view elaborated above has it that the scientists are *correct* in how they regard the status of their own discovery—as if in fact their updated understanding of “ravens are black” is *really* just the same as their antecedent understanding only now with some formerly implicit content made explicit in an act of anamnesis. Let’s think through a modified example to help see our way to a more plausible version of the view.

Suppose that rather than discovering that the ravens’ environment contained an industrial pollutant that blocked a metabolic pathway, the researchers piece together a plausible evolutionary story. They find good evidence suggesting that the population of grey ravens initially belonged to an homogenously black population. At some point, a subpopulation became geographically isolated in a new selective environment that, for one reason or another, favors grey plumage. The story they settle on is that the ravens evolved grey plumage by natural selection. In light of finding this to be the case, how will these researchers view their original hypothesis that ravens are black?

The quote from Strevens’ above suggests an answer, “. . . the blackness hypothesis was intended to describe the consequences of the *natural coloration mechanism*” for raven plumage (my emphasis). Supposing these scientists to believe that natural selection is the mechanism responsible for ravens being black, they will now see the greyness of the grey ravens as being a product of the natural mechanism for raven coloration. Strevens’ view suggests, then, that the researchers in the modified example will view their original hypothesis that ravens are black as false because they have come to view grey plumage as mechanically consistent with the normal operation of the natural coloration mechanism—natural selection.

For my purposes, however, the issue of where these scientists will settle with respect to the truth of “ravens are black” is beside the point. The point of my modified example is to show that, rather than the scientists appealing to the *ontogenetic* mechanism to which they appealed in Strevens’ own version of the example, the scientists in the modified version will appeal to a *phylogenetic* one–natural selection–as relevant for updating their understanding of the relationship between ravenhood and blackness.[[13]](#footnote-13)

The more general point that emerges from the juxtaposition of the two examples is that which mechanism for raven coloration—what specific *means by which ravens are black­—*they will appeal to depends upon the facts they uncover downstream in their empirical research. If the facts point in one direction, the mechanism they will attend to may be ontogenetic as in Strevens’ example. If the facts go another way, it may be phylogenetic as in my modified version. However it goes down, on pain of running headlong into the anamnesis problem, it cannot be said that, prior to the facts coming in, the CP-clause that they tacitly understood to qualify “ravens are black” referred determinately to one or the other kind of mechanism. Further, for the same reason, the particular facts they find downstream cannot be thought to correspond to bits of doppelganger content lurking all along in the shadowy corners of the semantics of “ravens are black.”

So, again, what could it mean to say that we intuitively understand generalizations like “ravens are black” mechanically? The lesson we’ve learned from our discussion of Strevens’ is that it can’t be that we understand the sentence to pick out a particular mechanism nor even a particular kind of mechanism (e.g. phylogenetic vs. ontogenetic) without running into the anamnesis problem. This is precisely why I include the term “underspecific” in my formulation of how we pre-theoretically understand generalizations like “ravens are black”—ravens are black by some *underspecific* yet characteristic means*.* Keeping the lesson we’ve learned from Strevens in mind, let’s turn back to the taxonomic and nomological ways of understanding these generalizations that I set out at the beginning of the inquiry. As I stated in my introduction, these constitute hypotheses regarding how we intuitively understand generalizations like the ones at hand. By further developing these hypotheses and noting the contrast between what they suggest and how we actually understand these generalizations, the latter is thrown into further relief.

  **Section III: Ravens are Black by some Underspecific yet *Characteristic* Means**

Above I blurred the distinction between the taxonomic and nomological ways of understanding generalizations like the ones in question suggesting that they are not as distinct as they might at first appear. I gave a few reasons for thinking so. Here is another one, this one more historical than logical.

In tracing an important thread running through the history of analytic philosophy, Robert Brandom writes:

The Early Modern philosophical tradition was built around a classificatory theory of

consciousness and (hence) of concepts . . . The paradigmatic cognitive act is understood as classifying: taking something particular as being of some general kind. Concepts are identified with those general kinds.[[14]](#footnote-14)

On Brandom’s reading of the history, the development of Frege’s logic – analytic philosophy’s moment of conception – provided the tools for a mathematical explication of the core theory of mind that had animated the early moderns. On this view, thought was understood to be essentially *taxonomic –* concepts are identical to *classes* and reasoning consists in reasoning about these classes, the relations between them, and what belongs in them*.* Frege’s logic lays bare the structure of taxonomic thought and reasoning and so lays bare “the structure of sapience itself.”[[15]](#footnote-15)

The logical positivists were enthusiastic about the prospects of using the new mathematical logic for explicating the structure of scientific theories. In their hands, a formal sentence—e.g. ∀x(Rx 🡪Bx)—that was originally conceptualized, as Brandom tells us, as specifying the structure of taxonomic judgments (being black is a necessary condition on being a raven)was redeployed to explicate the content of empirical generalizations or laws. This represents progress, arguably. There may besome *intuitive* difference between understanding a statement as specifying conditions for category membership and understanding it to specify an empirical law but, when we discipline our unruly intuitive understanding with the new logic, we can appreciate that whatever intuitive difference there may be is illusory. Logic, not our messy human intuitions, is the final arbiter of content. Since “ravens are black” is properly explicated as ∀x(Rx 🡪Bx), and since this formalism recognizes no distinction between a taxonomic and nomological reading, then there just is no such distinction. On a progressive reading of the history, Frege’s logic brings our inherently flawed human understanding to heel and allows us to *discover* that, our erring intuitions aside, there is in fact no difference between the taxonomic and nomological ways of understanding generalizations of the relevant sort.

One may object, however, claiming that I’ve missed the point here. “May I remind you,” goes the objection, “that your task was to interrogate the structure of our *pre-theoretical* *intuitive* understanding of such generalizations. In your telling of the history—a highly cursory and probably false one, I might add—you suggest that there may be a pre-theoretical, intuitive difference between understanding a generalization taxonomically and understanding it nomologically and claim that developments in logic allowed us to discover that that difference is merely an illusion. But, illusory or otherwise, *that difference* is the target of your inquiry and simply calling it an illusion does not an adequate account make.”

This objection is spot on. Simply calling some counter-intuitive consequence of our logic an illusion does not constitute an adequate treatment. If this were the case, Hempel’s Paradox could be solved with a word. So, thanking our objector for the reminder, let’s return to the topic at hand.

In section I, while blurring the distinction between the taxonomic and nomological ways of understanding I suggested that, though it may be that the taxonomic way takes the generalization to be a matter of category and the nomological way, a matter of law, they are both, so to speak, *a posteriori.* What this means is that whatever difference there may be between them, it is not going to be explicable in terms of the way in which the knowledge was acquired—both require fieldwork, after all. This suggests that the place to look is in how the knowledge is structured once gained. What is the difference between structuring this knowledge taxonomically and structuring it nomologically?

Let’s start with the taxonomic way. One simple way to think of it is in terms of a Venn Diagram:

The Venn Diagram encourages us to think of the relation between being black and being a raven expressed in “ravens are black” as being one of *containment*. The category “raven” is *contained within* the broader category of “black things.” This makes sense. We frequently talk about items being “in” a category.

Notice, importantly, that on the taxonomic understanding the raven category is not special vis-à-vis blackness. Just as a real container can contain any number of things indifferently, the category “black things” contains all sorts of subcategories other than the raven one. The raven category holds no pride of place in the “black things” category. That is, *there is nothing that the relation between blackness and ravenhood has*, on this taxonomic way of understanding the generalization, *that the relation between blackness and any other black thing doesn’t have.*

 This is perhaps a bit of a subtle point so here is another way of making it. In mathematics we say that two numbers are *commensurable* when they can be shown to be composable out of the same base units. 5 and 10 are commensurable. We can show this by, for instance, choosing “5” as our base unit. 5 is composed of one “5” and 10 is composed of two “5”s. We can also show this by choosing “1” as our base unit. 5 is composed of five “1”s and 10 is composed of ten “1”s. The prime-ness of prime numbers like 7 consists in the fact that they can only be shown to be commensurable with other numbers by appeal to a base unit of “1.”

 “Properties” understood as things that some particular must bear in order to *count as* a member of some category, are the “base units” out of which members of a category can be composed. Thus, on the taxonomic hypothesis, when we understand “ravens are black” we understand the property “blackness” to be a “base unit” without which a raven cannot be constructed but, equally, a property that can be used to construct indifferently any number of black things. Just like “1,” construed as a base unit, bears no special relation to any of the numbers it can compose—there’s nothing that base-unit-1’s relation to 4 has that its relation to 9 and 368 doesn’t have—“blackness” bears no special relation to ravenhood on this understanding. Again, there is nothing that “blackness’s” relation to ravenhood has that its relation to any other black thing doesn’t have. In other words, “properties” are the interchangeable parts—base units—out of which the world is composed insofar as we “cut it at its joints” taxonomically. The blackness of a raven can be switched out for the blackness of coal which can be switched out for the blackness of the sky at nighttime.[[16]](#footnote-16) The traditional way of putting this is that blackness is the same “universal” instantiated in ravens, coal and the night sky.

 To see this yet another way, consider the way in which we evaluate statements in predicate logic using “models.” We build a “universe of discourse” which consists of a set of “objects.” We further specify “predicates” and determine which predicates are true of which objects in the model. The model may have it that some predicate, F, is true of two objects, *a* and *b*, in the universe. From the point of view of evaluating a sentence with a model, there is just no difference between, on the one hand, the relation between *a* and F and, on the other, the relation between *b* and F. In other words, there is nothing that *a*’s relationship to F has that *b*’s relationship to F doesn’t have and vice versa. It would make no sense to ask after something like a difference in the “manner of connection” between *a* and F and that between *b* and F as, from the point of view of evaluating formal statements using models, the relation between object and predicate is just *predication* indifferently.[[17]](#footnote-17)

 However, it is clear that this taxonomic way of understanding generalizations is not how we intuitively understand them. Consider that we certainly do not respond to coming across exceptions to generalizations in the way we would if we understood them taxonomically. In coming across a white raven in a park, we don’t intuitively diagnose it in terms of a failure with respect to the instantiation of a universal or a failure of predication—“welp, I guess blackness failed to instantiate in that guy.” Or, “what we have here, friends, is a failure of a predication.” Someone who was thusly pathological in their diagnostic inclinations would be an utterly useless partner in inquiry. Further, one who was so inclined would have no resources to diagnose differentially a white raven and a white piece of coal. From the point of view of the taxonomic understanding, both could only be understood as essentially the same failure, a failure of the universal “blackness” to instantiate in the particulars in which it normally and, as I mentioned above, *indifferently* instantiates. Intuitively, we *do* differentially diagnose these two situations. In being confronted with a piece of white coal, no one would ever think to diagnose it with albinism. Our pre-theoretical, intuitive understanding of the relationship between ravenhood and blackness (or coalhood and blackness, for that matter) is therefore more diagnostically fine grained—more *intelligent—*then it would be if it were taxonomic in structure.

C.I. Lewis also recognized this matter of grain but from a slightly different point of view.[[18]](#footnote-18) Transposing his argument into the key of my own analysis, imagine that you point to a box and say of the object inside it, “if that is a raven, then it is black.” It turns out that it is not a raven. Nonetheless, adopting the subjunctive mood, you insist that you had uttered something true: “yes, it’s not a raven but what I said is still true. After all, if it *were* a raven, then it *would* be black.” Plausible enough. But why?

One might think that the plausibility we find in continuing to maintain the truth of the conditional derives precisely from the fact that the antecedent is false. After all, per the truth-tables for “🡪,” if the antecedent is false, then the conditional is true. However, if this were the case, then *any* conditional starting with “if this is a raven . . .,” independent of its consequent, would be equally supported by the fact that the thing in the box isn’t a raven. For instance, you could say, “if this is a raven, then my bratty nephew will grow out of it” or “if this is a raven, then the sky will fall.” If you understood the relation between ravenhood and blackness asserted in your initial conditional to be merely that summed up in the truth-tables for “🡪” you would be as inclined to come to the defense of any of these conditionals, given the falsity of the antecedent, as you in fact were in coming to the defense of the conditional you actually uttered. In fact, there would be no reason for you to even privilege the conditional you actually uttered over any other one with the same antecedent or, further, to limit what you take to be justified in asserting to any one such conditional.

But, clearly, no actual person would respond to realizing that the antecedent of a conditional they just uttered is false by unspooling an infinite list of conditionals with the same antecedent. That would reflect a gross malfunction of human cognition. But, thankfully, our actual understanding of the conditional is, as a matter of fact, more constrained—more *intelligent—*­than that. The plausibility of the defense you gave of your initial statement—the plausibility we find in the idea that the conditional holds even when its antecedent is contrary to fact—relies on more than simply the fact that its antecedent turned out to be false. The relationship between ravenhood and blackness asserted in “if that is a raven, then it is black” is therefore narrower or more fine-grained than what “🡪” means per its truth table.

 Lewis takes this to show that our understanding of generalizations like the ones at hand involves the idea of a “real connection.”[[19]](#footnote-19) For Lewis, the fact that we understand there to be a “real connection” between ravenhood and blackness is what explains why, after finding the antecedent to be false, you would be willing defend your initial claim, “if that is a raven, then it is black,” as still true but *not even think* to defend “if that is a raven, then my bratty nephew will grow out of it.” We don’t understand there to be the sort of connection between ravenhood and our nephew’s unfortunate behavior that would have to be in place in order for such a conditional to even occur to us as relevant under these circumstances. Such a connection *is* in place between ravenhood and blackness however—or so we understand it to be according to Lewis.

For Lewis, this “real connection” is what is not countenanced by the formal explication ∀x(Rx 🡪Bx) of “ravens are black.” For *me*, this difference between understanding the generalization as involving a “real connection” between ravenhood and blackness and understanding that relation as consisting in no more than what the formal “🡪” captures, *marks the difference between the nomological and taxonomic hypotheses.* On the taxonomic understanding, the relation between ravenhood and blackness expressed in “ravens are black” is merely “🡪.” Likewise, on the taxonomic understanding, the relation between a raven and its blackness expressed in B*a,* where *a* is a particular raven, is merely *predication*—precisely the same relation understood, taxonomically, to obtain between a given piece of coal and its blackness as expressed in B*c* where *c* is a particular piece of coal. Both “predication” and “🡪” are *thin*, indifferent formal relations compared to the *thick* relation of “real connection” that the nomological understanding takes to tie objects and their properties together.

However, while I am decidedly sympathetic to Lewis’ view, the mere presence of “real connection” in our intuitive understanding of such generalizations, thick though it may be, is insufficient to explain the fact that we differentially diagnose white ravens and white pieces of coal. Perhaps we understand there to be a “real connection” between ravenhood and blackness, on the one hand, and coalhood and blackness on the other, but the fact that we wouldn’t think to diagnose a white piece of coal with albinism tells us that our intuitive understanding recognizes *differences between* the manners in which they are really connected. This is why, I submit, our intuitive pre-theoretical understanding of the relationship between ravenhood and blackness consists not merely in their being really connectedbut, rather, in a sense of the *characteristic* *means* by whichravens are black. Mirroring the park bench example from section I, in confronting a white raven, our intuitive diagnosis is that there has been a failure with respect to the *underspecific yet characteristic means by which ravens are black.* Our understanding of these means differs from our understanding of the *underspecific yet characteristic means by which* coal is black that is constitutive of our pre-theoretical intuitive understanding of the relation between coalhood and blackness. Albinism, we understand, is just not a way in which the means by which coal is black can break down and so it just wouldn’t occur to us to go there diagnostically in confronting a white piece of coal.

Thus, our intuitive, *mechanical*,pre-theoretical understanding of the relation between ravenhood and blackness expressed in the generalization “ravens are black” takes it to mean that *ravens are black by some underspecific yet characteristic means*. To put this, with some reluctance, in terms that more closely mirror the structure of the relevant formal sentence, ∀x(Rx 🡪Bx) is intuitively understood to mean *ceteris paribus - for all these xs, they are black by some underspecific yet characteristic means, namely, ravenhood*.[[20]](#footnote-20) This same analysis applies to “particular” statements as well. That is, rather than understanding it to be one of “predication,” our intuitive pre-theoretical understanding of the relation between a particular raven and its blackness expressed by a sentence like “this is a raven and it is black” is that this thing is black by some underspecific yet characteristic means, namely, ravenhood.

In my introduction, I mentioned that this should be understood on analogy with how Nancy Cartwright has argued we ought to understand causal concepts. In the same sense as that in which Cartwright thinks our causal concepts are thick, the *means by which* ravens are black that is involved in our pre-theoretical, intuitive understanding of “ravens are black” is thick. But I also said that those means are “underspecific.” You might think that the terms “thick” and “underspecific” work against each other. How could the means by which ravens are black that is involved in our pre-theoretical understanding of “ravens are black” be *both* “thick” and “underspecific?” Isn’t that just oxymoronic?

Let’s look at Cartwright’s view on the matter of “thickness.” In writing on causation, she argues that “accounts that suppose that there is one thing—one characteristic feature—that makes a law a *causal* law” are mistaken. She offers an alternative:

Just as there is an untold variety of quantities that can be involved in laws, so too there is an untold variety of causal relations . . . that we represent most immediately using content-rich causal verbs: the pistons *compress* the air in the carburetor chamber, the sun *attracts* the planets, the loss of skill among long-term unemployed workers *discourages* firms from opening new jobs . . . These are genuine facts, but more concrete than those reported in claims that use only the abstract vocabulary of ‘cause’ and ‘prevent.’[[21]](#footnote-21)

The theories Cartwright sets herself up against—ones that explicate causality in univocal terms e.g. Bayes-nets—overlook the distinctions captured by our rich vocabulary of causal verbs and, in the process, “we . . . lose a vast amount of information that we otherwise possess . . .” To illustrate, Cartwright considers Judea Pearl’s discussion of

an experiment in which soil fumigants, X, are used to increase oat crop yields, Y, by controlling the eelworm population, Z, but may also have direct effects, both beneﬁcial and adverse, on yields beside the control of eelworms. . . . [F]armer’s choice of treatment depends on last year’s eelworm population, Z0 .... . . . the quantities Z1, Z2, and Z3 denote, respectively, the eelworm population, both size and type, before treatment, and at the end of the season . . . B, the population of birds and other predators.[[22]](#footnote-22)

The causal diagram that Pearl uses to represent this situation is presented in (Figure 2):



Figure 2: “A causal diagram representing the effect of fumigants, *X*, on yields, *Y.* Variables: *X*: Fumigants; *Y*: yields; *B*: the population of birds and other predators; *Z0*: last year’s eelworm population; *Z1*: eelworm population before treatment; *Z2*: eelworm population after treatment; *Z0*: eelworm population at the end of the season.

Here is the “thicker” description that Cartwright says we could give of the causal laws operating in this experiment;

Perhaps the soil fumigant *poisons* the infant eelworms, or perhaps it *smothers* the eelworm eggs. . . . Perhaps the fumigant *enriches* the soil or *clogs* the roots. Instead Pearl gives an even thinner description. He replaces all the thick descriptions by one single piece of notation – the arrow.[[23]](#footnote-23)

For Cartwright, and I agree, moving from a description involving multiple distinct content-rich causal verbs to a univocal description given in terms of the formal language of the diagram is a move from a thick to a thin description of the relevant causal reality. Likewise, I claim, when we move from our *thick* pre-theoretical and *mechanical* understanding of “ravens are black” to the formal ∀x(Rx 🡪Bx), we lose thickness. But we can say even more than that. When we move from our mechanical, pre-theoretical understanding of the generalization to ∀x(Rx 🡪Bx) the *means by which* ravens are black in terms of which we understand the relationship between ravenhood and blackness intuitively, drop out.[[24]](#footnote-24) Likewise, precisely what is abstracted away from when we move from Cartwright’s thick description to Pearl’s thin one is the *means* by which the realities represented by the variables in Pearl’s diagram affect one another.

 This move from thick to thin formulations—from involving means to abstracting away from them—is different to the move from specific to underspecific means. Imagine we had an exhaustive account of the ontogenetic mechanism by which ravens are black—every detail of every gene and every turn of every biological pathway from genotype to phenotype laid out in perfectly *specific* fashion before us. The move from that description to the *underspecific yet characteristic* *means by which ravens are black* that is involved in how we intuitively understand “ravens are black” is not a move from thick to thin—not a move from a *means-involving* understanding to a *means-less* one. It’s a move from *specific* to *underspecific* with, as Cartwright puts it, no “thickness” being stripped away in the process. Thus, there is nothing oxymoronic involved in the idea that intuitively we understand “ravens are black” as thick and yet underspecific with respect to the means by which ravens are black.

**Section IV: The Relation Between the Taxonomic, Nomological and Mechanical Understanding**

With all the pieces on the table, we are now in a position to understand the relationship between the various hypotheses regarding how we understand generalizations like “ravens are black” that I have distinguished throughout the paper—the taxonomic, the nomological and the mechanical. The mechanical understanding of “ravens are black” takes the generalization to mean that *ravens are black by some underspecific yet characteristic means.* As we move from this mechanical understanding to the nomological understanding, we retain the *means* but lose their characteristic-ness. As a result, we end up with an understanding of “ravens are black” that is just as thick involving, as it does, a “real connection” between ravenhood and blackness but a “real connection” that is not distinct from that between, say, coalhood and blackness that is involved in a nomological understanding of “coal is black.” In other words, this is not a move from “thick” to “thin,” it’s a move from characteristic to non-characteristic means. As we move from the mechanical to the taxonomic we lose *means* altogether, specific or underspecific, characteristic or otherwise. This *is* a move from “thick” to “thin” as what “thick” means is just *means-involving.* This corresponds to the move from our intuitive pre-theoretical understanding of “ravens are black” to ∀x(Rx 🡪Bx). Thus, the move from the mechanical to the nomological, on the one hand, and from the mechanical to the taxonomic, on the other, are moves made in different directions—the former from characteristic to uncharacteristic means, the latter from means-involving to not-means-involving. Both moves, however, take their departure from the pre-theoretical and intuitive point of view which, as I have argued, is a *mechanical* (i.e. means-involving) one. [[25]](#footnote-25)

So where does this leave us with respect to Hempel’s Paradox? The problem is one that arises in an attempt to squeeze our intuitive, “thick,” means-involving understanding of generalizations like the ones at hand into the “thin” formal apparatus of predicate logic. And anyone who has seen the comedy classic *Tommy Boy* knows what happens when you try to squeeze a fat man into a little coat—it rips.[[26]](#footnote-26)

What about the problem of induction? How do we come to know the generalization “ravens are black” given that we intuitively understand it to mean *ravens are black by some underspecific yet characteristic means?*

Whatever the process is, presumably it starts with the observation of a particular raven. So, imagine that someone who has never seen a raven before looks at this object, notices it is black and is told, “that is a raven.” They come to believe something like “this black thing is a raven.” As I argued above, just as the relation between ravenhood and blackness that is involved in our pre-theoretical intuitive understanding of the generalization “ravens are black” is not fully explicated by “🡪,” so too the relation between a *particular* raven and its blackness is not intuitively understood as mere predication. In both the general case and the particular case, the relation between ravens and blackness is intuitively understood to be thick, i.e. means-involving. That is, what they both mean, from our intuitive, pre-theoretical standpoint, is that this/these thing(s) is/are black by some underspecific yet characteristic means, namely, ravenhood. So, when our hypothetical person comes to believe about a particular raven that “this black thing is a raven” what they understand is that *this thing is black by some underspecific yet characteristic means, namely, ravenhood*. This is the structure of the knowledge of the particular raven that our hypothetical person has acquired. Now when that person is told that there is a raven outside on the lawn and is asked what color they think it is, how will they respond? Naturally, they will say it is black. Why? Because in being taught that the particular black thing that they saw is a *raven* what they learned was that, by some underspecific yet characteristic means (i.e. ravenhood) the thing before them is black. In being told that there is another raven outside, they are being told that those same underspecific yet characteristic means are operating out there. And, so, they make the inference.

Notice, importantly, that there are no categories and no laws, no “generalizations” involved. No foray through a “major premise” is necessary in order for the inference to work. Rather, the entire inferential process happens within the domain of the particular. In other words, our pre-theoretical, intuitive way of making the inference, which is to say, the *actual* way in which we humans make an inference from the *particular* knowledge “this black thing is a raven” to the *particular* conjecture “the raven outside is black” involves no passing through a “major premise” like “ravens, in general, are black.” The means-involving “content,” so to speak, of the knowledge of the particular “this is a raven and it is black” is sufficient bring off the inference—no “generalization” required.

But why would philosophers suppose that humans deploy “generalizations” in the first place? Why suppose that people engage in a process of “induction” by which knowledge of such empirical generalizations is achieved? Though I cannot spell this out in detail here, I suggest that “empirical generalizations” and the process by which we achieve knowledge of them—induction—are two coupled aspects of a venerable philosophical apparatus constructed, in the first instance, to account for a what is indeed a remarkable fact about human knowledge—humans know about particulars that we have yet to encounter. What are the *means by which* this remarkable phenomenon occurs? The standard empiricist picture provides a more or less *specific* answer—the means by which humans know about particulars they have yet to encounter involves, first, using the domain of encountered particulars as a basis on which to inducttheir way up to knowledge of a “generalization.” Once such knowledge is achieved, it can be deployed to extend beyond merely the domain of encountered particulars to the domain of particulars yet to be encountered in the form of “predictions.” But, as Hume pointed out, if this inductivist picture of human knowledge is correct, then skepticism follows—humans are constitutionally incapable of attaining knowledge.

My inquiry suggests an alternative account of the means by which the human understanding extends to particulars it has yet to encounter. It is not because it trades in general categories or general laws or “particular-subsuming” generalizations of any kind. It trades, rather, in mechanics or *means.* Our actual “knowledge of particulars” is more capacious and richly structured than it would be if it were taxonomical or nomological in structure. In actuality, our knowledge of particulars is mechanical in structure and, as such, supports inferences the likes of which have traditionally been taken to involve knowledge of generalizations or “major premises.” And that thing that we philosophers have been calling “generality”—housed in “knowledge of general truths” obtained by way of “induction” and deployed in making “predictions”—is, as it were, *immanent* in knowledge of particulars because knowledge of particulars is ineluctably *means-involving.* What my analysis suggests, in short, is that there is no such thing as induction. And if there is no induction, there is no problem of induction nor are there any of the “local” problems that attend attempts at formalizing induction—Hempel’s Paradox being a case in point.

1. Goodman, N. (1983). *Fact, fiction, and forecast*. Harvard University Press. [↑](#footnote-ref-1)
2. Cartwright, N. (2004). Causation: One word, many things. *Philosophy of Science*, *71*(5), 805-819. Her notions of “thick” and “thin” are discussed in detail in section III. [↑](#footnote-ref-2)
3. Ibid., 814-815. [↑](#footnote-ref-3)
4. Popper, K. R. (1971). Conjectural knowledge: My solution of the problem of induction. *Revue internationale de Philosophie*, 167-197. [↑](#footnote-ref-4)
5. This first exchange regarding “freezing” is meant to establish the nephew’s smarmy character. He is *that guy.* As philosophers, we all know *that guy.* In fact, as my partner is keen to point out regarding my own case, becoming *that guy* may be something of an occupational hazard for us. [↑](#footnote-ref-5)
6. For more on “wonder” and “horror” in philosophy and science see the magisterial: Daston, L., & Park, K. (1998). *Wonders and the Order of Nature, 1150-1750* (p. 120). New York: Zone books. [↑](#footnote-ref-6)
7. It should be noted that I do not intend my use of the term “mechanism” here to allude to any particular account of mechanism in the philosophical literature. At this point in the analysis, I use it simply to distinguish this third hypothesis regarding how we pre-theoretically understand generalizations like the ones at hand from the taxonomic and nomological hypotheses. In other words, I do not mean to suggest that one’s response to confronting the floating park bench would be to seek an account specifically in terms of “entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions” (MDC 2000) or in terms of “a structure performing a function in virtue of its component parts, component operations, and their organization” (Bechtel and Abrahamsen 2005). These conceptions of mechanism are philosophically downstream from where we are at in our analysis at present and there is no need to get ahead of ourselves. The response, as I stated above, would be to seek the *means by which* the exception to the generalization is occurring. It may be that, after inquiring into the matter, we settle on an account that would count as a mechanistic explanation by the lights of the philosophers alluded to above. But, if we ended up finding out that it’s a matter of divine intervention then *that* would be the relevant means - or, the *mechanism* - in the broader sense of “mechanism” that I intend. Machamer, P., Darden, L., & Craver, C. F. (2000). Thinking about mechanisms. *Philosophy of science*, *67*(1), 1-25. Bechtel, W., & Abrahamsen, A. (2005). Explanation: A mechanist alternative. *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences*, *36*(2), 421-441. [↑](#footnote-ref-7)
8. Strevens, M. (2012). Ceteris paribus hedges: Causal voodoo that works. *The Journal of Philosophy*, *109*(11), 652-675. [↑](#footnote-ref-8)
9. *Ibid.* [↑](#footnote-ref-9)
10. Ibid., 675. [↑](#footnote-ref-10)
11. But there is a certain *direction* to Strevens’ analysis, a *loop* that it follows, that from the point of view of my analysis, is superfluous. As I have argued, we already *pre-theoretically* understand generalizations like “ravens are black” as countenancing exceptions. We do violence to that understanding when we formalize in it a way that renders it exceptionless – i.e. when we explicate it as ∀x(Rx 🡪Bx). Tacking a CP-clause in front of this in reparation would be unnecessary if the violence hadn’t been committed in the first place. In the end, Strevens’ analysis seems to come full circle when he claims that his view applies even to unhedged generalizations suggesting that they are tacitly CP-hedged to begin with. But we had to pass through a cycle of violence and reparations to get there. And even then, characterizing our intuitive understanding of such generalizations in terms of their being *tacitly CP-hedged* is a way of characterizing it that still bears the mark of that cycle. [↑](#footnote-ref-11)
12. We can make this same point without going all the way back to the Meno. Imagine that as the scientists in Strevens’ example leave their lab to set out and study ravens in the field, a security guard in the building asks them, “are ravens black?” The scientists respond, “indeed ravens are black.” The security guard, who is a compulsive gambler and a persuasive man, convinces them to put 50 dollars on the matter. They all shake on it. Then, the situation plays out as Strevens describes. The scientists discover the grey ravens and find that their habitat contains the industrial pollutant and learn that the pollutant blocks a metabolic pathway and prevents the normal development of black plumage. They return home to their lab and present their findings to their colleagues. After their talk, the security guard approaches them, holds out his palm, and asks for his fifty dollars. The scientists refuse to pay saying that, while they were not in a position to appreciate it at the time, when they said, “indeed, ravens are black” that statement contained an opaque rider and, so, what they actually meant was “ravens are black *provided there is no significant amount of ABC in the ravens environment.”* They were unaware of this bit of content at the time – that rider was opaque to them - and they argue that bets made under conditions of “ignorance” are not binding. Understandably, the security guard rolls his eyes and reflects on how these scientists remind him of his bratty nephew. The implausible version of Strevens’ view takes the scientists’ smarmy rationalization to mirror the actual truth of the matter. [↑](#footnote-ref-12)
13. Given the complexity of issues regarding taxonomy in biology and the concept of “species,” the way such findings would lead researchers to update their understanding of the relationship between ravenhood and blackness is likely much more complicated than my brief discussion here suggests. I confined my discussion to match the scope of Strevens’. Ereshefsky, M. (2007). Species, taxonomy, and systematics. In *Philosophy of biology* (pp. 403-427). North-Holland. Hull, D. L. (2010). *Science as a process: an evolutionary account of the social and conceptual development of science*. University of Chicago Press. [↑](#footnote-ref-13)
14. Brandom, R. (2009). How analytic philosophy has failed cognitive science. *TAP-2009 Towards an Analytic Pragmatism*, 121. [↑](#footnote-ref-14)
15. *Ibid.* [↑](#footnote-ref-15)
16. This is just another way of saying that the “raven” category, the “coal” category and the “nightsky” category all fall under the more general “black things” category indifferently. [↑](#footnote-ref-16)
17. This point could perhaps be put in terms of Hasok Chang’s “ontological principle – epistemic activity pairs.” Chang illustrates the idea using the “epistemic activity” of counting as an example. Counting things is only an intelligible activity insofar as the things to be counted are assumed to be discrete. That is, if things were all continuous with one another – if “all were one” – then counting wouldn’t make any sense. The epistemic activity of predicate logic requires, as its ontological correlate, that relations between properties and the objects that bear them be “predication.” This ontological principle is, in part, what makes intelligible predicate logic as an epistemic activity. Chang, H. (2009). Ontological principles and the intelligibility of epistemic activities. *Scientific understanding: Philosophical perspectives*, 64-82. [↑](#footnote-ref-17)
18. Lewis, C. I. (1946). An Analysis of Knowledge and Valuation (La Salle, Illinois. *The Open Court Publishing Company*, *45*(19), 524-532. [↑](#footnote-ref-18)
19. Lewis, *Ibid*., 212. Here is a representative quote from Lewis expressing his core idea: The relation of ‘*A*’ to ‘*E*’ in “If *A* then *E*” is *not* justly interpreted as the relation of material implication which many current developments of logic take as fundamental; it is *not* what is called in *Principia Mathematica* a formal implication; and it is *not* a strict implication or entailment such that ‘*E*’ is, assertedly, deducible from ‘*A*’. It *is* generically the same kind of relation which Hume had in mind when he spoke of ‘necessary connections of matters of fact’. And Hume, as we remember, affirmed that no such relation can be established as holding; though, as we also remember, he made no doubt that it is such a relation which is *asserted* as often as any objective fact or anything going beyond presentations of sense is taken to be empirically known. And whatever objections may be raised against Hume’s analysis on other points, on this point of meaning he was exactly right. [↑](#footnote-ref-19)
20. For an explanation of my reluctance, see fn. 12. Also note that, a primary point of my discussion is to point out how the formal exposition of the structure of a sentence like “ravens are black” does not mirror the structure of our intuitive understanding of it. It should not be surprising, then, the attempting to articulate the structure of our intuitive understanding of such sentences in terms that mirror the structure of the relevant formal sentence will yield an awkward locution. [↑](#footnote-ref-20)
21. Cartwright, ibid., 814. [↑](#footnote-ref-21)
22. Pearl, J. (1995). Causal diagrams for empirical research. *Biometrika*, *82*(4), 669-688. [↑](#footnote-ref-22)
23. Cartwright, Ibid., 816. [↑](#footnote-ref-23)
24. This is precisely why we find it counter-intuitive to think that the falsity of a conditional’s antecedent justifies believing any conditional with that antecedent whatsoever. Logic tells us that we are so justified:

P 🡪 Q. 2) Not-P. 3) Therefore, P🡪 Ψ

where Ψ is any sentence letter is a deductively valid inference. Abstracting away from *means* (“real connection” if you’re Lewis)is precisely what enables 3) to follow from 1) and 2). Yet, it is precisely for this reason that the idea that 3) follows from 1) and 2) is counter-intuitive. [↑](#footnote-ref-24)
25. The world understood nomologically is how Hume thinks we understand the world after custom and habit have had their effect. Hume would thus endorse the nomological hypothesis. He doesn’t think this is a *justified* worldview, but he thinks it’s the one we have nonetheless. But Hume is fundamentally incorrect. We do not understand the world nomologically, we understand it mechanically. [↑](#footnote-ref-25)
26. I sympathize with readers who may feel that this moment in the paper calls for rigorrather than wit*.* After all, this is precisely the moment when the framework developed over the course of the discussion is applied directly to the motivating problem. While I agree that a more rigorous discussion is in order, in this paper, my priority is exposition of the framework. I leave lengthier discussion of its application to Hempel’s problem (and others) for another paper. [↑](#footnote-ref-26)