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Laudan's Naturalistic Axiology

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Doppelt (1986,1990), Siegel (1990), and Rosenberg (1996) argue that the pivotal feature of Laudan's normative naturalism, namely his axiology, lacks a *naturalistic* foundation. In this paper I show that this objection turns on a misunderstanding of Laudan's use of the term 'naturalism'. Specifically, I argue that there are two important senses of naturalism running through Laudan's work. Once these two strands are made explicit, the objection raised by Doppelt and others simply disappears.

1. Introduction. Over the last fifteen years Larry Laudan has been advocating a naturalized philosophy of science. Naturalism is a term that gets bandied around in all areas of philosophy, and even within the philosophy of science it has a wide berth. What exactly Laudan means by the term 'naturalism' is the subject of this paper, and by its conclusion we will have seen that he endorses two related but distinct senses of naturalism, captured by the following definitions:

N1: P is naturalistic iff P is empirically testable.
N2: P is naturalistic iff P is prevalent in science.

Through a series of articles and books Laudan has taken on the task of carving out a middle ground somewhere between positivism and relativism, using naturalism as the foundation for a meta-methodology of science. Laudan is not the only philosopher of science to go this route (Giere 1984, 1985, 1988, 1989; Kitcher 1992, 1993), but Laudan's naturalism—he calls it 'normative naturalism'—has commanded the

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most critical attention. Briefly, Laudan argues that one can justify a prescriptive methodology by a descriptive account of the history of science. Moreover, he argues that throughout the history of science fundamental changes in aims have been guided by rational choice: evidence, good reason, and justified belief are what motivate changing aims in science. No wonder Laudan's normative naturalism has engendered so much debate. Its two main components, methodology and axiology (a term Laudan employs to mean, simply, an account of cognitive aims) are *both* contentious: Laudan warrants methodological rules with historical cases, which appears to commit the naturalistic fallacy in its epistemic form, and his account of aim change in the history of science goes against both Kuhn's account and that which is being advanced today by social constructivists.

Still, as Laudan's critics point out, there are other difficulties with his normative naturalism. In this paper I defend Laudan against one such difficulty, which has been raised by Doppelt (1986, 1990), Siegel (1990), and most recently Rosenberg (1996). The objection put forth by Doppelt and others is easily stated: Laudan's axiology, they argue, lacks a *naturalistic* foundation. If this criticism were on the mark it could prove fatal; but the objection is off target. Its strength turns on a misunderstanding of Laudan's use of the term 'naturalism'. This confusion is as much Laudan's fault as anyone's, for he has never clearly defined the two senses of naturalism given above, which together provide a naturalistic foundation for his axiology. Moreover, when Laudan has had the opportunity to respond to this very criticism he has sidestepped the challenge.[1] This is curious; it leaves one with the impression that he himself is not sure of the sense in which his axiology is naturalistic. But that is neither here nor there; I am convinced that it is, and the warrant for my conviction is based on Laudan's sporadic claims on the matter. In particular, a careful reading of *Science and Values* shows Laudan to be working with the two senses of 'naturalism' given above. Once these senses are made explicit, it becomes evident that Laudan's axiology is, indeed, naturalistic.

2. Normative Naturalism: Methodology. Laudan's account of methodological rules needs to be elaborated before turning to his account of cognitive aims. Methodology for Laudan consists of rule based prescriptions, prescriptions whose surface structure, he claims, are mis-

1. For instance, when Laudan had the opportunity to respond directly to Doppelt's criticism, he instead accused Doppelt of suggesting that his *intention* was to put forward a non-naturalistic axiology, which quite obviously was not Doppelt's point (Laudan 1990, 51).

leading. Although methodological rules in science often *look* like categorical imperatives, their hidden structure more closely resembles hypothetical imperatives. Thus, a methodological rule of the form 'one ought to do x' ought to be understood as 'if one's goal is y, then one ought to do x'. For example, as Laudan puts it, "Popper's familiar rule, 'avoid ad hoc hypothesis' is more properly formulated as the rule: 'if one wants to develop theories which are very risky, then one ought to avoid ad hoc hypotheses'" (1987, 24). This reformulation (and others like it) is supposed to give us a better picture of what actually goes on in science. And note, the force of this particular methodological rule (or any rule) will depend on our theories about x and y. If these theories tell us that x is the most effective way to achieve y, then we ought to act on this particular methodological rule (to achieve y); and the converse holds as well. As long as we are somewhat clear on how to go about testing theory claims, we will have no difficulties testing rival methodologies. Thus, for Laudan, normative rules are warranted hypothetically, in reference to cognitive aims, following the principle of means/ends, or instrumental rationality.[2]

3. Normative Naturalism: Axiology. One thing is clear: since methodological rules get their prescriptive force by reference to cognitive aims, axiology (again, an account of cognitive aims) is the pivotal feature of normative naturalism. As Laudan himself put it, "methodology gets nowhere without axiology" (1987, 29). Laudan's axiology has two main components. There is a descriptive or historical component, which is relatively straightforward. According to Laudan, "the aims of science in particular and of inquiry in general have exhibited certain significant shifts through time" (1990, 48). Laudan warrants this position by citing instances of what he considers to be significant aim change in the history of science. To get an idea of what Laudan means by 'significant aim change' we can look at a favorite example of his:

2. In his 1987, Laudan suggests that to get around the apparent circularity or regress this position faces, namely that to test any rule we need to depend on an already established rule, we should rely on the low-level empirical rule (R1) which (he claims) is shared by all otherwise disputing methodologies:

> (R1) If actions of a particular sort, m, have consistently promoted certain cognitive ends, e, in the past, and rival actions, n, have failed to do so, then assume that future actions following the rule "if your aim is e, you ought to do m" are more likely to promote those ends than actions based on the rule "if your aim is e, you ought to do n." (1987, 26)

"If (R1) is not sound," Laudan states, "no general rule is" (1987, 27). For two good responses to Laudan on this matter, see Leplin 1990, 22–24, and Kukla 1997, 450–453.

the abandonment of 'infallible knowledge' as a cognitive aim in science. Here it is helpful to quote Laudan in full:

> More or less from the time of Aristotle onward, scientists had sought theories that were demonstrable and apodictically certain. Although empiricists and rationalists disagreed about precisely how to certify knowledge as certain and incorrigible, all agreed that science was aiming exclusively at the production of such knowledge. This same view of science largely prevailed at the beginning of the nineteenth century. But by the end of that century this demonstrative and infallibilist ideal was well and truly dead. Scientists of almost every persuasion were insistent that science could, at most, aspire to the status of highly probable knowledge. Certainty, incorrigibility, and indefeasibility ceased to figure among the central aims of most twentieth-century scientists. (1984, 83)

According to Laudan, examples like this one, where one cognitive aim has been replaced by another, are abundant in the history of science and they support his position "that the predominant goals of the scientific community have changed through time, often in deep and significant respects" (1984, 47).[3]

In order to account for aim change in the history of science, Laudan outlines a position which is supposed to tell us how aim change can be rationally evaluated. This is the second component of his axiology, and it is captured in what he calls the 'reticulated model of scientific rationality' (1984). It is at *this* aspect of Laudan's axiology that the objection by Doppelt and others is directed.

4. Axiology: The Reticulated Model of Scientific Rationality. Laudan's reticulated model of scientific rationality is motivated by a dissatisfaction with what he calls "the best-known contemporary solution to the problem of consensus formation in science" (1984, 23), i.e., the hierarchical model of justification. According to the hierarchical model, factual disagreements in science happen at the lowest level of the hierarchy, and are resolved by appeal to the next level up the ladder, i.e.,

3. Although I won't evaluate Laudan's descriptive axiology here, I should note that it has come under attack. Notably, Leplin and Rosenberg both argue that Laudan, quite simply, has his history wrong. Leplin claims that "modern science—physical science from Galileo on, say—exhibits general, sustained methodological and axiological themes that survive changes in the localized prescriptions and constraints that scientific discoveries introduce" (1990, 24). Rosenberg agrees, he claims that in the history of modern science there has been one overriding goal of science, namely 'knowledge' (1990, 36). It is unclear how to temper this dispute, since the issue is plainly complicated by semantics: clearly, what some call a 'method' others call an 'aim'.

methodological rules. Sometimes, however, scientists disagree over which methodological rules to use, or how to apply them. When this happens, consensus is forged by going up one more rung in the hierarchical ladder to the level of shared aims or goals. According this model, aims are viewed as the final court of appeal.

Laudan's reticulated model of scientific rationality is supposed to reveal an aspect of science that the traditional model fails to account for: rational aim change.[4] The reticulated model is represented by Laudan as a triad consisting of theory, methodology, and axiology. On this model, each of these elements influence one another: justification flows both upward and downward in the hierarchy.[5] The reticulated model, in Laudan's opinion, better captures the "complex process of mutual adjustment and mutual justification going on among all three levels of scientific commitment" (1984, 62).

Significantly, with the reticulated model, no one level is more privileged than another. Aims are no longer construed as inflexible, nor are they the final courts of appeal. Theories and methods inform aims, just as aims inform theories and methods. Furthermore, change within any triad, according to Laudan, is *not* wholesale (e.g., as Kuhn would have it), but rather piecemeal (1984, 65). When we look at the history of science, we see only large scale global transformations; for example, we see that a triad **T**, consisting of theory T, methodology M, and axiology A has been replaced by another triad **T'**, consisting of theory T', methodology M', and axiology A'. But it is a great mistake, Laudan claims, to think that **T** was replaced by **T'** in one fell swoop; this, he argues, is neither historically accurate nor epistemically attractive (1984, 78, 82). What actually happens is that one or two aspects of the triad remain (temporarily) fixed, while one other is being challenged for revision. Laudan wants us to imagine, for example, that within triad **T**, both M and A remain stable, while T is being challenged by T'. In this scenario, we are able to judge T and T' against the standards set by M and A. As Laudan puts it,

> Changes in values and changes in substantive ontologies or methodologies show no neat isomorphism. Change certainly occurs at all levels, and sometimes changes are concurrent, but there is no striking covariance between the timing of changes at one level and the timing of those at any other. (1984, 84)[6]

4. It may be obvious that here Laudan has in mind Kuhn's account of hierarchical change which (on most interpretations) denies the possibility of rational adjudication of aim change in science.

5. See Laudan 1984, 63, for a helpful diagram of the reticulated model.

6. Some of Laudan's critics have argued, more or less convincingly, that his account of

5. How Does the Reticulated Model Allow for Rational Aim Change? Importantly, this reticulation between goals, methods and theories is how we arrive at a rational evaluation of aims. Specifically, aims are evaluated on the basis of information supplied by theories and methods, following one general mode of criticism: The utopianism, or unrealizability of aims.[7]

6. Utopianism/Unrealizability of Aims. In his 1984, Laudan identifies three different 'utopian strategies', although in his later writings these are subordinated to 'realizability in general'.[8] In general, an aim is 'utopian' if there is no conceivable way for that aim to be actualized. Our beliefs about the world (i.e., our theories) and about available methods of inquiry tell us when an aim is unrealizable. And, Laudan claims, if an aim is thought to be unrealizable, then it is only rational to abandon it. As he states, "if an agent comes to believe that a goal which he formerly espoused is *in principle unrealizable*, then continuing to hold that goal makes nonsense of the notion of rational action" (1987b, 227).

Laudan relies on historical examples to help illustrate how realizability functions as a tool for evaluating aims (1984, 51–53, 82–87). Take, for instance, the example above regarding the abandonment of 'infallible knowledge' as a cognitive aim in science. Eventually, Laudan's story goes, scientists concluded that there was no obvious, agreed upon method for demonstrating the infallibility of knowledge claims (even if theories at the time suggested such knowledge existed); in other words, the criteria for determining infallibility were utterly unclear. Thus, infallibility came to be seen as an unrealizable cognitive goal of science, and consequently was replaced by the (believed to be) realizable goal of 'highly probable' knowledge.

7. The Objection. The objection against Laudan's prescriptive axiology has been raised by Doppelt (1986, 1990), Siegel (1990), and most recently Rosenberg (1996). Again, the basic charge is that Laudan fails to provide a *naturalistic* account of aim justification; in other words,

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piecemeal change within any triad either presupposes a transhistorical goal of science or leads directly to relativism. See esp. Brown 1989, 124–126; Kitcher 1993, 157–160; and Worrall 1989, 376–388.

7. Laudan (1984) identifies a second criterion for the rational evaluation of aims, namely the harmonization of implicit and explicit aims; but this criterion is virtually absent from his later writings; it is the realizability criterion that Laudan continues to rely on in his 1987, 1987b, 1990, and 1990b.

8. See Laudan 1984, 51–53, for examples of three utopian strategies: demonstrable utopianism, semantic utopianism, and epistemic utopianism.

Laudan's reticulated model of scientific rationality is non-naturalistic.

Doppelt's characterization of this objection is perhaps the clearest. The fundamental problem with Laudan's reticulated model, according to Doppelt, is that realizability is simply not a naturalistic criterion. He argues that realizability has no more a naturalistic foundation than, say, internal consistency with our theory preferences, or any other super-empirical (i.e., conceptual) criterion. His point is essentially this: while it may be true that our theories can tell us—i.e., it is an empirical matter—that this goal x or that goal y is unrealizable, it is certainly *not* an empirical matter that we should not strive for unrealizable goals. Thus, Doppelt claims, Laudan's proposal is "a far cry from the straightforward naturalist method of appealing to empirical evidence in order to determine whether the means pursued are conducive to the particular ends embraced" (1990, 5). Moreover, Doppelt notes, since Laudan himself admits that 'methodology gets nowhere without axiology', his so-called 'naturalistic' meta-methodology faces a potentially fatal obstacle—dependent, as it is, on a non-naturalistic criterion.

Siegel makes the same point. He argues that although picking through aims and selecting ones that are realizable is an empirical process, the criteria we employ which places value on certain empirical characteristics and not others is super-empirical. As he aptly puts it, "That an aim is utopian (e.g.) may be established naturalistically; that a utopian aim ought not to be pursued is not" (1990, 311).

Rosenberg's criticism, on the face of it, appears to have a different target; but in the end his charge amounts to the same as Seigel's and Doppelt's. He claims that a naturalistic philosophy of science involves a commitment to the idea of 'progressivity' (1996, 4). And, he argues, because Laudan's descriptive axiology has it that throughout the history of science there have been fundamental changes in aims, he cannot account for the progressive nature of science. Hence, Rosenberg concludes, "Laudan needs a naturalistic axiology for cognitive enquiry" (1996, 12). However, Laudan's descriptive axiology, on its own, is not enough to motivate this criticism. There is a missing premise in Rosenberg's argument: namely, that Laudan's reticulated model cannot account for the progressive nature of science. Yet this is exactly what it sets out to do. Hence, Rosenberg's criticism, namely that Laudan's account lacks a naturalistic axiology, only makes sense if we suppose that he too thinks the reticulated model lacks a naturalistic foundation.

The fundamental point of the objection outlined here should be clear: unrealizability is a super-empirical, i.e., conceptual, criterion. And, while a super-empirical criterion may successfully pick between aims, there is no empirical basis underlying this choice; realizability has no more empirical impetus than, say, internal consistency, simplicity,

or even happiness-inducing. Hence the conclusion that there is no naturalistic warrant for the realizability criterion.

8. Natural*isms*. Is Laudan's reticulated model of scientific rationality and its main mode of criticism, the unrealizability of aims, naturalistic? Again, I argue that it is. As I stated earlier, the objection by Doppelt and others turns on a misunderstanding of the concept of 'naturalism'. The important step in answering this objection is to disentangle the two senses of naturalism (stated above) running through Laudan's work.

9. Naturalism-One: N1. It is obvious that the objection raised by Doppelt and others makes no sense unless we take it to presuppose the first definition of naturalism given above:

N1: An axiology is naturalistic iff it is empirically testable.

This definition of naturalism is familiar to philosophers of science; it is arrived at by making two moves. The first move connects epistemology—in its traditional role, i.e., as a normative enterprise—with the history of science. The second move links successes in the history of science with the heavy reliance, within the sciences, on the establishment and warrant of scientific theories and scientific beliefs via sensory evidence—in other words, through the method of empirical testing.

These two moves go a long way in explaining the current trend to naturalism in the philosophy of science. Just think, one of the main motivations for the 'naturalistic turn', in the first place, was the 'historical turn' a la Kuhn.[9] In effect, the historical turn charges that an epistemology of science should fit with the actual record of how science has been successful. In other words, the history of science matters to normative epistemology; meta-methodology is no longer be conceived of as an a priori enterprise. The main reason for this, as Laudan put it, is that "science has been successful at producing the epistemic goods" (1987, 28). Thus, the first move toward understanding this sense of naturalism is to recognize that there is an important connection between the processes by which we acquire our beliefs and the ones by which we ought to acquire our beliefs.

Again, the second move that gets us to N1 is to identify the main reasons for the success of science. And, a major reason for the success of many of the sciences has been the stress placed on the importance of sensory evidence for the establishment and justification of scientific

9. As Giere notes, "Although he did not use exactly these words, Kuhn was advocating a *naturalized* philosophy of science" (1985, 332).

theories and beliefs, and the heavy reliance on the method of empirical testability. And, because the benchmark of scientific activity is empirical testability, a naturalistic meta-methodology must also exhibit this essential ingredient. And so we arrive at an understanding of naturalism that is captured by **N1**: an axiology is naturalistic iff it is empirically testable. Hence the complaint by Laudan's critics: unrealizability has no empirical basis: it is not apprehended via sensory evidence; it is nowhere to be found in nature.

10. Half the Story. But this definition of naturalism is not the only important one for a naturalized philosophy of science, nor is it the only one running through Laudan's work. Empirical testability gets *us* only so far—since empirical testability gets *scientists* only so far. At some point, in everyday scientific practice, scientists take their empirical findings and subject them to particular (individual or shared) cognitive aims—aims which have no empirical basis to the extent that they are *not found in nature*, i.e., not apprehended through sensory experience. An oncologist searching for a cure for cancer will subject cells to various empirical tests. But can her goal 'find a cure for cancer' be properly construed as empirical? Certainly not. No amount of empirical investigation will tell us to find a cure for cancer. This is a cognitive aim. And why any particular scientist adopts this aim and not another is a different story, and naturalism in the philosophy of science *has* to be able to account for this aspect of scientific life: it has to capture the normative activity that occurs within science. This brings us to the second and important sense of naturalism operative in Laudan's work.

11. Naturalism-Two: N2. This leads us to the second definition of naturalism given above:

> **N2:** An axiology is naturalistic iff that axiology is prevalent in science.

This definition of naturalism captures the idea that a naturalistic meta-methodology must account for the normative activity within scientific practice. And note, this is not an ad hoc stipulation; there is a good reason *why* a naturalistic meta-methodology has this responsibility, and that reason is dictated by **N1**. For just think, the idea behind **N1** is that science has proved successful because of its reliance on empirical testability. As good naturalists, we adopt this method and apply it not just to our philosophy of science, but we rely on it to continue to learn about scientific practice. Through empirical investigations we discover that there is more to scientific practice than methodology. We uncover the normative activity present in scientific practice, and this activity

informs us about the various mechanisms that guide aim change within science proper.

Thus, if we want to take our cue from scientific practice, if we take seriously the connection between the history and practice of science and meta-methodology, then it seems we must do three things: first, we must acknowledge the gap, within scientific practice, between empirical research and cognitive aims. Second, we must investigate the ways in which scientists close this gap. And third, we must model our meta-methodology based on our findings. Thus, an axiology will be **N2** so long as it as modeled after scientific axiologies. A naturalistic justification of aims, for the epistemologist, amounts to an imitation of a scientific justification of aims; the burden on the epistemic naturalist is to accurately employ (in her philosophy of science) whatever criteria are found to influence the abandonment or adoptment of aims in science proper. As Laudan claims, "The naturalist, if true to his conviction that science and philosophy are cut from identical cloth, holds that the same mechanisms which guide the change of aims among scientists can guide the epistemologist's selection of epistemic virtues" (1990, 47). Thus, an axiology will be **N2** if and only if that axiology is prevalent in science, and it will be **N1** if and only if it has been arrived at by empirically testable methods.

12. Laudan's Naturalistic Axiology: N1 and N2. Laudan's axiology satisfies **N1**: to determine how cognitive aims change in science is not an a priori procedure. Thus, he has done empirical investigations in order to determine what the guiding criteria are for aim change in science. Laudan's results: *realizability is the main criterion for aim change in science*. Thus, his axiology satisfies **N2**: it replicates the dominant criterion for aim change in science. The warrant for realizability as the main criterion for the rational evaluation of aims is that it is the *guiding criterion for aim change in science*. Our conclusion: Laudan's axiology is thoroughly naturalistic.

13. In Laudan's Defense. Although Laudan never clearly distinguishes **N1** and **N2**, there is evidence littered throughout his writings, especially in *Science and Values*, which suggests that **N2** is the driving force behind realizability as the main criterion for justified aim change. Take, for instance, the passage "If we want to understand how science works, it is clearly important to understand the reasoning processes that drive communities of researchers so far as to change some of their basic aims and goals" (1984, 47). And it is the unrealizability of aims, according to Laudan, which explains the majority of cases of the rational abandonment of aims throughout the history of science. He states, "[Real-

izability] is a criticism which one regularly finds in scientific controversies" (1984, 53). To which he adds "it is the adjudication of such criticism and the responses it produces which have led to the revision of some of our once highly cherished cognitive ambitions for science" (1984, 53). Quite clearly, this is a descriptive claim about the enterprise of science, specifically about how goals are evaluated in science. This points to Laudan's justification for the naturalistic character of his axiology: the reason for the prominence of the realizability criterion in the reticulated model of scientific rationality is because empirical testing has shown that scientists have acted with something approximating the realizability criterion in mind.

Further evidence that Laudan's warrant for realizability is **N2** can be found in his example of the abandonment of 'infallible knowledge' as a cognitive aim in science. In the quote already cited Laudan clearly states why this change in aims occurred:

> But by the end of that century this demonstrative and infallibilist ideal was well and truly dead. *Scientists of almost every persuasion were insistent that science could, at most, aspire to the status of highly probable knowledge.* Certainty, incorrigibility, and indefeasibility ceased to figure among the central aims of most twentieth-century scientists (1984, 83; my italics).

In other words, scientists eventually came to recognize the utopianism of infallible knowledge as a scientific aim, and this is why they abandoned it.

Implicitly, Laudan's warrant for the realizability criterion is **N2**. He is guilty only of not being explicit about the way this is supposed to work. Simply put, there is a link missing in Laudan's writings, the connection which establishes the copycat nature of the naturalist. Without that link, it is certainly easy to see what motivated the objection by Doppelt and others, since, of course, realizability is a super-empirical criterion, and consequently fails to satisfy **N1**. But **N1** has led Laudan to **N2**, and Doppelt et al. fail to recognize both this connection and the presence in Laudan's writings of **N2**. Once **N2** is made explicit, it becomes evident that Laudan's axiology is naturalistic. True, his axiology is *not* completely empirical, but that is not important. What *is* important is that, as Laudan states, "the whole of meta-methodology is a mixed empirical/conceptual discipline, rather like the theoretical sciences, with precisely the same links to experience exhibited by those sciences" (1987b, 231). The realizability criterion, according to Laudan, is just one of those links. And with this link in place, the objection disappears.

14. Conclusion. The worry that a non-empirical component in Laudan's axiology betrays his naturalistic meta-methodology is plainly misguided; to think otherwise would be to confuse the naturalist's responsibility. At its core, rational aim change in Laudan's reticulated model is dependent on super-empirical criteria—Laudan's critics are right about this. But they are wrong to think that this is a problem for Laudan. The burden on the naturalist is to emulate science, that is, to determine by empirical means what guides aim change in science, and then mimic those findings. In other words, to be good naturalists our meta-methodology must be both **N1** and **N2**. It must capture both the empirical and normative activity that occurs within scientific practice. That our empirical findings indicate that justified aim change in science hinges on conceptual criteria is not a mark against the naturalistic character of an axiology. Laudan's account of aim change, as captured in his reticulated model of scientific rationality, is thoroughly naturalistic.

REFERENCES

Brown, James Robert (1989), *The Rational and the Social*. London: Routledge.
Doppelt, Gerald (1986), "Relativism and the Reticulational Model of Scientific Rationality", *Synthese* 69: 225–252.
———. (1990), "The Naturalist Conception of Methodological Standards in Science: A Critique", *Philosophy of Science* 57: 1–19.
Giere, Ronald N. (1984), "Toward a Unified Theory of Science", in James T. Cushing, C. F. Delaney, and Gary M. Gutting (eds.), *Science and Reality*. Notre Dame, IN: University of Note Dame Press, 5–31.
———. (1985), "Philosophy of Science Naturalized", *Philosophy of Science* 52: 331–356.
———. (1988), *Explaining Science*. Chicago: University of Chicago Press.
———. (1989), "Scientific Rationality as Instrumental Rationality", *Studies in the History and Philosophy of Science* 20: 377–384.
Kitcher, Philip (1992), "The Naturalists Return", *The Philosophical Review* 101: 53–115.
———. (1993), *The Advancement of Science*. Oxford: Oxford University Press.
Kukla, Andre (1997), "Review: Beyond Positivism and Relativism," *British Journal of the Philosophy of Science* 48: 447–454.
Laudan, Larry (1984), *Science and Values*. Berkeley: University of California Press.
———. (1987), "Progress or Rationality? The Prospects for Normative Naturalism" *American Philosophical Quarterly* 24: 19–31.
———. (1987b), "Relativism, Naturalism and Reticulation", *Synthese* 71: 221–234.
———. (1988), "If It Ain't Broke, Don't Fix It", *British Journal of the Philosophy of Science* 39: 369–375.
———. (1990), "Normative Naturalism", *Philosophy of Science* 57: 44–59.
———. (1990b), "Aim-Less Epistemology", *Studies in the History and Philosophy of Science* 21, 2: 315–322.
———. (1996), *Beyond Positivism and Relativism*. Boulder, CO: Westview Press.
Leplin, Jarrett (1990), "Renormalizing Epistemology", *Philosophy of Science* 57: 20–33.
Rosenberg, Alexander (1990), "Normative Naturalism and the Role of Philosophy", *Philosophy of Science* 57: 34–43.
———. (1996), "A Field Guide to Recent Species of Naturalism", *British Journal of the Philosophy of Science* 47: 1–29.
Siegel, Harvey (1990), "Laudan's Normative Naturalism", *Studies in the History and Philosophy of Science* 21, 2: 295–313.
Worrall, John (1989), "Fix it and be Damned: A Reply to Laudan", *British Journal of the Philosophy of Science* 40: 376–388.