

Epistemic Benefits of the Material Theory of Induction

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ABSTRACT: C. D. Broad famously labelled the problem of providing our inductive practices with a proper justification “the scandal of philosophy” (Broad, 1952). Recently, John Norton has provided a dissolution of this problem (2014). According to Norton, inductive inference is grounded in particular facts obtaining within particular domains (J. Norton, 2003b, 2010, 2014). Because the material theory does not involve a universal schema of induction, Norton claims it dissolves the problem of induction (which implies that such universal schemas cannot be justified).

In this paper, I critically evaluate Norton’s dissolution. In particular, I argue that the problem of induction is an epistemological problem, that Norton’s material theory entails an externalist epistemology, and that it is a common feature of such epistemologies that they dissolve the problem of induction. The upshot is that the material theory is not unique in its ability to reap the specifically epistemic benefits of dissolving the problem of induction, and thus that the epistemic advantages of the material theory over extant alternatives in this regard are fewer than it may appear at first sight.

1. Introduction

Over the past fifteen years, John Norton has in different works advocated a ‘material theory of induction’ (J. Norton, n.d., 2003a, 2003b, 2010, 2014). It is a theory of inductive logic, a theory that explains how different propositions support each other inductively. According to Norton, inductive arguments are warranted not by their instantiating a universal inductive schema, but rather by specific facts prevailing in particular local domains. One of the advantages of such an approach to induction is, according to Norton, that Hume’s problem of induction is dissolved (J. Norton, 2014).

In this paper I critically evaluate this claim. Section 2 starts with an overview of the material theory and in section 3 I discuss its claim to dissolve the problem of induction. In sections 4 and 5, I argue that the problem of induction is best conceived of as an epistemological problem, in particular a problem for *internalists* about epistemic justification. In section 6, I argue that the material theory of induction implies an externalist epistemology, and that externalist epistemologies are generally able to dissolve the problem of induction. The upshot of the argument is that it is unclear whether the material dissolution of the problem of induction provides an improvement over existing externalist theories of inductive inference with regards to its ability to dissolve the problem of induction.

In arguing for the claims mentioned above, this paper aims to do two things: first, to elucidate the relation between logic and epistemology, particularly as it pertains to Norton’s material theory of induction, and second, to critically evaluate the advertised epistemic benefits of adopting the material theory.

2. The material theory

The material theory is a theory of induction. ‘Induction’ can mean at least two things. First, induction may refer to a relation of support that holds between two or more propositions. Second, induction may refer to an inference pattern, a method of coming to hold new beliefs on the basis of old ones.¹ Let us call the former inductive implication and the latter inductive inference. Whereas the study of inductive implication is properly part of logic, the study of inductive inference belongs to epistemology, and because of the prominent role induction plays in science, to philosophy of science.

Although Norton consistently speaks of inductive inference, it is clear that the material theory is meant to be a theory of inductive implication in the sense defined above. Consider for example the following quotes:

According to [the material theory], all inductive inferences are warranted by facts. Since these facts are contingent, there are no universal warrants. No system of inductive logic holds universally; each holds only in the limited domain in which the warranting facts are true. (J. Norton, 2014, p. 674)

We have been misled, I believe, by the model of deductive logic into seeking an account of induction based on universal schemas. In its place I will develop an account of induction with no universal schemas. (J. Norton, 2003b, p. 648)

While some domains may be large and governed by their own well-defined [inductive] logic, no single logic is warranted in all domains. The slogan is “all induction is local.” (J. Norton, 2010, p. 765)

My concern in this paper is inductive logic. Might replicability provide a universal schema or principle that figures in a formal logic of induction, or at least in that portion of the logic that treats experiments? (J. D. Norton, 2015, p. 230)

As becomes clear from the quotes, Norton does not always clearly distinguish between implication and inference. But when he talks about the material theory as a theory of logic, it seems clear that he means to be talking about the relations of support that may hold between propositions primarily, and only derivatively about a method of belief-formation. After all, a logic describes relations of support between propositions. The material theory is thus primarily a theory of inductive implication, not of inductive inference. As we will see in the next section, there are important connections between inductive implication and inductive inference. Here I want to stress, however, that Norton considers the material theory as a theory that explains relations of inductive support between propositions.

That being said, the critique I will develop in this paper is epistemological in nature. Given that the material theory is a theory of logic, this means that my attack is *indirect*; I will remove an epistemological reason for adopting Norton’s material theory of inductive logic. But as will become clear later, logic and epistemology are closely related, and Norton himself mentions the ability to dissolve an *epistemic* puzzle – the problem of induction – as one of its advantages.

¹ Cf. Susan Haack, on the difference between deductive implication and inference (Haack, 1982).

It is only on this latter claim that I aim to cast doubt. For all the present paper is concerned, the material theory is adequate as a theory of inductive *logic*.

A good way to bring out the core idea behind the material theory is to contrast inductive implication with deductive implication. Whereas deductive support relations hold in virtue of the *formal* characteristics of the propositions involved, inductive support relations hold, according to Norton, in virtue of specific *facts* obtaining.² Consider the following two sets of propositions:

A	B
A1: Some samples of the element bismuth melt at 271°C.	B1: Some samples of wax melt at 91°C.
A2: Therefore, all samples of the element bismuth melt at 271°C.	B2: Therefore, all samples of wax melt at 91°C.

Here, A1 inductively implies A2, but B1 does not inductively imply B2. Norton argues that both putative implications have the same formal properties, and that the difference in support relations thus cannot be attributed to these formal properties. Rather, it is attributable to different *facts* concerning the properties of bismuth and wax. What establishes the support between A1 and A2 is the fact that generally, chemical elements are uniform in their physical properties (J. Norton, 2003b, p. 650). The propositions expressing facts that establish inductive support relations are called ‘material postulates’ by Norton. No material postulate is available for B.

3. A material dissolution of the problem of induction

An important virtue of the material theory of induction is its ability to dissolve ‘the problem of induction’. The problem of induction is among the most well-known puzzles in philosophy. Its canonical formulation is due to Hume, who states in his *Treatise*:

... ’tis impossible for us to satisfy ourselves by our reason, why we shou’d extend that experience beyond those particular instances, which have fallen under our observation. (Hume, 2007, sec. 1.3.6.11)

The problem is that of extending experience beyond the actually observed: of deriving general conclusions from a finite set of observations. Why can we not ‘satisfy ourselves by our reason’ in this regard? The problem has an inductive and a deductive horn (Henderson, 2019; Salmon, 1967). On the deductive horn, the argument runs that we cannot deductively show that inductive implication is valid. Contrary to deductive implication, inductive implications are valid only contingently: no matter how many black ravens we have seen, it remains possible that the next one will be white. Inductive implications therefore only contingently preserve

² Whether deductive inferences are justified exclusively because of their formal properties is somewhat controversial. For a critique of the idea, see (Dutilh Novaes, 2010).

truth. To show deductively that they are valid would amount to showing that it is a necessary truth that they preserve truth. But since induction is by definition ampliative, this is impossible.

It is possible to interpret the inductive horn of the dilemma in two different ways. First, we can argue that to justify inductive implication by means of an inductive argument is circular. We cannot *use* inductive implication to support inductive implication. The second interpretation of the inductive horn acknowledges that there may be *different* kinds of implication besides inductive and deductive ones, and that we may draw on these additional kinds in our argument in support of induction. Unfortunately, our stock of different kinds of inductive implication is quite limited, and we can keep on asking for justification indefinitely. On this interpretation of the inductive horn, the problem is a vicious regress rather than circularity.³

Importantly, the problem of induction shows only that it is impossible to provide a justified *argument* that validates inductive implication. It is still possible, for all the argument shows, that inductive implication *is* inductively valid.⁴ Now, it is easy to see how the material theory dissolves this problem: because there is, on the material theory of induction, no universal kind of inductive implication, the fact that we cannot justify it is unproblematic. As Norton says

The problem of induction consists of the possibility of rapidly generating a circularity or pathological regress when we seek the justification of inductive inferences. That problem, I have argued here, is an artefact of the wrong conception of induction, a formal account of inductive inference. If we adopt the correct material account of induction, the problem is dissolved. The considerations that generated a circularity or pathological regress in the formal theory no longer do so in a material theory. (J. Norton, 2014, p. 688)

Norton's dissolution of the problem of induction appears to be simple and elegant. But is it right? Even if Norton does not succumb to the standard form of the problem of induction, one may still worry his account faces a related problem: if all inductive implication is licensed by local facts, what licenses these facts? In our example above, the material postulate that "generally, chemical elements are uniform in their physical properties" provides the required support relation between "Some samples of the element bismuth melt at 271°C" and "All samples of the element bismuth melt at 271°C". But now one may wonder, since the material postulate is itself a general claim, how this claim itself is supported. It seems to be an empirical generalization, supported by various observations. If this is so, then its support depends on yet another material postulate. If some material postulates receive support from further material postulates, then we may wonder where the inductive support structure ends. If it ends in pure observation, it is hard to see how the first more general material postulates may be licensed by these observations, without the resources of further general material postulates. If the chain has no end, this threatens to collapse the support of each link. If it ends with a general material

³ Cf. (Popper, 1959)

⁴ To see this difference, consider a nearby possible world where enumerative induction always has and will have turned out to provide the correct results (that is, delivered true generalizations). Presumably, in such a world the rule would 'be' justified. Even if this would be the case, the problem of induction specifies that we could still not appeal to either deductive or inductive arguments in the defence of enumerative induction, and so carrying out the justification of enumerative induction would still be impossible.

postulate, we still have no explanation of what licenses *that* postulate, and the problem of induction has not been solved.

Worries along these lines have been raised by Peter Achinstein (2010), Thomas Kelly (2010), and John Worrall (2010). These authors all argue that even if the inductive validity of *some* inductive implications may depend on local facts only, they cannot all do so, as the material theory would have it. If certain universal claims are still needed to licence inductive implication, then the problem of induction, that states we cannot justify our reliance on such claims, has not properly been dissolved.

In response, Norton argues that Achinstein, Worrall, and Kelly conceive of the interrelating inductive support relations in the wrong way. Rather than an inductive ‘tree’, where material postulates of greater generality are themselves licensed by inductive support relations depending on material postulates of *lesser* generality, until we reach the bedrock of pure observation, the more accurate picture is one of the arch, where material postulates of greater generality may be supported by postulates of both greater and lesser generality:

My proposal is that the relations of inductive support in mature science form an analogous, non-hierarchical structure. Take any proposition in mature science. We will be able to display a rich and varied inductive case for it that draws on propositions in other parts of science. The inductive support is empirical in the sense that all relations of support eventually call upon facts of observation and experience, the bedrock in the analogy. However, the relations do not form a hierarchical structure. The support for a proposition will draw on propositions of generality both lesser and greater than it. However, just as no stone in the tower is unsupported, none of these propositions of greater generality will lack support (J. Norton, 2014, p. 686).

While these worries are interesting in their own right, it is not my aim here to evaluate Norton’s response to the claim that not all induction is local. Rather, I will simply assume that all inductive implication is warranted by local facts obtaining in particular domains. Furthermore, I will also assume that the material dissolution succeeds in dissolving the problem of induction. My concern is not with Norton’s story of the logic of induction, nor with his claim that it dissolves the problem of induction. Rather, I will argue that the material theory is not unique in its ability to do so. To separate issues of logic and epistemology, I will start in the next section by arguing that the problem of induction is an epistemological problem.

4. The problem of induction is an epistemological problem

My aim is to problematise Norton’s dissolution of the problem of induction. In this section, I will argue that the problem of induction is a specifically epistemological problem. As we saw in the previous section, the material theory is best understood as a theory of logic. That means that in order to bring the material theory to bear on the problem of induction, we have to specify first how a theory of logic can have epistemological implications at all. This is what I will do in the first part of this section.

While logic and epistemology are strictly speaking distinct, they are nevertheless related in interesting ways. Consider the distinction between *doxastic* and *propositional* justification.⁵ Doxastic justification is the justification you have for your beliefs. It is the kind of justification that features in the classical tripartite account of knowledge. A belief is doxastically justified if and only if it is formed in accordance with the relevant epistemic norms (whatever these may be).⁶ Propositional justification attaches to propositions rather than beliefs. A proposition is propositionally justified for an agent if and only if the agent were to be doxastically justified if she formed her belief in that proposition in accordance with the relevant epistemic norms (again, whatever these may turn out to be).⁷ What this means is that doxastic justification implies propositional justification. If S is doxastically justified in believing *p*, then *p* must be propositionally justified for S.

There are many different views on what propositional justification requires. But virtually everyone agrees that propositional justification depends at least partially on the logical support relations between propositions (e.g. Chisholm, 1977, pp. 135–137; Conee, 1980). For example, we are generally propositionally justified in believing the logical consequences of the propositions we currently justifiably believe, in the sense that, if we were to form our belief in those consequences in the appropriate way, we would be doxastically justified in believing them. If this is so, then what we are propositionally justified in believing is determined in part by which kinds of logical implication are valid, and therefore, by whether inductive implication is inductively valid. If it is, I may (provided other conditions are met) be propositionally justified in believing the inductive implications of my current beliefs. If it is not, then I cannot be so justified.

Since we have seen that doxastic justification implies propositional justification, the logic of induction has consequences not just for what we are propositionally justified to believe, but also for what we are doxastically justified in believing. In this way, the epistemic justification of beliefs formed through inductive inference will depend on the logical justification of inductive implication. This means that the material theory of inductive logic will have ramifications for the epistemology of inductive inference.

In particular, Norton claims the material theory allows us to dissolve the problem of induction, which is, as I will now argue, a specifically *epistemic* virtue. The upshot of that problem, I said above, is not that induction is unjustified, but rather that there is no possible argument to establish that it is. Or, in other words, that there are no good reasons for us to believe that induction is justified. But, by parity of reasoning, neither is there a good argument to establish that induction is *not* justified. The problem of induction, on this account, is an epistemological

⁵ This distinction is well-known in epistemology, although different authors have slightly different ideas on how they are related. Since I leave open here what the relevant epistemic norms of belief are, the characterization in this paper is meant to be compatible with a wide range of options for filling out the details. The primary point of relevance for this paper is that doxastic justification implies propositional justification, a thesis that follows from many otherwise different accounts (Goldman, 1979; Kornblith, 2017; Kvanvig, 2003, pp. 7–8; Pollock & Cruz, 1999, p. 35; Silva & Oliveira, n.d.; Turri, 2010)

⁶ The formulation is explicitly vague here to accommodate different views on the relevant epistemic norms.

⁷ This is the same distinction that Alvin Goldman called the difference between *ex ante* (propositional) and *ex post* (doxastic) justification (Goldman, 1979, p. 103).

problem: it says we cannot know that induction is justified, not that it is not justified. For all Hume has shown, nature is uniform, and inductive implication inductively valid.

If Norton claims the material theory dissolves *this* problem of induction, then he himself is thus spelling out some of its epistemic consequences. Because there is no universal schema of inductive implication, certain epistemic puzzles about the justification of such a schema do not arise. In the next section I shall argue that the material theory is not unique in providing these benefits.

5. The problem of induction is a problem for internalists only

The problem of induction is thus that we cannot know that inductive implication is justified. How serious this problem is will depend on one's epistemological theory. I will now proceed to argue that such inductive scepticism is a problem only for *internalists* about epistemic justification.

The distinction between internalism and externalism runs deep through epistemological theorizing of the second half of the twentieth century.⁸ The literature on the topic is vast, and so my overview will by necessity be coarse and relatively brief. But I hope it will be sufficient for our present purposes.

To start, epistemic internalism and externalism are understood in this paper as theories of doxastic justification.⁹ As such, they specify properties of actually formed, epistemically justified beliefs. What properties are these? Various internalism-externalism oppositions may be distinguished. Here I focus on what may be called the *justifier* debate.¹⁰ Justifiers are defined as facts that determine the justificatory status of our beliefs (Goldman, 2009, p. 310). The debate between internalists and externalists on this point concerns whether all such facts are internal to us, in some yet to be specified sense. Internalists affirm, externalists deny this.

What is the relevant notion of internal here? Despite some variation in the vast literature, it is possible to distill a broad common consensus: a justifier is internal just in case it is part of, or supervenes on, our *mental states*. These include both perceptual states, beliefs, hopes, dreams and all other propositional attitudes.

We thus arrive at one of the most prominent contemporary internalist theories of epistemic justification:

⁸ A comprehensive overview of this vast literature is impossible here. Influential internalist accounts include (Audi, 1993; Bonjour, 1980; Chisholm, 1977; Feldman & Conee, 1985; Ginet, 1975; Wedgwood, 2002). Prominent externalist accounts include (Dretske, 1981; Goldman, 1979; Littlejohn, 2012; Plantinga, 1993; Sosa, 2007).

⁹ This is not entirely uncontroversial. In particular, a causal basing requirement on justification will complicate the internalist position here. For discussion, see (Poston, 2016; Turri, 2010).

¹⁰ 'Justifier debate' is my own term. It relates to the debate about the nature of the facts that determine doxastic justification. This is contrasted to what I call the accessibility-debate, which concerns the required access to those facts that determine doxastic justification. Although these terms are my own, the distinction is generally recognized (e.g. G. Pappas, 2014; Poston, 2016).

Mentalism: The justificatory state of a person's doxastic attitudes strongly supervenes on the person's occurrent and dispositional mental states, events and conditions (Conee & Feldman, 2001, p. 2).

One's dispositional mental states are mental states that could possibly become occurrent (Addis, 1988, p. 4; Audi, 1994).¹¹ The exact contents of one's occurrent and dispositional mental states, events and conditions are difficult to specify, but beliefs are certainly among the 'things' that can confer justification on this view. However, the definition also leaves room for other mental states, such as direct perceptual awareness states, to justify some of our beliefs as well. According to Conee and Feldman, the totality of one's occurrent and dispositional mental states constitutes one's 'mental life' (Feldman & Conee, 1985, p. 55).

Conee and Feldman maintain that justifiers strongly supervene on one's mental life. Strong supervenience is generally defined in terms of possible worlds:

A-properties strongly supervene on B-properties if and only if for any possible worlds w_1 and w_2 and any individuals x in w_1 and y in w_2 , if x in w_1 is *B*-indiscernible from y in w_2 , then x in w_1 is *A*-indiscernible from y in w_2 . (Kim, 1987, p. 317)

Applied to the definition of mentalism (taking justifiers as *A* properties and mental lives as *B* properties), this means that the mentalist claim can be interpreted as the claim that for any possible worlds w_1 and w_2 , and any individuals x in w_1 and y in w_2 , if x in w_1 has the same mental life as y in w_2 , then x in w_1 has the same justifiers as y has in w_2 . In order worlds, one's total mental life *determines* the justifiers one has for one's beliefs.

As I said, externalism denies the internalist thesis;

Externalism: It is false that a person's beliefs are justified only by the person's occurrent and dispositional mental states, events and conditions.

Externalists may complement this negative account of justification with various positive conditions that justified beliefs need to meet. And indeed, the literature features many distinct suggestions as to what external facts may be particularly relevant for justification.¹² To make my point I only need to spell out the general externalist commitment that external justifiers may be cognitively *inaccessible* in the sense that we may not be able to determine whether they obtain or not.

As an example, take the externalist theory of process reliabilism (Goldman, 1979). Roughly, according to process reliabilism, a belief is justified if and only if it results from a reliable process. The reliability of the process is at least partially dependent on the external world, so reliabilism counts as an externalist theory. But we may sometimes lack cognitive access to the reliability of

¹¹ This possibility-clause serves to discount cases of failure of memory, for example, to influence the justificatory status of a given belief. Such failures of cognitive capacities do not influence the justificatory relation that exists between a belief and its justifiers. For example, it seems an extraordinarily high demand on reasoners to require them to be aware of all their justifiers all the time: in the extreme case, this would mean that upon being asked for justification, one should, in order to be justified, be able to produce one's complete system of beliefs.

¹² Some classic proposals are: process reliabilism (Goldman, 1979, 2009), virtue epistemology (Sosa, 1980, 2007), proper functionalism (Plantinga, 1993).

our methods. Of course, sometimes we may have good reasons for believing that a particular method is reliable, but we may still be wrong about this, and sometimes we may lack such reasons in principle, as when we use a method for the first time. Only the actual reliability of the method counts, so, according to the reliabilists, any reasons we may have for *believing* our method is reliable are simply irrelevant to the justification of their resultant beliefs.¹³

How does the reliabilist respond to the problem of induction? First, consider why the problem has bite for the internalist. The problem concerns the fact that we cannot provide an argument for the validity of inductive implication, and thus for the justification of inductive inference. For the internalist, this is a problem, since if all facts that determine whether our beliefs are justified are cognitively accessible mental states, then it seems that we should be able to provide such an argument, at least in principle. Of course, we may sometimes be distracted, or fail to remember some of our beliefs, but for the internalist the items that determine whether we are justified are all accessible in principle, and so, by closely inspecting our mental life, we should be able to determine whether inductive inference is justified. On the basis of this investigation, we should be able to provide an argument, either for or against the justification of inductive inference. The problem of induction has bite for the internalist precisely because of its upshot that this is impossible.

The externalist, on the other hand, recognizes that not everything that determines justification is accessible. Because of this, it will sometimes be the case that the justification of our beliefs depends on factors that we lack access to in principle. If this is true, then it is impossible to determine in these cases whether we are justified, and thus, to provide an argument for the justification of the relevant beliefs. The problem of induction has no bite for the externalist because she can admit the possibility that our inductive beliefs are justified by facts that we lack reflective access to, such as the ‘uniformity of nature’. Note that this does not amount to a positive justification of inductive inference: only if nature truly is uniform are our inductive beliefs justified. The crucial difference between the internalist and the externalist is that the former thinks the principled absence of an argument for the uniformity of nature prevents even the possibility of justification, whereas the latter denies this.

For the process reliabilist, *reasons* for believing the method is reliable are simply not required for a belief-forming method like inductive inference to be justified. Either the method is reliable, or it is not. If it is, then, for a reliabilist like Goldman, inductive beliefs are justified. If it is not, then they are not. But in any case, the problem of providing an argument for the inductive validity of the method disappears.

That reliabilists evade the problem of induction is not a novel claim. Here is James van Cleve’s version (Argument A is an inductive inference from the past success of inductive inference to its general success):

The conclusion of Argument A tells us that inductive inference is a reliable process. The reliability theory tells us that beliefs resulting from justified beliefs by a reliable process

¹³ I will come back to this issue in the next section.

are justified. It follows that beliefs arrived at by inductive inference from justified beliefs are themselves justified. (van Cleve, 1984, p. 559)

Van Cleve's argument is slightly different from ours. It uses an inference from the past success of inductive inference to its general success (Argument A). Since this is itself an inductive argument, many will renounce it as circular. But as van Cleve notes, its circularity need not be vicious on an account of justification in terms of reliability. If justification is a matter of employing a reliable process, and induction is such a process, then according to the reliabilist Argument A will be justified, and with it our belief in the justification of induction.

As van Cleve notes, however, he does "not expect everyone to be convinced that Argument A is noncircular" (van Cleve, 1984, p. 565). In particular, non-reliabilists will find the defence above unconvincing. Our present purposes are more modest than van Cleve's, who wants to provide an argument that shows that inductive inference *is* justified. My present aim is only to establish that a reliabilist would not be troubled by the problem of induction. And that follows from the fact that reliabilists maintain that reliability is sufficient for justification, and that inductive inference may be reliable even if it is impossible to provide an argument for its inductive validity. We thus do not need to make the controversial assumption that inductive inference is, in fact, reliable.

Reliabilism is one externalist epistemology among many. I have not shown how other forms of externalism dissolve the problem of induction, nor do I have the space to do so. But externalists commonly deny that arguments are necessary for justification, and so at least these other externalists are able to dissolve the problem of induction in a similar manner.¹⁴ The upshot of the foregoing is that if the material theory of induction dissolves the problem of induction, it is certainly not unique in its ability to do so.

6. The epistemology of the material theory of induction

We have argued so far that the problem of induction is an epistemological problem, and that it can be dissolved by externalist accounts of justification like reliabilism. That already diminishes some of the benefit of adopting the material theory of induction: we do not need it to evade the problem of induction. But for the internalist, the material dissolution may still be preferable if it dissolves the problem of induction *without* entailing a commitment to externalism. In this section, I will show that proponents of the material theory of induction are in fact committed to an externalist epistemology. This means that the material dissolution of the problem of induction will not be available to the internalist about epistemic justification.

It is relatively easy to see that Norton's material theory of induction leads to an externalist epistemology of inductive inference. Consider Norton's classic example of inferring that all samples of Bismuth will melt at 271 degrees Celsius from the observation that some of them do. What validates the implication according to Norton is a set of facts about the physical constitution of elements and how those interact with melting points. So far, these are claims

¹⁴ For some expressions of this sentiment, see (BonJour, 1980, p. 65; G. Pappas, 2014; Poston, 2016)

about the logic of the inference. But whether we are epistemically justified in believing the conclusion of this inference will depend on the inductive validity of the implication. Presumably, as things stand, we are justified in making the inference. But if the implication were invalid, for example because we turned out to be wrong about the facts concerning the physical constitution of chemical elements and their melting points, then we would not be justified in making the inference. This is essentially to repeat the point that doxastic justification depends on propositional justification which in turn depends on the logical support relations between propositions. For Norton, the justification of inductive inference thus crucially depends on facts related to the subject matter of the inference. If these facts change, the epistemic status of our inductive beliefs will too, and since these facts will not generally supervene on one's occurrent and dispositional mental states, events and conditions, we can conclude that any subscriber to the material theory will be committed to an externalist epistemology in the sense defined above. At least of our inductive beliefs, justification will depend crucially on facts outside our mental lives (e.g. facts about the general uniformity of the physical properties of chemical elements).

Note that the same does not hold necessarily for theories of induction where inductive validity depends on the adherence of inductive implications to formal schema (nor for deduction, where it is relatively uncontroversial that deductive validity depends on adherence to formal schema). For whether an inference is justified depends on the validity of the implication, but the validity of the implication is determined by the contents of the propositions involved. Which propositions are involved supervenes on the subject's mental states, and so does the fact that they instantiate a particular schema. Put more simply, on formal accounts of inductive and deductive validity, validity depends on the *form* of the propositions involved in our inference, and these are facts that supervene on the contents of our thought.

This is of course not to say that we may never go wrong in determining whether our inference instantiates a particular schema. We often do. Our access to some properties of our thought is fallible. But the fact remains that these properties do supervene on those thoughts, and that is enough for the internalist as characterized in this paper.

All of this does not mean that it is not possible to give an external reading of some formal theory of induction. For this, it suffices to add a requirement of reliability to one's formal theory of induction. If one requires that inductive implication is valid only if it matches certain formal properties, and, in addition, these formal properties entail that inductively valid inference patterns will generate mostly true beliefs, then whether these requirements are met will partly depend on the external world, and so one's epistemology of inductive inference will be externalist. However, no such externalist requirement is necessary for the proponent of a formal theory of induction. The formal properties of propositions involved in inductive inference supervene on our (propositional) mental states, and so the minimal claim that justification of

inductive inference depends on the formal properties of the propositions involved has a possible internalist reading.¹⁵

Like extant forms of externalism, Norton's material theory of induction dissolves the problem of induction. But since the material theory *entails* an externalist epistemology, one may suspect it is this externalism that does the epistemological work here. And to a certain extent this seems right: like the reliabilist, Norton ultimately makes the justification of our inductive inferences depend on the contingent features of the external world. At times Norton's formulations resemble externalist accounts of justification:

[The material postulates] justify the induction, whether the inducing scientist is aware of them or not, just as the scientist may effect a valid deduction without explicitly knowing that it implements the disjunctive syllogism. (J. Norton, 2003b)

If we interpret the justification at issue as *epistemic justification*, and we replace [the material postulates] with [the fact that the belief is produced by a reliable method] then the quote simply expresses the reliabilist position. For the reliabilist, as long as our belief-forming process are reliable, their resulting beliefs are justified, whether we are aware of the reliability or not. What then surfaces as the primary difference between the epistemology Norton is committed to and the reliabilist, is the external facts that they think are the driving the justification of inductive inference. For Norton, it is local facts, the material postulates, whereas for the reliabilist, it is the general reliability of the method. And even in this regard Norton and the reliabilist may be less apart than is initially apparent, since presumably the reason *why* the material postulate 'generally, chemical elements are uniform in their physical properties' licenses the inductive implication from 'Some samples of the element bismuth melt at 271°C' to 'All samples of the element bismuth melt at 271°C' is that *if* this fact obtains, then the implication will generally preserve truth. And using inference patterns that generally preserve truth is of course a way to be reliable, or at least reliable conditional on the truth of their premises. The material postulates thus seem to be unified in the fact that they facilitate reliable inference. Of course, this is all a bit speculative, and I do not mean to imply this is the way Norton conceives of the epistemology of inductive inference, but it does show that his material theory of inductive implication entails an externalist epistemology that is at least compatible with reliabilism.

Perhaps, however, I am reading the quote above in the wrong way. Perhaps it is not a statement about the justification of inductive inference, but rather about the validity of inductive implication. As always, we must be careful not to confuse logic and epistemology. Interpreted more charitably, the quote merely specifies what is required for the inductive implication to be inductively valid. It is silent on what is required for inductive inference to be justified. Norton is free to add requirements for the epistemic justification of induction, such as a requirement to be able to provide arguments for believing the material postulates on which the implication's inductive validity depends.

¹⁵ If this were not the case, we would have an interesting argument against internalism generally, for the same holds for the epistemic justification of deductive inference, and formal accounts of deductive validity are relatively uncontroversial.

Let us suppose this line of defence is taken. Does the addition of extra requirements on epistemic justification open up the possibility for Norton to adopt an *internalist* epistemology of inductive inference? It does not. Because even the addition of additional requirements for justification does not detract from the fact that the material postulates are still needed for justification, and they are mind-independent facts that are sufficient to make the resulting theory qualify as externalist. So, our main point still stands.

There is another problem with this strategy, for such added internalist requirements seems too demanding, especially if Norton's theory is meant to cover laymen cases of inductive inference as well as scientific ones. For we routinely make inductive inferences in daily life, and presumably these are by and large justified. But most of the time people will be unable to refer to the material postulates in defence of our inferences. Take the example of the melting point of bismuth, but change it to be about the boiling point of water. Virtually everyone knows that all water boils at 100 degrees Celsius, and presumably many people are epistemically justified in believing so on the basis of an inductive inference with their experienced samples of boiling water as premise. But I submit that *not* many people can spell out the material postulates that justify these inferences if the material theory is correct. If people need to be aware of these postulates to be justified in making the inference, far less people than we think will be justified in their inductive beliefs. I conclude that an internalist reading of the epistemology of material inductive inference is implausible.

In closing this section, I want to briefly consider how to square our diagnosis of the epistemological implications of the material theory with Norton's own account of the situation.¹⁶ Is Norton aware that his material theory implies an externalist epistemology? As we saw in section 2, Norton characterizes the problem of induction as the problem that we cannot justify formal schema of induction. Since the material theory provides an alternative account of the validity of inductive implication that does not depend on such schema, he does not face the problem of induction. In short, Norton solves the epistemological problem of induction by changing the logic of induction. Norton does not clearly distinguish these problems in his writings. For example, as our discussion in the previous pages shows, Norton talks about material postulates *justifying* inductive inference, but he does not specify whether he means that they justify inductive inference (an epistemological claim) or that they validate inductive implication (a logical claim). Because he does not clearly draw the distinction between inductive inference and inductive implication, it is hard to judge whether Norton would agree that his theory has externalist implications. The fact that, to the best of my knowledge, Norton nowhere in his writings discusses the problem of induction in relation to the internalism/externalism opposition weakly suggests he is not aware that his theory of inductive logic implies an externalist epistemology. I believe the most charitable interpretation here is to assume that Norton simply means to be talking about the logic of inductive implication rather than about the epistemology of inductive inference.¹⁷ As I have argued in this paper, however, his account

¹⁶ Thanks to an anonymous referee for pressing me on this issue.

¹⁷ This can be supported by quotes such as the following from Norton's recent book manuscript on the material theory:

does have epistemological consequences. So, whether or not Norton is aware of this, he seems to be *committed* to externalism about inductive inference.

In this section, I argued that Norton is committed to an externalist epistemology. This means that it is not just the case that the material theory does not have an advantage over extant externalist accounts of (inductive) justification, like reliabilism, in terms of the ability to dissolve the problem of induction, but moreover, that it does not seem to have *any* epistemic advantages over other externalist theories of justification, at least not with respect to dissolving the problem of induction.

7. Conclusions

Let us take stock. In this paper I focussed on what may be called epistemic consequences of the material theory of induction. To be sure, the material theory is a theory of logic, not epistemology, but logic influences epistemology, and it is no different in the case of the material theory. In particular, one of the advantages of adopting the material theory, according to its principal defender, is that it allows one to evade the vexed problem of induction. In this paper I argued the material theory shares this epistemic benefit with other externalist theories, thus removing one reason for adopting the material theory specifically, at least with regard to the problem of induction.

The foregoing shows the advantages of connecting logic and epistemology. By studying the precise relations between these fields, we improve our evaluation of theories of logic and/or epistemology. In this case, I have critically evaluated one of the putative advances of adopting the material theory of induction. I argued that the material theory is not unique in providing these. Much will therefore depend on the other arguments Norton provides for the material theory of induction.

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“Throughout this volume, unless some context demands a momentary exception, I will restrict notions of inference and logic to relations of deductive and inductive support between propositions, independently of our beliefs and thought processes.” (J. Norton, n.d., p. 2)

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