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Coherentism and the Material Theory of Induction

John D. Norton
http://www.pitt.edu/~jdnorton

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1. Introduction

On the large scale, relations of inductive support within the material theory of induction are non-hierarchical and admit circles. In this aspect, these relations are similar to the relations of justification within coherentist theories of epistemic justification in epistemology. This was, to me, a welcome coincidence and offered the possibility that the coherentist literature would be useful in addressing outstanding issues in the large-scale structure of material relations of inductive support. Are circularities in the overall structure troublesome? Are they vicious? Do they leave inductive structures underdetermined? These questions do have satisfactory answers within the material theory. They have been developed in the two preceding chapters. In developing these solutions, it became apparent that the coherentist literature was consistently unhelpful in solving these problems. Further investigation showed that this was no mere oversight by coherentist philosophers. Rather the framework of coherentism in epistemology is sufficiently different from that of the material theory of induction that its problems are only similar to those of the material theory, but not identical. Moreover, the resources accessible to coherentist analysis prove to be weaker than those accessible in the material theory, so that coherentists can at best provide weaker solutions to the problems.

This chapter will review the similarities and dissimilarities between the two approaches with the purpose of substantiating the appraisal just given. Section 2 below will recall the basic claims of coherentist theories of justification and Section 3 will note the aspects in which they are similar to the large-scale structure of relations of inductive support of the material theory. Section 4 will catalog the many dissimilarities. Coherentism is holistic, whereas the material

theory is local (Section 4.1). Coherentism takes global coherence as its basic relation, where the material theory takes a local relation of inductive support as its basic relation (Section 4.2). Coherentism defines itself by its opposition to foundationalism in epistemology. As a result, it faces significant difficulties in accommodating the role of the world in its justifications. The material theory has no corresponding problem. (Section 4.3) Where the material theory is a theory of inductive logic independent of human cognition, coherentism takes beliefs as the relata for relations of justification and must in addition give an account of how these relations appear in an agent's cognition. (Section 4.4). Finally, in a lesser concern, the common exemplars of beliefs for coherentism are prosaic beliefs in ordinary life. The material theory is designed to be an account of evidential relations in the sciences. The result is that coherentists identify different problems from material theorists as pressing and emphasize different aspects of the relations of support. (Section 4.5)

Section 5 reviews the common problems facing both coherentism and the material analysis: Are the circularities in their structures harmful? Do these structures allow multiple, equally admissible systems? How does the world inform the relations of support and justification? Are the structure's justifications indicative of truth? In their efforts to answer to these problems, it is argued that coherentism has fared poorly, where the material theory has not.

Sections 6 reviews the recent Bayesian literature on coherentism. The primary goal of that literature is to vindicate or disprove the idea that overall coherence leads to truth-conducive justification. That means that it proceeds from the holism of coherentism. Since the material analysis of the large-scale structure of inductive support is not holistic, the Bayesian analyses are tangential to it. Section 7 arrives at a negative appraisal of the entire Bayesian project of examining coherentism. It is misplaced, since the notion of coherence is not itself a probabilistic notion. The probabilistic formalization is premature since the notion of coherence remains poorly articulated. And finally, it follows from the material theory of induction that a probabilistic framework is not general enough to provide any universally applicable results on coherence. Claims of such results are ill-founded.

2. Coherentist Theories of Epistemic Justification

Coherentist theories of justification came to prominence in the later part of the twentieth century through the work of several philosophers, most notably Keith Lehrer (1974, 1990, 2000)

and Laurence BonJour (1985). The literature seems to have lost its momentum in the early 2000s. Presumably part of the reason was that BonJour (1999) abandoned the approach after recognizing the gravity of the problems facing it.[1] The coherentist approach was subsequently revived by Bayesians, notably Bovens and Hartmann (2003) and Olsson (2005). These Bayesian accounts proceed from the assumption that a coherentist approach is already at hand. They seek to express and assess the core notion of coherence in probabilistic terms. Often, their results contradict coherentism. My impression is that BonJour's (1985), *The Structure of Empirical Knowledge*, provides the best articulated version of coherentism and in a form that can be connected most readily with the concerns of the material theory of induction. Hence, I will draw on his treatment.

The coherentist theories of justification (here, henceforth just "coherentism") should be distinguished from a coherentist theory of truth, such as is articulated in Rescher (1973). The latter gives an account of what it is for a proposition to be true,[2] whereas the coherentist theories of justification seek only the grounds under which an agent is justified in holding a belief.

The core claim of coherentism has been stable over the decades. Lehrer (1974, p. 154) gives it as

> … justification is a reciprocal relation of coherence among beliefs belonging to a system. According to a coherence theory, a belief is completely justified if and only if it coheres with a system of beliefs.

More recently, Olsson (2017) in his article in the *Stanford Encyclopedia of Philosophy* gives it as:

> According to the coherence theory of justification, also known as coherentism, a belief or set of beliefs is justified, or justifiably held, just in case the belief coheres with a set of beliefs, the set forms a coherent system or some variation on these themes.

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[1] Murphy (2020, §6) "With the exception of work being done by Bayesians, few epistemologists are presently working on coherentism." BonJour (1999, p. 139) "… coherentism is pretty obviously untenable, indeed hopeless…"

[2] Bonjour (1985, p.88, his emphasis): They "hold that truth is to be simply *identified* with coherence."

The stipulation (Lehrer) "if and only if" and (Olsson) "just in case" is strong and will prove troublesome. It reflects the conception of coherentism as the alternative to foundationalism. In the foundationalist conception, beliefs are justified inferentially by other beliefs. A regress ensues as we trace back along the chains of the justificatory inferences. The regress is halted by positing basic beliefs that terminate the chains, since are not themselves justified inferentially. The obvious candidate for these basic beliefs are those somehow given to us directly by experience. This direct connection with experience is what allows us or even compels us to accept them. The existence of some form of basic beliefs is the distinctive thesis of foundationalists.

In opposing foundationalism, coherentists seek to escape the regress argument by denying the linearity of relations of justification. Instead of tracing the chains of justification back to these anchoring beliefs, coherentists urge that tracing the chains merely takes us on a tour of our system of beliefs that will eventually cycle back to our starting point. There is no need for terminal beliefs to anchor our chains of justification. All that is needed is that our full system of beliefs forms a coherent system.

3. Similarities

It is in the articulation of this last conception that coherentist writing comes closest to resembling the description of Chapter 2 here of large-scale relations of inductive support in the material theory of induction. BonJour (1985) introduces the coherentist escape from the foundationalist's regress argument as follows (pp. 91-92, his emphasis):

> According to the envisaged coherence theory, the relation between the various particular beliefs is correctly to be conceived, not as one of linear dependence, but rather as one of mutual or reciprocal support. There is no ultimate relation of epistemic priority among the members of such a system and consequently no basis for a true regress. Rather the component beliefs of such a coherent system will ideally be so related that each can be justified in terms of the others, with the direction of argument on a particular occasion of local justification depending on which belief (or set of beliefs) has actually been challenged in that particular situation. And hence, a coherence theory will claim, the apparent circle of justification is not in fact vicious *because it is not genuinely a circle*: the

> justification of a particular empirical belief finally depends, not on other particular beliefs as the linear conception of justification would have it, but instead on the overall system and its coherence.

Correspondingly, as we saw in Chapter 2, the material theory of induction introduces a large-scale structure of relations of inductive support that is non-hierarchical and contains circles of dependency of all sizes.

4. Dissimilarities

While the similarities noted in the last section are striking, there are many dissimilarities between coherentism and the material theory of induction. They differ on so much that they are best understood as distinct theories. This section will review the main differences.

4.1 Holism versus Localism

BonJour (1985, p. 91) distinguishes "local" and "global" levels of justification. The local level contains justifications for a belief or small set of them that take the larger belief system for granted. The global level concerns the justification of the belief system in its entirety. It is this global level, BonJour argues, that has been neglected and becomes the basis of coherentism. He had earlier given priority to the global over the local (p. 24):

> According to a holistic view [coherence theory], it is such a system of beliefs which is the primary unit of justification; particular beliefs are justified only derivatively, by virtue of membership in such a system.

He then insists on the importance of the global level for *any* admissible view (p. 91):

> For the sort of coherence theory which will be developed here—and indeed, I would argue, for any comprehensive, nonskeptical epistemology—it is the issue of justification as it arises at the latter, global, level which is in the final analysis decisive for the determination of empirical justification in general.

More tersely, Bonjour (p.103) avers that "the basic unit of justification for a coherence theory is an entire system of beliefs."

The conception is holistic. The justification of a belief derives from its relationship to a belief system that is, in its totality, coherent. This large-scale coherence is constitutive for justification.

This holistic conception brings recalcitrant problems for coherentism. For the strength of a belief system is gauged by its coherence at the global level. The obvious and immediate difficulty is that systems can vary in the strength of their coherence in different parts. How are these varying strengths to be combined into a single global measure? There are many ways to provide synoptic measures of a varying quantity. When the quantities are numerical, we can choose among arithmetic means, geometric means, medians, modes and much more. Since we do not have a precise measure of coherence, we cannot even begin to ask which is the appropriate synoptic assessment. Thus, the strength of the justification of any particular belief in the system depends on a univocal judgment of the strength of its coherence, where no such univocal judgment is available. The problem is compounded when we seek to decide among competing belief systems. We must arrive at judgments of each system's coherence clear enough to sustain univocal comparison.[3] This difficulty will return below when we report that Bayesians have found it impossible to identify a single probabilistic measure of coherence.

The material theory of induction is, by its constitution, a local theory. It inverts BonJour's conception of the global as the primary unit and the local as derivative. That is, materially, the basic relation is the inductive support accrued to each proposition by the evidence and warranting facts. The totality of all these relations is the large-scale structure. Whatever notion of support applies to this structure as a whole is derivative. It results from the combination of the local relations of inductive support. Similarly, that there are circular interdependencies is not constitutive of inductive support. It is a derivative result recovered only after all the local relations of inductive support are combined.

Since the material theory does not anchor the support of individual propositions to the coherence of the entire system, it escapes the difficulty just sketched for coherentists. The inductive support for some proposition is in turn dependent on the inductive support for its evidence and warranting fact. We can trace this support back through the support for further propositions and may end up touring through much of the pertinent science. The overall strength

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[3] BonJour (1985, pp. 93-94, his emphasis) concedes this problem: "But the main work of giving such an account [of coherence], and in particular one which will provide some relatively clear basis for *comparative* assessments of coherence, has scarcely been begun, despite the long history of the concept."

of support for the original proposition derives from the summation of these relations of support. These summations can deliver different overall strengths of inductive support for different propositions. They do not depend, as a holist would require, on a single measure of the coherence of the science as a whole.

Thus the material theory accommodates cases of sciences in which coherence is strong in some places but not in others. It allows the strength of inductive support for individual propositions to reflect these differences, as it should if coherence matters at all.

Quantum mechanics is one of our most successful scientific theories. It underpins much of modern science, from particle physics, to the physics of condensed matter and semiconductors, to modern theories of chemical structure and reactions; and more. However, in places it lacks coherence. Most notably, quantum measurement is a recalcitrant unsolved problem. There are multiple, competing accounts of it. Their persistence is a clear sign that none is correct or, at least, that none is demonstrably so. A second area of difficulty is that quantum field theory breaks down at sufficiently high energies. This is revealed by the appearance of infinite energies whose presence needs to be controlled by computational techniques such as renormalization.

These weaknesses reflect a lack of coherence in those parts of quantum theory. They will affect some results of quantum theory more than others. These differences will then be reflected in differences of inductive support assigned by the material theory. For example, quantum theory has met with extraordinary success in accounting for the emission spectra of the elements. According to the material theory, the support for this account propagates through much of quantum theory. It does so in a way that is insensitive to the vagaries of quantum measurement and thus can be very strong. Matters are different with the familiar claim that quantum measurement as "collapse of the wave packet" consists in an instantaneous effect that has propagations faster than light. The strength of inductive support for this superluminal propagation in turn depends on the strength of support for this particular approach to quantum measurement. Its status remains unclear and there are competing accounts of quantum measurement that do not include this collapse as a physical process.

The differences in inductive support for these two propositions is recovered fully from summation of the iterated supports. Neither is traced back to a univocal measure of the coherence of quantum theory as a whole.

4.2 Coherence versus Inductive Support

The problems just sketched for coherence theories derive from the supposition that coherence is assessed holistically. Those problems are compounded by a lack of a clear articulation of the notion of coherence, whether understood holistically or locally. At an intuitive level, the idea is simple enough. Coherence is a matter of how well "a body of beliefs 'hangs together'…," to use BonJour's (1985, p. 93) expression. Giving a clearer account, however, presented BonJour with so many obstacles that he began with a disclaimer that his response is "deliberate—though I think, justified—evasion." (p. 94) What follows (pp. 94-100) is a four component "outline" of the notion of coherence. A system of belief is coherent to the extent that it is:

- logically consistent;
- probabilistically consistent;
- explanatory;
- and includes significant conceptual change.

Logical and probabilistic consistency are enhanced by the extent of inferential relations among beliefs. The explanatory strength of the system rises as the extent of the explanatory anomalies falls. Finally, the inclusion of significant conceptual change is justified by noting that such changes commonly come with scientific advances.

The difficulties of this outline are all too clear. Since it depends on four conditions, the possibilities for internal conflict are great. For example, the early forms of quantum theory in the first decades of the twentieth century were extraordinarily explanatory. That was their appeal. However, equally clearly, they were logically inconsistent.

The deeper problem is that the articulation of the notion of consistency now depends on further theories, most notably of probability and explanation. The presumption is that, elsewhere, there are cogent accounts of each.[4] That is not so. These are troubled notions. I spent considerable effort in *The Material Theory of Induction* in showing that these notions fail to function as routinely expected. There is a default presumption that, whenever we have some sort

[4] BonJour (1985, p. 93) writes: "Thus various detailed investigations by philosophers and logicians of such topics as explanation, confirmation, probability, and so on, may be reasonably taken to provide some of the ingredients for a general account of coherence."

of uncertainty or indefiniteness, then probabilities capture it. Chapters 9-16 were devoted to showing that this presumption has no good foundation and leads to mistaken judgments. As to explanation, there is no single, universal understanding of the term. Chapters 7-8 argued that there is no distinctive notion of explanation that proves able to power inductive support, even in the canonical and celebrated examples of inference to the best explanation.

BonJour has no stomach for any real defense of his account. "A fully adequate explication of coherence," he admits (1985, p. 93), "is unfortunately not possible within the scope of this book (nor, one may well suspect, within the scope of any work of manageable length)." Matters have not improved by the time of the writing of BonJour (1999) where he tells us that (p. 124) "the precise nature of coherence remains a largely unsolved problem."

Lehrer (1990, 2000) offers a different account of coherence. It is narrower and takes explanation as the core notion within what he calls (Ch.5) "The Explanatory Coherence Theory of Truth." The basic definition is (2000, p. 105):

> *S* is justified in accepting that *p* if and only if the belief of *S* that *p* is consistent with that system *C* of beliefs having a maximum of explanatory coherence among those systems of beliefs understood by *S*, and the belief that *p* either explains something relative to *C* that is not explained better by anything which contradicts *p* or the belief that *p* is explained by something relative to *C* and nothing which contradicts it is explained better relative to *C*.

Impressive as this definition appears, its content is obscure as long as the core notion of explanation invoked in it remains vague. Subsequent discussion of the then current state of accounts of explanation prove to be no help in clarifying the notion. Lehrer reviews the "immense literature" on the topic and arrives at the sober conclusion (2000, p.106):

> This literature illustrates most clearly the futility of hoping to find an explication of explanation to which we can fruitfully appeal in our articulation of the explanatory coherence theory.

Lehrer (1999) provides a correction to his earlier accounts.[5] Using formulations similar to his (1990, Ch.6; 2000, Ch. 6), coherence is derived from the notion of an "acceptance system." He writes (p. 247)

> To summarize, my acceptance of *p* coheres with my evaluation system if and only if all objections to my acceptance of *p* are beaten or neutralized on the basis of my evaluation system.

There is considerable discussion of how this coherence with the evaluation system is to be understood. The overall import is not clear, at least to me. Lehrer allows (p. 246), for example, that logical inconsistency does not preclude further acceptance. There are repeated allusions to what is "reasonable," while "reasonable" is left as primitive term.[6] Curiously, the notion of explanation has all but disappeared from the account.

Thagard's (2000) account of coherence as constraint satisfaction is heavily influenced by computational perspectives. It is a significant work that deserves more attention than I have space here. However, it shares the weakness of other accounts discussed here. It relies on further relations whose nature is unclear. The constraints that figure centrally in the account include those expressed in terms of explanatory and analogical relations. Their import is translated into summable weights that provide an holistic measure of the system's overall coherence. (See for example pp. 7, 38, 43.) Explanation and analogy are commonly invoked in such discussions, while their principled nature and relation to inductive support remains obscure, as I have argued at some length in *The Material Theory of Induction*, Ch 4, 8 and 9.

In sum, these accounts of coherentism are compromised by a failure to articulate clearly the core, global notion of coherence. Their efforts rely on invoking local relations, notably probabilistic and explanatory relations, while neglecting to give cogent accounts of them or admitting that none are at hand.

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[5] It is presumably Lehrer (1990), although the second edition Lehrer (2000) has only minor changes.

[6] An earlier treatment, Lehrer (1989) based coherence on a notion of "comparative reasonableness." Lehrer (p. 253) suggests that comparative reasonableness could be explicated in terms of comparative expected epistemic utility "but no such account, including ones I have articulated, strikes me as quite adequate to my purposes."

The material theory of induction faces no comparable problem. Its core notion is not global, but the local relation of inductive support. That notion has been elaborated extensively in *The Material Theory of Induction*. The material theory succeeds just where coherentism fails. For the material analysis of probabilistic, explanatory and analogical relations, as they figure in evidential support, supercedes the vaguer notions appealed to by BonJour and Lehrer above.

4.3 Coherentism versus Foundationalism

A principal motivation of coherentism is its opposition to foundationalism. The latter, as we saw above, asserts that there are certain basic beliefs that are foundational in the sense that they do not require further justification for belief. This concept has proven to be the Achilles heel of the view. It leads directly to what BonJour calls the "input objection" (1985, p. 108) or the "isolation objection" (1999, p. 127). It is the obvious problem that one can have entirely fictional narratives that exhibit considerable coherence while having nothing to do with the real world. Creating such artifices is the trade of writers of fiction. In BonJour's (1985, p. 108) version, it asserts:

> Nothing about any requirement of coherence dictates that a coherent system of beliefs need receive any sort of input from the world or be in any way causally influenced by the world. … Such a self-enclosed system of beliefs, entirely immune from any external influence, cannot constitute empirical knowledge of an independent world…

The difficulty facing coherentists is that they need to allow for input from the world without conceding to foundationalists. Chapters 6 and 7 of BonJour (1985) contain a labored, extended struggle to allow worldly input to beliefs without being forced to this concession. The result, as summarized by Murphy (2020, §5a), is that this input arises through "cognitively spontaneous beliefs" that arise non-voluntarily and also an "observation requirement" that stipulates that such input is required.

This challenge of allowing wordly input without conceding to foundationalists has been a defining issue for coherentism. It is, as far as I can see, based on a false dilemma that demands that we choose either to be coherentists or foundationalists. Haack (1993) has argued cogently that a quite serviceable epistemology arises from a combination of foundationalist and coherentist positions. Her "foundherentism" is initially formulated as (p. 19):

> Foundherentism may be approximately characterized thus:

(FHl) A subject's experience is relevant to the justification of his empirical beliefs, but there need be no privileged class of empirical beliefs justified exclusively by the support of experience, independently of the support of other beliefs;

and:

(FH2) Justification is not exclusively one-directional, but involves pervasive relations of mutual support.

The material theory of induction is almost entirely indifferent to this issue, which has so controlled coherentist thinking. On the local level, the theory proceeds without any need for input from the world. The theory can authorize inductive inferences in mathematics.[7] When treating the large-scale structure of inductive support for a science, the analyses of this volume do presume that science is empirical. That is, that the content of the science is to be supported by empirically accessible facts of the world. That condition is essential to the argument of Chapter 4 for the uniqueness of the inductive structures of a mature science. According to it, the decision among competing theories will eventually be made empirically, as long as those theories are genuinely distinct empirically.

This application of the material theory requires only that the overall system of propositions in some way gains input from the world in order that the resulting science is empirical. The epistemologies presently under discussion are foundationalism, coherentism modified to allow wordly input and foundherentism. All allow for input from the world. In so far as each of their schemes can be reimplemented within relations of inductive support, the material theory of induction can work with all of them.

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[7] Goldbach's unproven but widely believed conjecture is that any even number can be expressed as a sum of two prime numbers. A familiar heuristic argument for it notes that, the larger the number, the more ways it can arise as the sum of two numbers, which increases the chances that two of them are prime. This is an inductive argument warranted by the supposition that the two numbers summed are distributed independently enough of the distribution of primes that it is highly likely always to include a pair of primes. For this and more examples, see Franklin (2013, p. 18).

Indeed, coherentism and material theory differ in the role that circularities play in their structures. For coherentism, the circularities among relations of justification arise explicitly as a way to block the foundationalist regress argument for basic beliefs. (For example, see BonJour's introduction of circularities in his (1985, p. 87).) For the material theory, as we saw in Chapter 2, circularities block a different regress argument. Without them, warranting facts would require further warranting facts of ever greater generality.

4.4 Beliefs versus Propositions

A major difference, implicit in the discussion above, will now be made explicit. It concerns the relata of the relations of justification or inductive support. For coherentists, the relata are *beliefs* consciously held by some agent. For the material theory of induction, the relata are the *propositions* of an inductive logic, independent of any agent's thoughts. There is no presumption that these propositions are the objects of belief in any consciousness. Both BonJour and Lehrer are internalists in their coherentism. That is, the justification of some belief must be accessible cognitively to the agent. In this regard they are closest to the relations of inductive support of the material theory of induction, for it is also supposed that these relations can be made explicit. In an externalist version of coherentism, if there is such a thing, the justifications of beliefs would not always be accessible.[8] They may arise through some causal process that connects with the world, while that process is not cognitively accessible to the agent.

This difference adds a burdensome extra layer of complications to coherentism. Here is how BonJour (1985, p.102) expresses it:

> But if the fact of coherence is to be accessible to the believer, it follows that he must somehow have an adequate grasp of his total system of beliefs, since it is coherence with this system which is at issue. One problem which we will eventually have to confront is that it seems abundantly clear that no actual believer possesses an *explicit* grasp of his overall belief system; if such a grasp exists at all, it must be construed as tacit or implicit, which creates obvious problems for the claim that he is actually, as opposed to potentially, justified.

[8] BonJour (1985, pp. 101-102) dismisses an externalist coherentism as unacceptable since it would be weaker than an externalist foundationalism.

That the relations of justification must be consciously thought or at least cognitively accessible[9] to some agent does indeed visit problems on coherentism (and internalist epistemologies in general). The difficulties are so well known that I need only briefly mention them here. Such epistemologies face a dilemma. Are the justificatory relations those of an ideally rational agent? Or are they those of the actual cognitive processes of real people?

If the relations are those of ideal rationality, then the normative injunctions of the theory are unrealizable by ordinary human cognition. For establishing the logical consistency of even a fairly small set of beliefs is so computationally burdensome that ordinary minds cannot do it.[10] These complications arise already in the easiest case of deductive relations. They will be no easier when it comes to securing probabilistic and explanatory consistency as varieties of coherentism require.

If, instead, coherentism pertains to the actual reasoning processes of human agents, then the method of analysis is misplaced. How we humans actually reason is properly the subject of empirical psychology.[11] A long-standing and well-established tradition in empirical psychology has shown just how poor we folk are in ordinary deductive and probabilistic reasoning.[12] That we human reasoners conform with the conditions of coherence requires that we have achieved deductive and probabilistic consistency in our belief systems or aspire to it. According to empirical studies in psychology, this goal seems beyond the reach of most human agents.

BonJour does not, as far as I can see, directly address this dilemma. Instead he identifies a reflexive concern of the type that seems to trouble inward looking philosophers, but few others. The believer must have a correct grasp of the believer's own system; and the correctness of this grasp is in turn a further belief that requires justification. The impending regress is blocked, according to BonJour, by a *presumption*, called the "Doxastic Presumption." Its content is

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[9] For example, BonJour (1985, p. 19, his emphasis) writes: "A person for whom a belief is inferentially justified need not have explicitly rehearsed the justifying argument in question—to others or even to himself. … What is required is rather that the inference be *available* to the person in question, so that he would be able in principle to rehearse it …"

[10] For details, see Cherniak (1984).

[11] Goldman (1985) has investigated the relationship of epistemology and psychology.

[12] For a small sample of this enormous literature, see Kahneman et al. (2002).

developed over several pages and, in one formulation (p.105), asserts: "I assume that the beliefs constituting my overall grasp of my system of beliefs are, by and large, correct."

If the material theory of induction is conceived most abstractly merely as a codification of inductive logic, then it escapes all these problems. There is no requirement that its relations of inductive support are to figure in their totality in some agent's consciousness. This abstract conception, however, brings the danger that the theory is one of ideal rationality as inaccessible to human agents as the ideal rationality of coherentism. While that danger is present, the burden taken by material theory is considerably less than that of coherentism.

In the simplest cases, the material theory allows scientists to answer specific questions. Does the evidence of the cosmic background radiation provide more support inductively for big bang cosmology than steady state cosmology? The material theory of induction can answer that question without taking on the burden of establishing the coherence of the entirety of the scientist's belief system.

The more complicated case does concern the entirety of the inductive support for a particular science. Is it, informally speaking, coherent? Coherentism requires a single agent to be able to affirm coherence for the totality of that agent's belief system. The corresponding coherence of the evidential support of a science does not reside in the satisfaction of some overarching concept of coherence. Rather it is simply the summation of many local relations of support, such that, in mature sciences, each proposition is well supported. Since the overall burden consists merely of many local parts, there is no requirement that any individual scientist has a grasp of their totality. Rather the task is distributed over the entire community of scientists. For a modern science of any depth, this distribution is inevitable, for full comprehension of all the details of its evidential support lies outside the cognitive powers of a single scientist. Experts in one wing of the science rely on the affirmations of experts in the other wings; and conversely. The process continues over time. Great professional rewards await a scientist who can find evidence or internal inconsistencies that threaten or overturn an existing science. The result is that new generations of scientists scrutinize the consistency and evidential foundations of existing sciences anew. Mature sciences generally survive this scrutiny, indicating their solidity. When they do not, a new science emerges.

4.5 Examples

Associated with these last differences is one of lesser importance that I find, nonetheless, to be striking. Coherentist epistemology is designed to apply to beliefs of the most mundane variety. Here are a few examples from Bonjour (1985) that are typical of the literature in the epistemology of belief:

> "I believe that the piece of paper upon which I am now typing is the very same piece of paper upon which I was typing late yesterday afternoon." (p.20)
>
> "As I sit at my desk (or so I believe), I come to have the belief, among very many others, that there is a red book on the desk." (p. 117)
>
> "…the car going by is a Lotus…" (p. 119)
>
> "… a figure … coming towards me … is my friend Frank…" (p. 119)
>
> "There is a man lurking in the bushes." (p. 120)

The material theory of induction is designed for relations of inductive support in science. There, typical propositions that count as empirical evidence are things like:

> Space is filled with electromagnetic radiation of a thermal character with a temperature of 2.7K
>
> The perihelion of Mercury advances by 43 seconds of arc per century more than predicted by Newtonian gravitation theory, after perturbations from other planets are accommodated.

The difference is that the exemplar beliefs of coherentism concern ordinary experience. The corresponding empirical propositions in the material theory of induction are quite remote from ordinary experience. No one just notices a 2.7K radiation heat bath in the depths of space; or that Mercury is moving just a little bit too fast over the span of a century. These propositions are secured only after considerable investigation and analysis and are major pieces of science in their own right.

It would be rash to infer from these differences that justification in the epistemology of belief and in inductive science are qualitatively different. Indeed, I incline towards the idea that justification in both are the same in their basic natures. Einstein (1936, p. 349) remarked: "All of science is nothing more than the refinement of everyday thinking." However, there may still be very great differences in the refinement, that is, the details and thoroughness of execution. When someone accepts that there is a red book on the table, their justifications may proceed with similar principles as that of the cosmologist who accepts the 2.7K background microwave

radiation. Where the first is a snap judgment happening in moments, the second is underpinned by decades of careful, explicit analysis. These differences matter greatly. In judging there to be a red book on the table, we pay scant attention to the possibility that our experience is due to some other cause. For the cosmologists, it took decades of measurements at many frequencies before the cosmic radiation could be affirmed to be thermal at 2.7K and not of some other nature.

Further, the differences in the exemplars indicate that the two approaches will prioritize different aspects of the relations. Hence BonJour frets extensively on the reflexive problem of whether we are justified in our own beliefs about our justifications (which is addressed in the "Doxastic Presumption.") By contrast, quantitative methods, such as can be found in elaborate statistical testing, are important in inductive inferences in science, but do not figure in the simple examples routinely used in coherentist epistemology.

5. Problems of Coherentism

My initial hope, upon recognizing the similarities between coherentism and the large-scale structure of inductive inference, was that coherentist analyses might be a useful resource in resolving problems in the material theory. These hopes have not been realized. The two ventures do share similar problems. However, it seems to me that coherentism has fared worse in addressing them, either because of its weaker suppositions or its failure to address the problems better.

The most serious problem facing both systems, in my view, is that they harbor circularities of justification and support. As noted in Chapter 3, it is all too common to find that the mere presence of such circles is sufficient for rejection without any further analysis. Bonjour's (1985, pp. 91-92) response has already been quoted in Section 3 above, to which the reader is now referred. The specific response to the threat of circularities in that passage is:

> And hence, a coherence theory will claim, the apparent circle of justification is not in fact vicious *because it is not genuinely a circle*: the justification of a particular empirical belief finally depends, not on other particular beliefs as the linear conception of justification would have it, but instead on the overall system and its coherence.

BonJour's later (1999, p. 123, his emphasis) analysis gives the same response:

> …justification, when properly understood, is ultimately *nonlinear* or *holistic* in character, with all of the beliefs in the system standing in relations of mutual support, but none being epistemically prior to the others. In this way, it is alleged, any true circularity is avoided. Such a view amounts to making the system itself the primary unit of justification, with its component beliefs being justified only derivatively, by virtue of their membership in an appropriate sort of system.

This response has been quoted here at length to make its inadequacy clear. The rejection of a linear dependence of relations of justification does not eliminate circularities in the interdependencies within the overall system. We are urged, incorrectly, to think that the potential harm of these circularities evaporates because the justification of particular empirical beliefs depends on the whole system. Murphy's (2020) encyclopedia review recalls BonJour's holistic attempt at escape, finds it lacking and suggests (§2b) that circularities are benign if they are within sufficiently strong relations of mutual support. Of course, nothing about strength precludes a vicious circularity or the possibility of arbitrariness.

A stronger response could have been given by coherentists along the lines given in Chapter 3 here. First, benign circularities are prevalent enough in science that there can be no default supposition that a circularity is harmful. Rather we have a positive obligation to establish that some specific circularity is harmful and how it is so. The two dangers explored in Chapter 3 were the contradictions of vicious circularities and its opposite, indeterminateness through the possibility of multiple structures that satisfy the circular relationships. In Chapter 3, I argued that both dangers are precluded in the support relations of a material theory of induction by the dynamical character of scientific investigation. Vicious circularities are removed when found and indeterminateness triggers further investigations that eliminate it (unless we have a true convention). Surely a similar argument can be made concerning circularities among the justifications of beliefs.

This concern over circularity does not figure in BonJour's (1985, p. 106) list of "three standard and extremely forceful objections." They are:

(I) The alternative coherent systems objection.

(II) The input objection.

(III) The problem of truth.

Bonjour's narrative struggles with all three, where the material theory does not.

The second "input" objection has already been discussed in Section 4.3 above. It is an unnecessary weakness the derives from the damaging conception of coherentism as opposed to foundationalism. There is no corresponding problem for the material theory.

The first objection is that there might be multiple, equally admissible coherent systems, which would undermine the justification of the one chosen. The difficulty BonJour finds in answering derives directly from his conception of coherentism as the alternative to foundationalism. As a result, his coherentist analyses seek to favor coherence over some sort of foundational input from experience. As we saw in Chapter 4, the material theory can argue for the uniqueness of relations of support in mature science precisely by relying heavily on empirical evidence to decide among competing systems. BonJour (1985, p. 143) does start to make an argument along these lines. He argues that, once observational input is considered, "it is no longer clear" that multiple, equally admissible systems can be sustained in the long run. That it is no longer clear, is not enough. The possibility is there. In Chapter 4 where empirical evidence is given a greater role, this long-term possibility is eliminated through the empirical character of science: if the long-term accumulation of empirical evidence cannot separate two theories, we have grounds for concluding that they are not distinct in their physical content in the first place. The material character of inductive inference also provides an added resource: it induces an instability in competition among theories such that, when one theory has gained an advantage evidentially, that advantage would be amplified, driving the competition towards resolution in its favor.

The third objection is that mere coherence among beliefs is not enough to establish that they are truths of the world. The obvious counterexample are the coherent narratives of works of fiction. Mere coherence does not establish truth, unless one is willing to adopt a coherence theory of truth, which BonJour (p. 109) is prudently unwilling to do. This problem could be ameliorated if coherentism where not conceived as opposed to foundationalism, for then truths of the world could enter more freely as foundational experiences.

The material theory has no corresponding problem of truth. It does not seek truth conduciveness in some single, global property of the relations of inductive support, such as coherence. Rather the task is distributed over all the inductive relations. It is the burden of the individual warranting facts of an inductive inference to be truth conducive for that inference. When a warranting fact warrants an inference to a proposition or warrants its inductive support,

what is inferred or supported is the truth of the proposition. The truth conduciveness of the full structure of relations simply results from the accumulated truth conduciveness of the individual relations of support.

6. Probabilistic Accounts of Coherence

In recent decades, there has been vigorous activity in writing on coherentism amongst Bayesian philosophers of science. There have been two strands of analysis. In one, probabilistic vindication is sought for the coherentist's notion that coherence among beliefs either constitutes their justification or, more weakly, enhances their justification. Olsson (2005), for example, argues that this notion is not vindicated probabilistically but disproven. Huemer (2011) finds that the probabilistic analysis is inadequate for a disproof, while providing an apparently cogent probabilistic implementation of coherentism. Further possibilities of probabilistic implementation are considered in Wheeler (2012). In the second strand, a single probabilistic measure of coherence is sought, such that belief systems that score higher are better justified. Once again, the leading results are negative. Bovens and Hartmann (2003) offer a proof that no single probabilistic measure of coherence can serve this function, but suggest that a quasi-ordering[13] by probabilistically defined coherence is possible. These negative results have been disputed. Schupbach (2011) defends a coherence measure devised by Shogenji. To complicate matters, Shogenji (2013, p. 2544) then uses probabilistic analysis to argue for an anti-coherentism in which coherence reduces the transmission of probabilistic support. These last contributions are only part of a vigorous debate. For a survey, see Olsson (2017, §§6-8).

Since there is no consensus among Bayesians on these results, it would be of little value to pursue the details any further. Rather I will assess at the most general level the relevance of this work to my project. The principal goal of the Bayesian analyses has been to capture the essential intuitions of coherentism within a probabilistic framework and thereby to provide some deeper foundation for it; or, pessimistically, a definite refutation of it. That is, they seek to vindicate probabilistically the holistic approach of coherentism; or to refute it. As I have indicated above, the material theory does not adopt that coherentism's holism. This means that

[13] That is, the relation is reflexive, transitive but not complete.

these probabilistic proofs or refutations are of tangential relevance only to the project of this book.

However, since the probabilistic analysis aspires to conclusions concerning justification considered on the large scale, we might wonder if it can somehow connect with the large-scale conceptions of the material theory concerning relations of inductive support. My overall assessment is that these Bayesian analyses provide very little of value to someone who does not share the radical Bayesian goal of reducing as much as possible of epistemology and philosophy of science to repeated applications of Bayes' theorem. This assessment is defended in the next section.

7. Why the Bayesian Analysis of Coherence Fails

Overall, the Bayesian analysis of coherentism has proven to be, at best, an infertile but benign distraction for non-Bayesians; and at worst a positive misdirection. There are three reasons for this.

7.1 The Coherence of Coherentism is not a Probabilistic Notion

Non-Bayesian coherentists have included probabilistic notions in their efforts to explain coherence. Sometimes coherence is manifested within a system of probabilistically related beliefs. However, the notion of coherence itself is not fundamentally a probabilistic notion, such that all its cases can be reduced to results expressible probabilistically.

This non-probabilistic character is evident in important examples. One of the best known arises in the competition between Ptolemaic and Copernican astronomy. The two systems could be adjusted so that they provide the same predictions for planetary motions. However, as detailed in Chapter 12, "The Use of Hypotheses in Determining Distances in Our Planetary System," the Copernican system was more coherent than the Ptolemaic. The Ptolemaic system needed an independent epicycle-deferent construction for each planet. The Copernican system resulted from the recognition that many of the Ptolemaic circles were not independent motions, but actually the superposition of the Earth's orbital circle on that of the other planets.

This greater coherence of the Copernican system was a key argument in its favor. It was widely recognized in the century after Copernicus' death. Most importantly, it was not probabilistic in nature. It was then expressed and debated without any need for probabilistic conceptions.

7.2 Formalization is Premature

Coherentism proceeds on the assumption that the coherence of this last example and others like it, is a manifestation of a general notion of coherence that can serve to justify the system of beliefs in which is arises. The problem for coherentists is that a general characterization of coherence remains elusive and is one of the recalcitrant problems of coherentism. Just what is coherence?

It is easy to become impatient with the recalcitrance of a problem like this. Then one can be tempted by the idea of a formal framework in which the solution of the problem is reducible to a precise mathematical question whose answer is provided by mathematical demonstration. In the seventeenth century, Leibniz offered the prospect of a universal language with this perspective in mind. He wrote: "when there are disputes among persons, we can simply say: Let us calculate, without further ado, and see who is right."[14] A similar optimism motivates the Bayesian analysis. Olsson (2017, §5) writes:

> The arguably most significant development of the coherence theory in recent years has been the revival of C. I. Lewis's work and the research program he inspired by translating parts of the coherence theory into the language of probability.

He proceeds to promise the benefits of the translation:

> The probabilistic translation(s) of coherence theory has made it possible to define concepts and prove results with mathematical precision.

My assessment of this development is that it is retrograde. It is, of course, both satisfying and decisive when mathematical demonstrations in a formal system can resolve vexing, informal confusions. I will celebrate all such successes. However, such a resolution requires that the original problem is one that admits precise mathematical formulation in the first place. This is not the case with coherentism in epistemology. Just what is its notion of coherence remains poorly understood. Instead of a successful clarification of the notion of coherence, we have an intemperate rush to formalization. To superimpose a veneer of probabilities over an imprecisely understood notion is not to illuminate it but to obscure it and its problems.

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[14] As quoted by Kulstad and Carlin (2020, §3), with the citation *The Art of Discovery* (1685); C 176/W 51.

The focus of the present probabilistic analyses of coherence has drifted away from clarifying coherence. It has been replaced by extended and apparently fruitless debates on just how to represent probabilistically some simple notions to do with coherence. Because probabilistic independence is a major component of strong results in the probability calculus, there is premium on giving it a place in the probabilistic analysis. The opportunity for introducing it comes from a notion in coherence theory of the independence of witnesses. How can that independence be expressed probabilistically? Olsson (2005, p.25) considers witness testimonials E_1 and E_2 agree in that both assert H. The independence of the testimony is then represented probabilistically by independencies of the conditional probabilities $P(E_2|E_1, H) = P(E_2| H)$ and $P(E_2|E_1, \sim H) = P(E_2| \sim H)$. This seems odd, since we expect it to be more probable that witness 1 and witness 2 will agree on H, if H is the case, than they would if H is not the case. We then learn (p. 45) that, under correction from other authors, the representation is incorrect since it assumes perfect reliability or unreliability of the witnesses. A more elaborate model turns out to be needed. Then Huemer (2011, p. 40) argued that the independence of testimonies is too strong a condition in the first place for the probabilistic representation of coherence. All that is needed is that the truth of H makes agreement among the witnesses more likely: $P(E_2|E_1, H) > P(E_2|E_1, \sim H)$. That is, the attempt to base a probabilistic treatment on the probabilistic independence of testimonies was too hasty in the first place.

These are just the beginning of familiar problems peculiar to Bayesian probabilitistic representations. A non-Bayesian might be willing to admit a probability $P(E_2| H)$ that represents the chance that witness 2 testifies to H when H is the case. But what are we to make of $P(E_2|\sim H)$, the probability that witness 2 testifies to H, when H is not the case? We might imagine all sorts of scenarios in which H might be false, so that $\sim H$ is true. How likely is the aberrant testimony in each? How likely is each scenario? Have we exhausted all the scenarios? All the quantities arising here must be multiplied and summed. And when all this is done and we sum up all our quantities, do we have a resultant with sufficient probabilistic meaning that it can figure in the precise computations that follow? It requires quite an indulgence to imagine so.

The issue here is not just the problem of assigning a precise value to $P(E_2| \sim H)$. It is the very idea that we have a quantity here, well represented by any additive measure at all, and moreover that it is one with sufficient commonality of meaning with the additive measure

$P(E_2|H)$ for it to be combined freely with it in subsequent computations. It is a standard presumption that all these maneuvers are admissible, for otherwise Bayes' theorem could not be applied. Presumption and a familiarity bred of necessity, however, is not the same as a well-founded resolution of an enduring problem.

Thagard (2000, Ch. 8, 2004, 2005) has mounted a related critique of the Bayesian treatment of coherence as a part of a defense of his account of coherence as constraint satisfaction. Among his many concerns is that Bayesian analysis requires "a host of conditional probabilities that people would be hard pressed to specify." (2005, p. 311)

Matters become worse when we consider the second strand of the probabilistic analysis, the attempts to define a single numerical measure of coherence in some system that is a function solely of the probabilities in that system. They go beyond problems associated with the mere use of probabilities. It is a risky speculation that any single measure of coherence is possible in the first place. And it is an even riskier speculation that probabilities alone suffice to define it when the notion itself is not probabilistic. It is hardly surprising that no consensus has emerged from the dense fog of elementary theorems in probability and counterexamples that constitute this literature.

For Bayesians who are committed to the idea that fundamental notions like coherence are reducible to probabilistic notions, all these complications are simply work proceeding as usual. The path is not easy, but they are convinced that a happy outcome awaits them eventually. They must persist. They must calculate more.

For those who are not Bayesians, the entire enterprise is one of premature haste in the pursuit of an illusion of precision. The original problem of the nature of coherence has faded away. In its place, are exercises in elementary probability theory, endless revisions of them, all with increasingly dubious connections to the original problem. That no consensus has emerged over these probabilistic conjurings is no surprise if one doubts the appropriateness of the formalization in the first place.

Setting Bayesian or non-Bayesian commitments aside, let us recall that we have good reason to think that the notion of coherence is not a probabilistic notion. Is it really wise to persist in efforts to find a probabilistic basis for it?

7.3 A Probabilistic Framework is not Sufficiently General

The Bayesian analysis of coherence aims at general results. If a probabilistic foundation can be found for coherentism, then it is vindicated universally. If coherentism is refuted in the Bayesian analysis, then it is refuted everywhere.

The problem is that a probabilistic framework is not sufficiently general to support universal conclusions of this type. This is one of the main consequences of *The Material Theory of Induction*. It asserts that a case by case examination of the warranting facts of each domain determines whether relations of inductive support of the domain are probabilistic. There are many domains in which the relations are probabilistic. And there are many in which they are not. Chapters 10-14 of *The Material Theory of Induction* gives extended examples. They do not need to be rehearsed here. Insofar as credences are set by strengths of inductive support, the same conclusion applies to them. Thus, one cannot proceed with probabilities as the automatic default when it comes to representing uncertainties in inductive support or credences. There is a positive obligation in each domain to display the facts warranting the probabilistic representation.

When such warranting facts are present, the justification of the results of the probabilistic analysis can in part ultimately be traced back to the facts warranting the probabilities. Figuratively, there should be a disclaimer attached to the Bayesian analysis that says: "Applies in domains only where probabilities are warranted." To omit this disclaimer is to advance conclusions without proper basis. To suggest that the results have universal applicability is a misrepresentation.

These concerns can be reformulated as a general argument against the possibility of a universally applicable Bayesian epistemology or Bayesian philosophy of science. Any analysis of this type will begin with general framing assumptions. Commonly, the probabilistic analyses of coherentism presume a collection of witnesses testifying to various facts. Further assumptions concern the reliability of the witnesses and the extent to which their testimonies are related, other than through the truth or falsity of facts to which they testify. Any conclusions drawn from these assumptions alone are secure in the sense that they are merely restating what is asserted by the framing assumptions of the analysis.

The delicate part comes when the probabilistic analysis gives us results that go beyond the framing assumptions. If these results are to have universal applicability, their derivation is flawed since it depends essentially on the assumption that probabilistic relations can apply

everywhere. Thus, for any result claimed to have universal validity, we cannot preclude the possibility that it is merely an artefact of an illegitimate assumption.[15] We end up believing that we have proven results, when we have not.

Once we are alerted to the danger, examples of this sort of fallacy are easy to find. Here are several. The principle of indifference is a truism of evidence and credence. If you have no basis for distinguishing the support of two outcomes and find them equally favored, then you should accord equal support or equal credence to them. This framing assumption is as anodyne a principle as one can imagine. Yet—famously—it cannot be implemented in a probabilistic system. We end up with the widely known paradoxes of indifference. What is their origin? Perversely, the routine conclusion is that there is some fault in this truism of evidence. The fault lies elsewhere. It is the assumption that probabilities can capture support or credence within this framing. Rather this framing requires different relations of support or credence. For details, see Norton (2008, 2010).

Another example arises in Chapter 1 above, through Laplace's rule of succession. The rule tells us that, as a general matter, if we have had 1,826,213 successes, we should expect a success on the next trial with very high odds of 1,826,214 to 1. As I point out in the chapter, the framing is bare and simply assumes 1,826,213 unrelated successes. Nothing in it warrants the application of probabilities. As a result, nothing more can be inferred using probabilities about future successes. The inference to the very high odds of future successes is fallacious and simply an artefact of applying probabilities without a warrant.

A related example concerns an hypothesis H and its deductive consequences E_1, E_2, E_3, …. It is a well-known result of Bayesian analysis, reviewed in Norton (2011, pp. 430-31), that it entails either an excessive pessimism or an excessive optimism concerning projectability of the

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[15] Another potential source of error lies in the translation of non-probabilistic framing assumptions into probabilistic relations. The translation may be erroneous, but correctibly so. More seriously, there may be no good probabilistic translation. This is the case for a state of complete ignorance or completely neutral support. It leads to the failure of probabilistic analysis to accommodate the principle of indifference, as discussed in the main text and Norton (2008, 2010).

hypothesis and its consequences, but nothing in between. If we set the prior probability of H to zero as $P(H) = 0$, then conditionalizing on any evidence whatever fails to alter the zero probability. We are dogmatically committed to the failure of any evidence to support H. If however we set $P(H) > 0$, even if $P(H)$ is as small as we care to make it, we commit to an excessive optimism in the projectability of its consequences. That is, if the first 10^n of these consequences have obtained, we become arbitrarily certain that the next 10^{n+1}-10^n will obtain, as n increases, for it is easy to show that:

$$\text{Lim}_{n\to\infty} P(E_{(10^n)+1} + E_{(10^n)+2} + \ldots + E_{(10^{n+1})} \mid E_1 + E_2 + E_3 + \ldots + E_{(10^n)}) = 1$$

That is, we become arbitrarily confident of roughly a tenfold increase in the number of consequences we expect to obtain. That this is excessively optimistic, even credulous, is clear once we recall that the framing assumptions are sparse. They allow the set $\{E_1, E_2, E_3, \ldots\}$ to be *any* non-contradictory set of propositions whatever (and then H could merely be their conjunction). This excess of optimism or pessimism is an artifact of the application of probabilistic analysis where the framing assumptions are too sparse to authorize them. They far outstrip what the framing assumptions authorize.

There is an easy escape from this difficulty. Bayesians should renounce the illusion that they are able to deliver results of universal applicability in epistemology and philosophy of science. Rather, their results apply only in domains in which probabilities are warranted by some positive factual basis. Then strong and interesting, domain specific results will be recoverable and their basis will not be mysterious. They will rest ultimately on the factual warrant for probabilities in the domain.

8. Conclusion

It appears initially that much is shared by the material account of the large-scale structure of inductive support and coherentism, that is, coherence based accounts of the justification of beliefs in epistemology. For both require that their respective relations of support are non-hierarchical or non-linear. That agreement gave some hope of further, fruitful connections. These hopes were dashed by the rather negative results of this chapter. The similarities in the two projects, we find, scarcely extend beyond the initial agreement on non-hierarchical structures.

The main difference is that coherentism bases justification on a holistic property, the overall coherence of belief systems. The material analysis bases inductive support on local

relations; and the overall non-hierarchical structure is derived from them. There a many further differences: coherentism assumes various, poorly articulated accounts of justification at the local level, where the material analysis is devoted to a full articulation of a relation of inductive support at the local level. Coherentism is formulated as an alternative to foundationalism. That conception creates the enduring problem for coherentism of discerning how the world impinges on beliefs without conceding to foundationalism. The material analysis has no corresponding problem. Coherentism concerns beliefs and thus struggles to accommodate the limits of cognition of any one cognizer. The material theory concerns abstract relations of inductive support as matters of inductive logic and escapes these problems. Partly through these differences, coherentism has proven less able than the material theory to respond to the standard problems that face both systems.

This chapter has reviewed Bayesian analyses of coherentism. Since these analyses accept the holistic conception of coherentism, they are of little relevance to the material analysis of the large-scale structure of inductive support. The review finds the Bayesian analyses to be over-reaching. There is a powerful negative result: in so far as a Bayesian analysis offers universally applicable results on coherentism that go beyond the non-probabilistic framing assumptions, they are without proper foundation.

Finally, this chapter indicates how the material theory of induction relates to the more general literature in the epistemology of belief. While the chapter focused on coherentism specifically, much of what it concludes applies more generally. Two more general conclusions can be recovered:

Epistemologists of all varieties treat local relations of justification and inductive support as antecedently understood. They use notions such a probabilistic and explanatory relations in their accounts, while leaving the elucidation of such relations to others. The goal of the material theory of induction is to elucidate these very relations and others like them. Hence the two projects proceed at different levels.

Epistemology concerns beliefs held by cognizers and how these beliefs are justified. The material theory avoids belief as much as possible. It gives an account of what inductively supports what, independent of beliefs and knowing agents, as matters of independent inductive logic. How some agent can use those relations to inform belief is a further problem left largely to the epistemologists.

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