Values in Science beyond Underdetermination and Inductive Risk

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Proponents of the value ladenness of science rely primarily on arguments from underdetermination or inductive risk, which share the premise that we should only consider values where the evidence runs out or leaves uncertainty; they adopt a criterion of lexical priority of evidence over values. The motivation behind lexical priority is to avoid reaching conclusions on the basis of wishful thinking rather than good evidence. This is a real concern, however, that giving lexical priority to evidential considerations over values is a mistake and unnecessary for avoiding the wishful thinking. Values have a deeper role to play in science.

1. Introduction. This article contributes to the project of understanding the structure of values in science. This is distinct from strategic arguments that try to establish that science is value laden while assuming premises of the defenders of the value-free ideal of science. It is becoming increasingly hard to deny that values play a role in scientific practice—specifically nonepistemic, noncognitive, or contextual values (e.g., moral, political, and aesthetic values; I will use the term "social values" to refer to such values in general). What is less clear is where scientific practice requires values or value judgments. This is not primarily a historical or sociological question, although historical and sociological data are frequently brought to bear. Ultimately it is a normative question about the role that value judgments ought to play in science, how they can and should contribute to scientific inquiry.

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†I would like to thank Ken Williford and the University of Texas at Arlington Philosophy Department; Martin Carrier, Don Howard, and the Center for Interdisciplinary Research (ZiF) at Bielefeld Universität; and Andrea Woody and the PSA for opportunities to present these ideas, as well as the audiences at those talks for their valuable feedback. I would especially like to thank Heather Douglas, Kevin Elliott, Kristen Intemann, Dan Hicks, and Philip Kitcher for their feedback and encouragement on this article.

Philosophy of Science, 80 (December 2013) pp. 829–839. 0031-8248/2013/8005-0008$10.00
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https://doi.org/10.1086/673720 Published online by Cambridge University Press

As such, we must consider both ethical questions about how the responsible conduct of science requires value judgment and epistemological questions about how the objectivity and reliability of science is to be preserved.

There are a number of phases of inquiry where values might play a role: in determining the value of science itself and the research agenda to be pursued, in framing the problem under investigation and the method of data collection, in choosing the hypothesis to propose, in the testing or certification of a proposed solution, and in choices about application and dissemination of results. Various accounts have allowed values in some stages, while excluding them in others, or have argued for specific limits on the role for values at each stage. In this article, I will focus on the testing phase, where theories are compared with evidence and certified (or not) as scientific knowledge, as this is the most central arena for discussion of value-free versus value-laden science. Traditionally, philosophers of science have accepted a role for values in practice because it could be marginalized into the "context of discovery," while the "context of justification" could be treated as epistemically pure. Once we turn from the logical context of justification to the actual context of certification in practice, the testing of hypotheses within concrete inquiries conducted by particular scientists, we can no longer ignore the role of value judgments.[1]

There are two main arguments in the literature for this claim: the *error argument* from inductive risk and the *gap argument* from the underdetermination of theory by evidence. While both arguments have historically been important and have established important roles for values in science, they share a flawed premise, *the lexical priority of evidence over values*.[2] While this premise serves the important aim of avoiding the problem of wishful thinking, I argue that there are several problems with this premise. We should seek an alternative ideal for science that provides a deeper and broader role for values but nevertheless preserves an important feature of science: the ability to surprise us with new information beyond or contrary to our hopes and expectations.

2. Underdetermination: The Gap Argument. Underdetermination arguments for the value ladenness of science extend Duhem's and Quine's thoughts about testing hypotheses. The starting point for this argument may be the so-called Duhem-Quine Thesis (or Duhem-Neurath-Quine; Rutte 1991, 87) that no hypothesis can be tested in isolation because auxiliary assumptions are needed for theories to generate testable hypotheses. There

1. I use "context of certification," following Kitcher (2011), as referring to actual practices of acceptance.

2. Strictly speaking, both arguments can be taken as strategic arguments, compatible with any positive approach to the role of values in scientific inquiry. For the purposes of this article, I will instead take the arguments as attempts to articulate a positive ideal.

https://doi.org/10.1086/673720 Published online by Cambridge University Press

exists what Helen Longino calls a "semantic gap" between theory and evidence (Longino 2002, 2004, 2008). This is generally taken to imply that no theory can be definitively falsified by evidence, as the choice among rejecting the theory, altering the background assumptions, or even (although more controversially) rejecting the new evidence itself is underdetermined by each new item of evidence—call this "holist underdetermination" (Stanford 2009). Another form of underdetermination—"contrastive underdetermination" (Stanford 2009)—depends on the choice between identically confirmed rival hypotheses. As all of the evidence available equally supports either hypothesis in such cases, that choice is underdetermined by the evidence.

If the evidence we are talking about is just all the evidence we have available to us at present, then we have *transient* underdetermination, which might be relatively temporary or might be a recurrent problem. If instead the choice is underdetermined by all possible evidence, we have *permanent* underdetermination, and the competing theories or hypotheses are empirically equivalent. The *global* underdetermination thesis holds that permanent underdetermination is ubiquitous in science, applying to all theories and hypotheses.[3]

The many forms of underdetermination arguments have in common the idea that some form of gap exists between theory and observation. Feminists, pragmatists, and others have sought to fill that gap with social values or to argue that doing so does not violate rational prescriptions on scientific inference. Call this the *gap argument* for value-laden science (Intemann 2005; Elliott 2011). Kitcher (2001) has argued that permanent or global underdetermination is needed to defeat the value-free ideal of science, and these forms of underdetermination are much more controversial. Transient underdetermination, however, is "familiar and unthreatening," even "mundane" (30–31).

Kitcher is wrong on this point; transient underdetermination is sufficient to establish the value ladenness of scientific practice (Biddle 2013). What matters are decisions made in practice by scientists, and in many areas of cutting-edge and policy-relevant science, transient underdetermination is pervasive. Perhaps it is the case that in the long run of science (in an imagined Peircean "end of inquiry") all value judgments would wash out. But as the cliché goes, in the long run we are all dead; for the purposes of this discussion, what we are concerned with are decisions made now, in the actual course of scientific practices, when the decision to accept or reject a hypothesis has pressing consequences. In such cases, we cannot wait for the end of inquiry for scientists to accept or reject a hypothesis, we cannot depend on anyone else to do it, and we must contend with uncertainty and

3. For discussion of forms of underdetermination, see Kitcher (2001), Magnus (2003), Intemann (2005), Stanford (2009), and Biddle (2013).

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underdetermination (see Elliott 2011, 62–64). Actual scientific practice supports this—scientists find themselves in the business of accepting and rejecting hypotheses in such conditions.

So what is the role for social values under conditions of transient underdetermination? Once the evidence is in, a gap remains in definitively determining how it bears on the hypothesis (holist case) or which competing hypothesis to accept (contrastive case). In this case, it can be legitimate to fill the gap with social values. Among the competing hypotheses still compatible with all the evidence, one might accept the one whose acceptance is likely to do the most good or the least harm. In social science work involving race, this might be the hypothesis most conducive to racial equality. One might do this in a more nuanced way, mediating the decision via appropriate auxiliary assumptions or constitutive values.

A common response is that despite the existence of the gap, we should ensure that no social values enter into decisions about how to make the underdetermined choice (e.g., whether to accept a hypothesis). Instead, we might fill the gap with more complex inferential criteria (Norton 2008) or with so-called epistemic or cognitive values (Kuhn 1977; McMullin 1983). Proponents of the gap argument have argued that this at best pushes the question back one level, as choices of epistemic criteria or cognitive values (Longino 2002, 185) and the application of cognitive values may not be entirely determinate (Kuhn 1977). Ensuring that no values actually enter into decisions to accept or reject hypotheses under conditions of transient underdetermination may turn out to be impossible (Biddle 2013). Another attempt to avoid a role for social value judgments—withholding judgment until transient underdetermination can be overcome or resolved by application of cognitive factors alone—is unreasonable or irresponsible in many cases, for example, when urgent action requires commitment to one or another option (Biddle 2013).[4]

What distinguishes legitimate from illegitimate uses of values to fill the gap is a matter of controversy, sometimes left unspecified. With some exceptions,[5] underdeterminationists insist that values only come into play in filling the gap (e.g., Longino 1990, 52; 2002, 127; Kourany 2003, 10).

3. Inductive Risk: The Error Argument. While underdeterminationist arguments for values in science are probably more well known, and may have a history going back to Neurath's early work (Howard 2006), the *induc-*

4. Proponents of the error argument make a similar point.

5. These exceptions either use a somewhat different sort of appeal to underdetermination than the gap argument, or they use the gap argument as a strategic argument. One example is the extension of the Quinean web of belief to include value judgments (Nelson 1990); cf. n. 3 and sec. 7.

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tive risk argument for values in science is older still, going back to William James (1896).[6] Heather Douglas has revived Rudner's (1953) and Hempel's (1965) version of the argument for the value ladenness of science, which basically goes as follows.

In accepting or rejecting hypotheses, scientists can never have complete certainty that they are making the right choice—uncertainty is endemic to ampliative inference. So, inquirers must decide whether there is enough evidence to accept or reject the hypothesis. What counts as enough should be determined by how important the question is, that is, the seriousness of making a mistake. That importance or seriousness is generally (in part) an ethical question, dependent on the ethical evaluation of the consequences of error. Call this argument for the use of value judgments in science from the existence of inductive risk the *error argument* (Elliott 2011).

According to the error argument, the main role for values in certification of scientific hypotheses has to do with how much uncertainty to accept, or how strict to make your standards for acceptance. In statistical contexts, we can think of this as the trade-off between type I and type II error. With a fixed sample size (and assuming no control over the effect size), the only way we can decrease the probability that we wrongly reject the null hypothesis is to increase the probability that we wrongly fail to reject the null hypothesis, and vice versa. Suppose we are looking for a causal link between a certain chemical compound and liver cancers in rats, and you take H_0 to be no link whatsoever.[7] If you want to be absolutely sure that you do not say that the chemical is safe when it in fact is not (because you value safety, precaution, welfare of potential third parties), you should decrease your rate of type II errors and thus increase your statistical significance factor and your rate of type I errors. If you want to avoid "crying wolf" and asserting a link where none exists (because you value economic benefits that come with avoiding overregulation), you should do the reverse.

Douglas emphasizes at length that values should never be taken as reasons for accepting or rejecting a hypothesis, reasons on a par with or having the same sort of role as evidence in testing. This is an impermissible direct role for values. In their permissible indirect role, values help determine the rules of scientific method, for example, decisions about how many false positives or false negatives to accept. Values are not reasons guiding belief or acceptance; they instead guide decisions about how to manage uncertainty.[8]

6. This point is due to P. D. Magnus (2013, 845), who refers to the inductive risk argument as the "*James-Rudner-Douglas* or *JRD thesis*" for reasons that will become immediately apparent.

7. Douglas (2000) considers the actual research on this link with dioxin.

8. In Toulmin's (1958) terms, values cannot work as grounds or warrants for claims, but they can work as backing for warrants that connect grounds and claims.

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Rudner (1953) anticipated the (common) objection that scientists should not be in the business of accepting or rejecting hypotheses but rather just indicating their probability (and thus not having to make the decisions described above). This gambit fails for several reasons: because there are inductive risks in phases of inquiry before final certification and because probabilistic hypotheses are just as open to inductive risks as others. Furthermore, the pragmatic signal that accompanies a refusal to assent or deny a claim in practical or policy circumstances may be that the claim is far more questionable that the probabilities support. Simply ignoring the consequences of error—by refusing to accept or reject, by relying only on cognitive values, or by choosing purely conventional levels for error—may be irresponsible, as scientists like anyone else have the moral responsibility to consider the foreseeable consequences of their action.

4. A Shared Premise. These two arguments against the value freedom of science share a common premise. The gap argument holds that values can play a role in the space fixed by the evidence; if the gap narrows (as with transient underdetermination), there are fewer ways in which values can play a role, and if the gap could ever close, the conclusion would be value free.[9] The inductive risk argument allows values to play a role in decisions about how to manage uncertainty, not directly by telling us which option to pick but indirectly in determining how much uncertainty is acceptable.

Both arguments begin from a situation where the evidence is fixed and take values to play a role in the space that is left over. The reason that values must play a role is that uncertainty remains once the evidence is in. In a relatively weak version of this argument, social values fill in the space between evidence and theory because something has to, so it might as well be (and often is) social values. In more sophisticated versions, we must use social values to fill the gap because of our general moral obligation to consider the foreseeable consequences of our actions, including the action of accepting a hypothesis. The arguments of these two general forms all assume *the lexical priority of evidence over values*. The premise of lexical priority guarantees that even in value-laden science, values do not compete with evidence when the two conflict. This is often defended as an important guarantor of the objectivity or reliability of the science in question.

5. Why Priority? Why do proponents of value-laden science tend to be attracted to such a strict priority of evidence over values? Perhaps some such restriction is required in order to guarantee the objectivity of science. In order for our science to be as objective as possible, maybe it has to be as value free as possible (although this may not be very value free at all). That

9. Unless the view is supplemented by a form of holism more radical than Quine's.

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is, we want as much as possible to base our science on the evidence because evidence lends objectivity and values detract from it. This would be a problematic justification for opponents of the value-free ideal of science to adopt. With the gap and inductive risk arguments, they mean to show that values and objectivity are not in conflict as such. It would thus create a serious tension in their view if one premise depended on that conflict. If it is really objectivity that is at stake in adopting lexical priority, we need a more nuanced approach.

The main concern is that value judgments might "drive inquiry to a predetermined conclusion" (Anderson 2004, 11), that inquirers might rig the game in favor of their preferred values. As Douglas (2009) puts it, "Values are not evidence; wishing does not make it so" (87). In other words, a core value of science is its ability to surprise us, to force us to revise our thinking. Call the threat of values interfering with this process the *problem of wishful thinking*.

Lexical priority avoids this problem insofar as what we value (which involves the way we desire the world to be) is only a consideration after we take all of the evidence (which fixes the way the world is) into account. In Douglas's more nuanced approach, even once the evidence is in, social values (and even most cognitive values) are not allowed to be taken directly as reasons to believe anything; they only act as reasons for accepting a certain amount of evidence as "enough."

An alternative explanation may be that the adoption of lexical priority has *rhetorical value*.[10] Suppose, along with the defenders of the value-free ideal, that there is such a thing as *objective evidence*, which constrains belief. Even so, there is (at least transient) underdetermination and a gap that must bridged by social values. Such an argument can undermine the value-free ideal and establish that there is a major role for values in science, but as we turn instead to the positive project of determining more precisely the roles of values in science, the premises of such an immanent critique are unfit ground for further development. We no longer need to take the premises of our opponents on board, and we may find that they lead us astray.

While following the basic contours of my argument so far, one might object to characterizing of evidence as "prior" to values.[11] What the gap and inductive risk arguments purport to show is that there is always some uncertainty in scientific inference, and so there will always be value judgments to be made about when we have enough evidence or which among equally supported hypotheses we wish to accept, and so on. The pervasive need for such judgments means that value freedom does not even make sense as a limiting case; both values and evidence play a role, and neither is before the

10. My thanks to Don Howard for proposing this alternative interpretation.

11. My thanks to P. D. Magnus for bringing this objection to my attention.

https://doi.org/10.1086/673720 Published online by Cambridge University Press

other. This mistakes the sense of "priority" at work, however. Where priority matters is what happens when values and evidence conflict; in such circumstances, lexical priority means that evidence will always trump values.

6. Problems with Priority. The versions of the gap and inductive risk arguments that presuppose the lexical priority of evidence make two related mistakes. First, they require a relatively uncritical stance toward the status of evidence within the context of certification, relative to values.[12] The lexical priority principle assumes that in testing we ask, given the evidence, what should we make of our hypothesis? Framed this way, values only play a role at the margins. This is a mistake since evidence can turn out to be bad in many ways: unreliable, unrepresentative, noisy, laden with unsuitable concepts and interpretations, or irrelevant for the question at hand. More importantly, we may be unaware of why the evidence is bad; it took a great deal of ingenuity on the part of Galileo to show why the tower experiment did not refute Copernicus, and it took much longer to deal with the problem of the "missing" stellar parallax. While some epistemologists stick to an abstract conception of evidence according to which evidence is itself unquestionable, philosophers of science recognize that we can be skeptical about particular pieces or sets of evidence based on their clash with hypotheses, theories, or background assumptions that we have other good reasons to hold. As critics of strict falsificationism and empiricism have shown, we already have reason to adopt a more egalitarian account of the process of testing, independent of the question about the role of values. On such a picture, hypotheses and putative evidence are treated more on a level in processes of certification.

Second, the attitude about values that lexical priority takes reduces the idea of value judgment to merely expression of preferences rather than judgment properly so-called—in effect, they deny that we can have good reasons for our value judgments, or at least, they hold that they are systematically less reasonable. It is crucial to distinguish between preferences or valuings and value judgments or evaluations (Dewey 1915, 1939; Welchman 2002; Anderson 2010). Valuing may be the expression of a preference, but value judgments are reflective decisions about what to value and are better and worse on the basis of reasons. Value judgments may even be open to empirical test because they hypothesize relationships between a state or course of action to prefer and pursue and the desirability or value of the consequences of pursuing and attaining them (Dewey 1915; Anderson 2010). "Roughly speaking, a value judgment hypothesizes 'try it, you'll like it'"—

12. As Douglas (2009) makes clear, she does not take the status of evidence as unproblematic, as such. But any issues with the evidence are to be taken into account by prior consideration of values in selection of method and characterization of data, not the context of certification.

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a testable hypothesis (Anderson 2010). The evidence by which we test value judgments may include the emotional experiences that follow on adopting those values (Anderson 2004).

If value judgments are really judgments—adopted for good reasons, subject to certain sorts of tests—then it is unreasonable to treat them according to the lexical priority of evidence. Just as the good (partly empirical) reasons for adopting a theory, hypothesis, or background assumption can sometimes give us good reasons to reinterpret, reject, or even ignore evidence apparently in conflict with them, so too with a good value judgment. In treating values as having qualitatively lower epistemic status than evidence, lexical priority shows itself to be an unreasonable presumption. If evidence and values pull in opposite directions on a hypothesis, then we should not always be forced to follow the (putative) evidence.

7. Avoiding Wishful Thinking without Priority. If we reject the lexical priority assumption and adopt a more egalitarian model of testing, we need to adopt an alternative approach that can avoid the problem of wishful thinking. An alternative principle to lexical priority is the joint necessity of evidence and values, which requires joint satisfaction of epistemic criteria and social values. This is the approach taken by Kourany (2010). On such a view, the insertion of values, far from detracting from the rigor and objectivity of science, requires more rigorous standards of inquiry. Neither evidence nor values takes priority on a joint necessity account, but this principle leaves open the question of what to do when evidence and values clash. One option is to remain dogmatic about both epistemic criteria and social values and to regard any solution that flouts either as a failure, which appears to be Kourany's approach (Brown 2013; but see also Kourany 2013).

Alternatively, we can adopt the rational revisability of evidence and values in addition to joint necessity and revisit and refine our evidence or values. On this principle, both the production of evidence and value formation are recognized as rational but fallible, revisable processes. Such views include the radical version of Quinean holism that inserts values into the web of belief (Nelson 1990). The adoption of these two principles alone does not prevent wishful thinking, but adding some basic restrictions like minimal mutilation may overcome the problem (cf. Kitcher 2011).

Instead of Quinean holism, we might instead adopt a form of pragmatist functionalism about inquiry (Brown 2012), which differentiates the functional roles of evidence, theory, and values in inquiry. This retains the idea that all three have to be coordinated and that each is revisable in the face of new experience, while introducing further structure into their interactions. According to such an account, not only must evidence, theory, and values fit together in their functional roles, but they must do so in a way that actually resolves the problem that spurred the inquiry.

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8. Conclusion. The lexical priority of evidence over values is an unreasonable commitment and unnecessary for its goal of avoiding wishful thinking. The key to the problem of wishful thinking is that we not predetermine the conclusion of inquiry, that we leave ourselves open to surprise. The real problem is not the insertion of values but dogmatism about values (Anderson 2004). Rather than being the best way to avoid dogmatism, the lexical priority of evidence over values coheres best with a dogmatic picture of value judgments and so encourages the illegitimate use of values. A better account is one in which values and evidence are treated as mutually necessary, functionally differentiated, and rationally revisable components of certification. Such an account would allow that evidence may be rejected because of lack of fit with a favored hypothesis and compelling value judgments, but only so long as one is still able to effectively solve the problem of inquiry.

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