The Value of Cognitive Values

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Traditionally, cognitive values have been thought of as a collective pool of considerations in science that frequently trade against each other. I argue here that a finer-grained account of the value of cognitive values can help reduce such tensions. I separate the values into groups, minimal epistemic criteria, pragmatic considerations, and genuine epistemic assurance, based in part on the distinction between values that describe theories per se and values that describe theory-evidence relationships. This allows us to clarify why these values are central to science and what role they should play, while reducing the tensions among them.

1. Introduction. The value of cognitive values has been underdeveloped in philosophy of science.[1] They have largely been considered together in one group, and when examined in this light, they seem to trade off against one another, creating as much tension as guidance for scientific inference. Although some work has examined a particular value in greater depth and attempted to ground a justification for its importance in an epistemic argument (e.g., Forster and Sober 1994), for the most part, the values have been justified collectively and historically, that is, that some set of values is (by and large) what has been important to scientists in their practice and that that should be good enough for philosophers of science (e.g., Kuhn 1977).

This article will attempt a more robust justification. Through the tactic of organizing the conceptual terrain of cognitive values, I will argue that there are four distinct groups of values that normally get lumped together. Once the values are divided into these groups, it is clearer why the values

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1. Cognitive values have also been called epistemic values or theoretical virtues in the philosophy of science literature.

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are important and what their value to science and to scientists is. Justifications, clarifying the value of cognitive values, then follow. Creating these divisions requires finer-grained appraisals of the values than has been customary. For example, internal consistency will be considered distinct from external consistency. Simplicity has two distinct aspects as well, as does scope. While this multiplies the values, it will also create a less complex decision challenge for scientists than the collective pool.

This is because another benefit of clarifying the terrain is that the supposed tensions among the values prove to be far less common and problematic than is often presumed. Once the bases for the values becomes clearer, their functions in science become clearer, and thus which should be important when is clarified. In addition, as we will see, the values within a group are shown to often pull together rather than against each other. Finally, organizing the terrain and mapping the value of cognitive values will also illuminate the criticisms raised concerning the canonical distinction between epistemic/cognitive and nonepistemic/noncognitive values (e.g., Rooney 1992) and criticisms over what should count as a cognitive/epistemic value (e.g., Longino 1996).

First, I will provide a brief overview of how the standard view on cognitive values developed. Then, I will offer a more nuanced terrain for those values than has been traditionally offered. I will proceed to show how both tensions among the values are reduced (albeit not eliminated) and how the justifications for the various values are clarified. In conclusion, I will draw implications from this reorganization of the terrain.

2. A Brief History of Cognitive Values. Philosophers of science have long referred to and discussed various qualities of scientific claims deemed important in science. In the twentieth century, philosophers such as Duhem (1906/1982, 171, 217), Popper (1935/2002, 61–73, 122–28), and Levi (1960, 354; 1962, 49) famously described a range of qualities (and sometimes provided reasons for the importance of those qualities). But it was not until Kuhn's 1977 paper that these qualities became widely known as values, with the discussion framed in terms of values internal to science. For Kuhn (1977), McMullin (1983), Laudan (1984), and Lacey (1999), the values were a collective (if evolving) set. And there were clear tensions and trade-offs among the various values thought relevant at any given time. One might gain scope in a theory but lose precision. One might gain simplicity but lose scope. Understanding the history of science meant understanding how scientists made those trade-offs (or shifted their interpretation of those values) in the course of scientific debate.

But the collective pool of these values turns into a problematic swamp when one attempts to find a grounding for the values. This problem was worsened by the tendency of philosophers, in an attempt to make the values

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appear less overwhelming, to collapse various attributes together. For example, although some distinguished internal consistency (minimal logical consistency of a theory) from external consistency (broader considerations of whether a theory fit with prevailing scientific views), other philosophers collapsed the two and considered consistency tout court (e.g., Kuhn 1977, 357 vs. McMullin 1983, 15). This makes it harder to see how to justify consistency. While internal consistency can be viewed as a minimal requirement of empiricism (Duhem 1906/1982, 220; Popper 1935/2002, 72), external consistency is nothing of the sort and is valuable only insofar as one's confidence in the rest of scientific theory is high. Collapsing such attributes obscures their purpose and meaning.

It is time to extricate ourselves from this swamp. Laudan (2004) made the first steps in this direction when he divided theoretical virtues into those that were genuinely epistemic (truth indicative) and those that were cognitive (valued by scientists for other reasons). He suggested that few of the traditional theoretical virtues (construed as the swampy collective described above) have genuine epistemic (i.e., truth-indicative) merit. Two that did (on his view) were internal consistency and empirical adequacy. Laudan's distinction is a good start on the problem, but I will go further here, dividing up the terrain of cognitive values in an attempt to elucidate their strengths, their purposes, and their justifications.

3. The Terrain of Cognitive Values. Two distinctions will help our project. First, following both Laudan (2004) and Douglas (2009), we can distinguish between ideal desiderata and minimal criteria. We might prefer one grand, simple, unified theory of great scope that explains everything, but in practice we are willing to settle for less. (Indeed, some arguments for pluralism suggest we should be happy with a complex plurality of perspectives; see, e.g., Kellert, Longino, and Waters 2006; Mitchell 2009.) In contrast, there are some virtues or values that any acceptable scientific theory must instantiate (e.g., internal consistency). We might accept a theory that falls short on these criteria out of shear desperation, but we would know something was wrong and work furiously to correct it.

With this first distinction we can distinguish between internal consistency (a minimal criteria) and external consistency (an ideal desiderata, presuming a general confidence in other scientific theories). We can distinguish between predictive competency (the requirement that a theory at least minimally accommodate the available evidence) and predictive power or precision (that a theory predict successfully new evidence and do so precisely).

Second, it is important to note that in discussing the set of cognitive values, philosophers have lumped together two different kinds of things in science to which cognitive values can apply. By "apply," I mean that which the values are thought to describe, or the object of instantiation for the value

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(i.e., what has the value). The object of instantiation can either be a theory per se or the theory in relation to the evidence thought to be relevant to it. There are thus two different directions for assessment when using cognitive values: Are we describing the theory itself or the theory in relation to the available evidence?

To see how crucial these two different targets for cognitive values can be, consider the value of scope. If we are talking about a theory with scope (and just the theory), the theory might have the potential to apply to lots of different terrain or to wide swaths of the natural world (i.e., the claims it makes are of broad scope), but whether it in fact does so successfully can still be up in the air. Any proposed grand unified theory can be considered to have scope in this sense—it has broad scope but not in relation to any actual evidence yet gathered under that scope. Contrast that with a theory that already does explain a wide range of evidence and phenomena—so that the scope applies to a theory in relation to broadly based evidence (e.g., evidence from different phenomena or evidence gathered in different ways). Here the value of the cognitive value is quite different and brings with it an epistemic assurance from the diversity of evidence supporting the theory.

A similar point can be made with regard to simplicity. A simple theory (i.e., a simple *theory*, and not where simplicity is describing a relation to evidence) might be prima facie attractive, but unless we think the world actually is simple, we have little reason to think it true. A simpler theory, all other things being equal, is not more likely to be true. Contrast this with a theory that is simple with respect to the complex and diverse evidence that it captures. The simpler theory, in relation to the evidence it explains, is more likely to not be overfit to the evidence and thus more likely to be predictively accurate (Forster and Sober 1994). In such a case, simplicity has genuine epistemic import.

With these two distinctions in mind—(1) what we want our values for (minimal criteria vs. ideal desiderata) and (2) to what the value applies (the theory per se vs. the theory in relation to evidence)—we can turn to the terrain for such values. There are four groups into which we can divide the cognitive value terrain:

> *Groups 1 and 2*: Values that are minimal criteria for adequate science, applied to the theory per se (group 1) or the theory in relation to evidence (group 2)

These are values that are genuinely truth assuring, in the minimal sense that their absence indicates a clear epistemic problem. If a theory lacks these values, we know that something is wrong with our theory. Thus, these are truly minimal criteria, values that must be present if we are to be assured we are on the right track. These values include internal consistency (which

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is about the theory per se) and empirical adequacy (as measured against existing evidence, not all possible evidence, and thus is about the theory with respect to evidence). Philosophers as diverse as Duhem (1906/1982), Popper (1935/2002), Laudan (2004), and Douglas (2009) have noted these values as minimal criteria.

Group 3: Values that are desiderata when applied to theories per se

These are values that, when instantiated solely by the theory or claim of interest, give no assurance as to whether the claims that instantiate them are true but give us assurance that we are more likely to hone in on the truth with the presence of these values than in their absence. As such, these might be considered strategic or pragmatic values. I have used the term *cognitive* values, emphasizing the aid to thinking (Douglas 2009); Dan Steel has called them extrinsic epistemic values (2010). These include scope, simplicity, and (potential) explanatory power. When theories (or explanations or hypotheses) instantiate these values, they are easier to work with. Simpler claims are easier to follow through to their implications. Broadly scoped claims have more arenas (and more diverse areas) of application to see whether they hold. Theories with potential explanatory power have a wide range of possible evidential relations. (I say potential because if the theory has actual, known explanatory power, that implies that evidence is already gathered under its umbrella and this would bring us to the next category of values.) It is easier to find flaws in the claims and theories that instantiate these values. It is easier to gather potentially challenging (and thus potentially strongly supporting) evidence for them. In this sense, all of these values fall under the rubric of the fruitfulness of the theory.

Group 4: Values that are desiderata when applied to theories in relation to evidence

Finally, we should consider values that sound similar to pragmatic cognitive values (group 3), but because they qualify the relationship between theory and evidence, rather than just theory itself, they provide a different kind of assurance. Whereas groups 1 and 2 assured us that we have a viable scientific theory (genuine epistemic assurance) and group 3 assured us that, if we were on the wrong track, we should find out sooner rather than later, group 4 provides a particular kind of genuine epistemic assurance.

It provides assurance that our scientific claims are more likely to be reliable, that the evidence for them is in a strong form, or that we have not inadvertently made up a theory that only seems to fit the evidence, but is just a reflection of our own conceptual predispositions (i.e., assurance

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against ad hocery). One of our most central concerns in science is that we have a theory that looks good for a particular area, but all we have done is construct something that fits the narrow range of evidence for which it was made. If our theories are ad hoc in this way, they will have little reliability moving forward. Instantiation of these values in the relation between the theory and the evidence that supports it provides assurance that our theories will be reliable. If a diverse range of evidence can be explained, or the theory fits well with other areas of science (and, crucially, the evidence that supports them), or the theory makes successful novel predictions, we gain precisely the assurance we need. For this reason, these values have genuine positive epistemic import. These values include unification (in terms of explanatory scope, simplicity, external consistency, and coherence), novel prediction, and—modifying these values with an additional layer—precision.

What does this map of the terrain clarify? First, with this map we can see that the values do have justifications independent of scientists' historical reliance on them. We can articulate reasons why a scientist should care about these values and clarify what they are good for. There are clear epistemic reasons (independent of any particular objectives of science at any particular period) for demanding that scientific theories be internally consistent and empirically competent (groups 1 and 2). And there are good epistemic reasons for preferring scientific theories supported by a broad range of evidence (or some other value in group 4—more on this below). Finally, there are good pragmatic reasons for scientists to run with a simpler, broader, or more fruitful theory (group 3) if one is trying to decide where to put research effort next.

Second, the idea that the values are in a collective pool and pull against each other is misguided. Having this map makes it clearer what the purposes of the values are and shows that the tensions among the values are not as acute or problematic as they appeared when considered as a collective pool.

4. Reducing the Tensions among the Values. There are two possible sources of tensions within the terrain I have mapped above. The first arises from tensions among the groups of values. The second arises from tensions within each group.

Among the groups, one reduction in tension should be immediately clear. Minimal criteria do not (or at least should not) pull against pragmatic fruitfulness concerns of group 3 or the epistemic assurance concerns of group 4. Minimal criteria come first, and both must be met. Indeed, one cannot tell whether one has an empirically competent theory without minimal internal consistency. In practice, scientists may still choose to pursue the development of a theory with the characteristics of group 3, even in the face of

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failings in groups 1 and 2 (minimal criteria). But this must be done with full acknowledgment that the theory is inadequate as it stands and that it must be corrected to meet the minimum requirements as quickly as possible. Although philosophers like to quip that every scientific theory is "born falsified," no scientist should be happy about it.

Once the remaining values are divided into the pragmatic cognitive values (instantiated by theories only—group 3) and the epistemic assuring values (instantiated by the relations between theories and evidence—group 4), the two groups have less problematic tension within each than previously thought. Consider the possible tensions within the pragmatic cognitive values—group 3. Recall that within this group, the values describe theories or claims on their own, independent of the evidence that may or may not support them. In this group, all of these values are ultimately about the fruitfulness of the theory, the ease with which scientists will be able to use the theory in new contexts (not necessarily successfully), to devise new tests for the theory, and thus to refine, revise, or if need be overhaul completely the theory. It is true that some scientists will find scope an easier handle with which to further test a theory, as they will find it more amenable to apply the theory in a new arena to which the broadly scoped theory is applicable, and some scientists will find simplicity an easier handle with which to devise further tests. So some tensions may remain around the issue of what will be fruitful for different scientists.

But this need not create any epistemic worries, for three reasons. First, the proof will be in the pudding for fruitfulness, and the pudding is relatively straightforward to assess. If the theory cannot be used to devise additional tests, if the scientists are unable to use the aspects of the theory that instantiate the value they prefer, then the value is of no further use in that case. We will be able to tell readily if the instantiation of a pragmatic-based value in fact proves its worth. Second, because this category of values does not provide epistemic warrant but is instead focused on the pragmatic issue of the fruitfulness of a theory, there is little reason to be concerned about divergent scientific perspectives on these values. None of these pragmatic values provide a reason to accept a theory as well supported or true or reliable at the moment. Group 3 values are simply not epistemic. Third, social epistemological approaches to science (e.g., Solomon 2001; Longino 2002) have made it quite clear that having diverse efforts in scientific research is a good thing for science, that diversity of efforts in science is crucial for the eventual generation of reliable knowledge. So scientists having diverse views about what makes a theory fruitful is not a problem but a benefit for science. In sum, the values in this group are pragmatic, they are easily assessable by external criteria (are more new tests being produced?), their diversity supports a diversity of epistemic effort, and yet, they do not

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have direct epistemic import. Whatever tensions arise here can play out in diverse efforts of research practice.

Consider next the possible tensions within group 4. Because these values do have genuine epistemic import, tensions among them would be central to the problem of scientific inference and the epistemic assessment of scientific theories. But examining these values as instantiated by the relation between theories and the evidence that supports them reveals less tension among these values than initially appears. While simplicity, scope, and explanatory power are often thought to pull against each other when considering theories alone (group 3), they pull together when considering a theory in relation to evidence (group 4). A theory that has broad scope over diverse evidence is also simple with respect to that diverse evidence, unifies that diverse evidence, and has explanatory power over that evidence. Indeed, it is this set of relations that Paul Thagard (2000) has formalized under his conception of "coherence." Scientists might disagree over which evidence is more important to unify or explain under a particular rubric, either because of different purposes or because of different views on the reliability of the evidence under consideration. But that is a disagreement over which instantiation of a cognitive value is more important, not a disagreement based on tensions among values.

Yet there are still some tensions in group 4. For example, predictive accuracy (or the value of the novel prediction) might pull against the considerations captured by coherence. And indeed, when faced with such a tension, scientists can legitimately disagree, some scientists finding greater epistemic assurance in the successful novel prediction and other scientists finding greater epistemic assurance in the successful unification of evidence (i.e., the explanatory coherence of a theory). When we have both together, both successful explanation of the available evidence and a surprising prediction (use novel or temporally novel), we have Whewell's consilience (Fisch 1985), which is perhaps the strongest epistemic assurance we have available to us. When consilience is on the table, it is hard for other theories to compete. But we are not always so lucky. Hence, genuine epistemic tension can be present.

There is an additional qualifier for the value considerations of group 4. Whether we are considering the relation between theory and evidence that is some form of coherence or some form of prediction, the precision or tightness of fit between the theory and evidence also matters. The more precise the explanatory relations between theory and evidence, or the more precise the prediction *and* the evidence that tests it (having just one or the other is not helpful), the more we gain the epistemic assurance of group 4. This assurance is that we have not just made our theories up but that they have some empirical grip on the world. The more precision we have in the

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relations between theory and evidence, the more assurance we get. The more successful predictions we have, the more assurance we get. The more coherence or explanatory power over diverse evidence we have, the more assurance we get. Because there are these different sources of this kind of assurance, there will be tensions among them in practice. But why these tensions arise should be clearer.

So what of tensions between the values of group 3 and group 4? These two groups aim at different purposes, and thus any apparent conflict dissolves. It is particularly important to note that group 3, pragmatic cognitive values, has no bearing on what should be thought of as our best supported scientific knowledge at the moment. That a theory looks fruitful (whether because of its innate simplicity, scope, or potential explanatory power) is no reason to think it more reliable now than any other narrower or more complex theory. If one needs epistemic assurance, particularly for an assessment of our best available knowledge at the moment, group 4 is where one should look (after the requirements of groups 1 and 2 are met). When one needs to figure out what should be considered reliable knowledge now, pragmatic fruitfulness (group 3) concerns have no bearing. When one wants to justify future research endeavors, such pragmatic concerns are central.

With an account of the bases for cognitive values, their functions are clarified, reducing tensions among the values. Groups 1 and 2 (both necessary) trump groups 3 and 4. Groups 3 and 4 have different purposes. Within the groups, there are no tensions within groups 1 and 2, there are productive tensions within group 3, and there remain some tensions within group 4 (e.g., explanatory coherence vs. novel prediction). While some tensions among values remain, they are much reduced from the traditional view.

5. Implications. In earlier accounts of cognitive values, the tensions among them were thought to explain how scientists at any given moment could rationally disagree with each other—different scientists focused on different values. Does my organization of the values dissolve this ready-made explanation for rational disagreement? No—there are still resources we can draw on to explain disagreement. For example, one can still see a tension between the explanatory scope of a theory (with respect to available evidence—group 4) and the predictive precision of its competitor. Such a tension will likely continually arise in scientific practice. Or, consider the tension between a well-supported theory (with group 4 values supporting it) and an underdeveloped theory (with lots of group 3 values and thus lots of potential) when a scientist is deciding which theory to pursue next. The explanations of divergent choices that we give—scientists being risk takers with new theories or staying with the older, more developed theories—still hold in the account given here but with a sharper understanding of the source of the divergent choices. Indeed, we should help scientists distinguish an epistemic

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assessment from a pragmatic fruitfulness assessment in their commitments to scientific theories. Finally, social and ethical values are also important in deciding whether the available evidence is sufficient for a claim, and this is another source of rational disagreement among scientists (Douglas 2009). The organization of cognitive values provided here does not eliminate the uncertainty that drives the need for evidential sufficiency assessment. Rather, group 4 values can be part of the assessment of how much uncertainty is present, by helping to assess the strength of evidence for a claim. Social and ethical values, as well as pragmatic cognitive (group 3) values, still play an important role in deciding whether such strength is enough.

What has been gained in this account of the cognitive values? First, we can see more clearly where and why such values are indeed valuable. The justification need no longer rest on the contingency of the history of science (although it is certainly illuminated by the history of science). We can have philosophical justifications for the various values, giving reasons why these values have been so central. Groups 1, 2, and 4 have genuine epistemic import and, thus, do not bleed across the epistemic/nonepistemic boundary (although their instantiation depends on the available evidence that does depend on cultural values shaping which evidence is gathered). The pragmatic group 3 can have clear cultural influences on it. Rooney's concerns (1992) are thus illuminated. It also allows us to assess proposals for alternative sets of values (e.g., Longino 1996). We can consider alternative values under the groups proposed and see whether they assist us in reaching our goals.

Second, we can now address the reference often made to these values in other debates with greater conceptual clarity. For example, when critics of the value of prediction (as opposed to accommodation—e.g., Collins 1994; Harker 2008) attempt to reduce the value of novel prediction to accommodation plus a theoretical virtue (such as unification or explanatory power), we can see both what might motivate such an attempt (they are drawn to the power of group 4) and why it is misguided (the value of novel prediction can be in tension with the value of unification).

Finally, we have reduced (although not eliminated) tensions among the values. They are not a collective pool rife with tensions. They have different functions and purposes, depending on which value we are talking about and by what it is instantiated. If this is indeed a step forward in the clarity of the terrain, it is time for a renewed effort toward a qualitative theory of scientific inference.

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