

Aesthetic and Other Theoretical Virtues in Science

I. INTRODUCTION

In 1964, Harold Osborne lamented that

nowadays the concept of intellectual beauty is not, I believe, commonly repudiated so much as neglected; few of the standard works on aesthetics pay more than lip-service to it and I know of none which has either attempted a deep analysis or given to it equal weight with sensory beauties in the framing of general aesthetic concepts.¹

Osborne's lamentation still rings true today. As many times as we hear of a "beautiful" scientific theory or an "elegant" mathematical proof, intellectual beauty is largely ignored in contemporary aesthetics. At least three explanations are possible. First, if there is no disputing tastes, and matters of taste are entirely subjective, then aesthetic judgments have little if anything to do with scientists' pursuit of an objectively accurate account of the world. Second, since the time of Francis Bacon, scientists have been in the business of mastering nature for purposes of human advancement, particularly by technological means.² Thus aesthetic evaluation of scientific theories has taken a back seat to evaluating their practical or utilitarian applications. Finally, as Thomas Kuhn showed us, there seems to be a gap between normative ideas about scientific methodology and the reality of how scientists actually practice their art.³

Ironically, because scientists readily admit making aesthetic judgments in positing hypotheses and evaluating theories, most of what has been written on intellectual beauty comes from them, not philosophers or aestheticians.⁴ One exception is James McAllister's *Beauty and Revolution in Science*.⁵ Paying critical attention to McAllister's views, I first provide a brief historical background regarding the notion of intellectual beauty and some of the primary distinctions involved therein. Then I look to McAllister's critique of autonomist and reductionist views of the relation between empirical and aesthetic criteria in theory evaluation for science. Finally, I provide a critique of what he calls the "aesthetic induction" and defend an alternative model that emphasizes the holistic coherence of aesthetic and other theoretical virtues in scientific theorizing.

II. INTELLECTUAL BEAUTY

Francis Hutcheson was one of the chief proponents of intellectual beauty during the concept's heyday in the Enlightenment. He argued that beauty is "an idea raised in us" rather than a property of objects.⁶

Beauty is not understood [as] any quality supposed to be in the object which should of itself be beautiful.... For beauty, like other names of sensible ideas, properly denotes the perception of some mind; so cold, hot, sweet, bitter, denote the sensations in our minds, to which perhaps there is no resemblance in the objects which excite these ideas in us.⁷

And Hutcheson's understanding of how ideas of beauty are raised in us was axiomatic.

The figures which excite in us the ideas of beauty seem to be those in which there is *uniformity amidst* variety.... What we call beautiful in objects, to speak in the mathematical style, seems to be in compound ratio of uniformity and variety: so that where the uniformity of bodies is equal, the beauty is as the uniformity.⁸

Hutcheson's theory of beauty is instructive when considering aesthetic judgments regarding scientific theories. The emphasis on ideas of beauty rather than beautiful empirical objects draws our attention not to the world, but to how we represent it in scientific theories. The world itself may appear complex, random, even chaotic, but we can make it intelligible by constructing aesthetically pleasing scientific theories. For example, like many of his contemporaries, Hutcheson was fascinated with Newton's theory of celestial bodies because it made the relations between those bodies intelligible and thus revealed a uniformity-amidst-variety in the universe that could otherwise not raise ideas of beauty in us. But we also want our scientific theories to accurately represent the way the world is. Otherwise, we are merely constructing theories for the sake of their aesthetic qualities, and those theories may thus bear no accurate relation to what they represent, no matter how aesthetically pleasing they may be. So a tension holds between a theory's aesthetic value and the accuracy of its representation.

In an attempt at resolution, McAllister draws a distinction between theories and their representations, that is, between theories as abstract entities and their inscriptions in texts.⁹ And he warns against confusing the aesthetic qualities of a *theory* with the aesthetic qualities of the theory's *representation*: one is abstract—the theory—and the other is a physical representation—the model or inscription of the theory. Models or inscriptions do not necessarily share the same aesthetic qualities of the theories they represent. We often see simple models of highly complex theories, or vice versa, for example. Each aesthetic quality is tied to its respective object of appreciation or evaluation—the theory or the model of the theory. Moreover, we could appreciate the model in its own right, as if it were art, for example. But this would not be an instance of appreciation of *intellectual* beauty. Only appreciation of a scientific theory as an abstract entity would count as such, according to McAllister.

McAllister also warns against conflating the appreciation of aesthetic qualities of scientific theories with appreciation of the *phenomena* they represent. Just as models or inscriptions may share aesthetic qualities with the theories they represent, theories may share aesthetic qualities with the phenomena that are the focus of scientific investigation. But this is not always the case. Often we construct simple theories of complex phenomena. In short, we appreciate theories as intellectual constructs, models as representations of the theory, and phenomena as what the theory is about. Conflating the three different foci of aesthetic appreciation might sound like a problem we need not worry about, but when arguments for theory-laden observation are in play, this worry is justified.¹⁰ If the phenomena are shaped by scientific theory, and the theory heavily relies on models, identifying which particular aesthetic qualities are tied to the theory, the model, and the phenomena will be difficult. But isolating particular aesthetic qualities and the theories, models, and phenomena they are tied to may not be necessary from a practical point of view. Instead, we might recognize that aesthetic qualities of theories, models, and phenomena should be held conceptually distinct, though they are often mixed when we assess the overall value of a scientific theory, including all of its qualities, virtues, and values—aesthetic and otherwise.

III. EMPIRICAL VERSUS AESTHETIC CRITERIA IN THEORY EVALUATION

McAllister critiques what he calls “two erroneous views of scientists’ aesthetic judgments,” which he labels “autonomism” and “reductionism.”¹¹ Autonomism “regards scientists’ aesthetic and empirical evaluations as wholly distinct from and irreducible to one another, whereas reductionism views them as nothing but aspects of one another.”¹²

Autonomism brings us back to Hutcheson and the notion of disinterestedness. Oddly enough, Hutcheson is an advocate of both disinterestedness and intellectual beauty:

In the search of nature there is the like beauty in the knowledge of some great principles or universal forces from which innumerable effects do flow. Such is gravitation in Sir Isaac Newton’s scheme.... It is easy to see how men are charmed with the beauty of such knowledge, besides its usefulness.... And this pleasure we enjoy even when we have no prospect of obtaining any other advantage from such manner of deduction than the immediate pleasure of contemplating the beauty.¹³

Note here that Hutcheson does not rule out knowledge altogether when considering beauty. He suggests that we can both contemplate a scientific theory disinterestedly *and* appreciate its utility in the explanatory work it does, though the two modes of appreciation are conceptually distinct.

Although neither Edward Bullough nor Jerome Stolnitz’s defenses of disinterestedness deal with questions of intellectual beauty, McAllister interprets their view as marking a distinction between aesthetic and empirical values.¹⁴ Both Bullough’s notion of “psychical distance” and Stolnitz’s notion of the “aesthetic attitude” in fact sharply distinguish between aesthetic and *all* other values.¹⁵ While this is a fair interpretation for McAllister to make, he attaches the practical application of a theory, its utility, to its empirical value, and thus glosses over an important point. One may disinterestedly appreciate a theory’s aesthetic value by ignoring its utility, but this does not mean that we must ignore its other theoretical virtues, such as simplicity, symmetry, and elegance, which are valuable both aesthetically and theoretically. I agree with McAllister that disinterestedness fails as an example of autonomism in theory evaluation because it draws a distinction between aesthetic and empirical values. But disinterestedness fails also because it draws a distinction between aesthetic and theoretical values. Both autonomism and disinterestedness fail because they do not allow for the possibility that the aesthetic, empirical, and theoretical values of a theory can be somehow related.

The second erroneous view McAllister addresses is reductionism in theory evaluation, which is the view that either an aesthetic or empirical judgment is “nothing but a manifestation or aspect of the other.”¹⁶ Reductionism has two variants: the empirical success view and representationalism. J. W. N. Sullivan defends the first variant, and argues that the aesthetic value of a theory reduces to its empirical success:

Since the primary object of the scientific theory is to express the harmonies which are found to exist in nature, we see at once that these theories must have an aesthetic value. The measure of the success of a scientific theory is, in fact, a measure of its aesthetic value, since it is a measure of the extent to which it has introduced harmony in what was before chaos.¹⁷

As Sullivan rightly suggests, the aesthetic value of a theory seems to depend upon how well it organizes data into an intelligible framework. The question is whether the aesthetic value *reduces* to its empirical success, whether the aesthetic value of a scientific theory reduces to how successful it is in making intelligible the unintelligible.

The second variant of reductionism is representationalism, the view that the representational accuracy of a theory determines its aesthetic merit.¹⁸ On this view scientific theories are similar to

representational artworks such as many paintings and sculptures. But the aesthetic value of scientific theories, unlike that of artworks, is determined according to how accurately they represent the world. Thus, according to representationalism, the empirical value of a theory reduces to its aesthetic value—the exact opposite of the empirical success view.

The problem with the empirical success view, according to McAllister, is that “it entails that aesthetic judgments of theories are valid or invalid objectively: any aesthetic appraisal of a theory either correctly reflects the theory’s degree of empirical success and is thus valid, or is at variance with it and is thus invalid.”¹⁹ The problem with representationalism is just the opposite. By reducing a theory’s empirical value to its aesthetic value, scientific theories are not valid or invalid, but governed primarily by subjective preferences, assuming aesthetic preferences are subjective. For McAllister, each of the two reductive views has its merits, but both views suffer insofar as they are reductive. They don’t allow for the possibility of interrelated aesthetic and empirical values.

McAllister’s “aesthetic induction” is meant to provide a nonreductive justification for aesthetic criteria in theory evaluation. He argues that scientists over time isolate the aesthetic qualities of theories that have the most empirical adequacy and inductively project those aesthetic qualities into new theories in a goal-oriented way:²⁰

A community compiles its aesthetic canon at a certain date by attaching to each property a weighting proportional to the degree of empirical adequacy then attributed to the set of current and recent theories that have exhibited that property. The degree of empirical adequacy of a theory is, of course, judged by applying the community’s empirical criteria for theory evaluation. I name this procedure the aesthetic induction.²¹

The problem with McAllister’s aesthetic induction is that it focuses exclusively on empirical adequacy and no other theoretical virtues, and it seems that aesthetic considerations in science should account for theoretical virtues other than just empirical adequacy. Empirical adequacy is often considered as an indicator of a theory’s truth. But, as Hilary Putnam argues, “*Truth is not the bottom line*: truth itself gets its life from our criteria of rational acceptability, and these are what we must look at if we wish to discover the values which are really implicit in science.”²² But neither is empirical adequacy the bottom line. McAllister’s emphasis on empirical adequacy alone also makes the aesthetic induction virtually indistinguishable from the empirical success view, which he rejects as reductive. On his view, the aesthetic induction of a theory’s aesthetic qualities (or, in McAllister’s terminology, aesthetic properties) is proportional to the theory’s degree of empirical adequacy. But it seems likely that a theory may exhibit a variety of other theoretical virtues that would prompt the induction of an aesthetic quality (or qualities) regardless of a low degree of empirical adequacy. In other words, some assemblage of other theoretical virtues may substitute for a low degree of empirical adequacy. But this new model that includes theoretical virtues other than only empirical adequacy would not at all resemble McAllister’s aesthetic induction.

So what would this new model look like? Here we need lists of other theoretical virtues. Thomas Kuhn lists five: accuracy, consistency, breadth of scope, simplicity, and fruitfulness.²³ In *The Web of Belief*, W. V. O. Quine and J. S. Ullian list conservatism, modesty, simplicity, generality, and refutability.²⁴ McAllister has two lists. The first is a list of theoretical virtues: internal consistency, external consistency (it is consistent with other established theories), predictive accuracy, predictive scope, and fruitfulness.²⁵ Note that simplicity is not included in McAllister’s list, but it is found in Quine’s and Kuhn’s. McAllister places simplicity in a separate list, “aesthetic criteria in theory-evaluation,” including elegance, symmetry, and beauty.²⁶ By distinguishing simplicity as an aesthetic criterion, rather than a theoretical virtue, McAllister is then able to launch his argument for the aesthetic induction.

IV. HOLISM IN SCIENTIFIC THEORY EVALUATION

My view is that aesthetic criteria such as simplicity, elegance, and symmetry should be considered as not only aesthetic criteria, but also as virtues of scientific theories. A simpler theory, for example, may not only be more beautiful, or more elegant, but it is also more methodologically expedient, which may in turn make it more fruitful. For this reason, how theories are evaluated must also be a function of the relationships that hold between all of the aesthetic criteria and the theoretical virtues involved in that evaluation, which may require a series of trade-offs between aesthetic criteria and other theoretical virtues. A more internally or externally consistent theory may be less symmetrical, or a more general theory may be less elegant. Adjudicating among the web of criteria and virtues to achieve a coherent whole is then a matter of organizing not only the data, but also the criteria by which the data are organized. Quine said, “The unit of empirical significance is the whole of science.”²⁷ An overall, all-things-considered evaluation of a scientific theory must be tested against all of our background assumptions, beliefs, values, aesthetic criteria, and theoretical virtues as a whole. And making such a theory fit coherently within that whole will require a continuous revision of the whole itself. Thus the overall value of a scientific theory is relative to how the overall conceptual scheme exhibits structural coherence among its aesthetic and other theoretical virtues—how all the values, virtues, and criteria form an intelligible whole.

A holistic account of aesthetic criteria in theory evaluation may then fare better than one like McAllister’s aesthetic induction if the project is to *describe*, rather than justify, the role of aesthetic and other theoretical virtues in science. McAllister’s model of inductive projection of particular aesthetic qualities of theories may be justifiable as a *normative* theory, but it fails as a nonreductive description of the relationship between aesthetic and other criteria in science. And we might wonder which is better: a full-blown justification of the aesthetic induction, complete with a proportionate relationship between aesthetic qualities and a degree of empirical adequacy, or an accurate description of how aesthetic criteria figure into the whole of science. The latter option is preferable, mostly because it reveals the values implicit in scientific practice, truth being only one aspect of the whole of science. The ongoing revision of our values, and how those values figure into our scientific theories, does more than just point to the truth. The organization of values into a coherent framework makes scientific truths possible, and that organization may reveal more about how science works than truth itself.

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1. Harold Osborne, “Notes on the Aesthetics of Chess and the Concept of Intellectual Beauty,” *British Journal of Aesthetics* 4 (1964): 160–63.
 2. Francis Bacon, *The New Organon* (Cambridge: Cambridge University Press, 2000).
 3. Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).
 4. Einstein in particular had much to say on the topic. See Subrahmanyam Chandrasekhar, *Truth and Beauty: Aesthetics and Motivations in Science* (Chicago: University of Chicago Press, 1987).
 5. James McAllister, *Beauty and Revolution in Science* (Ithaca, NY: Cornell University Press, 1996).
 6. Francis Hutcheson, *An Inquiry Concerning Beauty, Order, Harmony, Design*, ed. Peter Kivy (The Hague: Martinus Nijhoff, 1973), 34.
 7. *Ibid.*, 38.
 8. *Ibid.*, 40.
 9. McAllister, “Abstract Entities and Aesthetic Evaluations,” in *Beauty and Revolution*, 24.
 10. See Kuhn, *Structure of Scientific Revolutions*, 16–17.

11. McAllister, "Two Erroneous Views of Scientists' Aesthetic Judgments," in *Beauty and Revolution*, 61–69.
12. *Ibid.*, 61.
13. Hutcheson, *An Inquiry*, 51.
14. Edward Bullough, "'Psychical Distance' as a Factor in Art and an Aesthetic Principle," *British Journal of Psychology* 5 (1912): 87–118; Jerome Stolnitz, *Aesthetics and Philosophy of Art Criticism: A Critical Introduction* (Boston: Houghton Mifflin, 1960).
15. Bullough, "Psychical Distance," and Stolnitz, *Aesthetics and Philosophy*.
16. McAllister, "Two Erroneous Views," *Beauty and Revolution*, 67.
17. J. W. N. Sullivan, "The Justification of the Scientific Method," *The Athenaeum*, no. 4644 (1919): 274–75.
18. Peter Kivy, "Science and Aesthetic Appreciation," *Midwest Studies in Philosophy* 16 (1991): 180–95; Eddy Zemach, "Truth and Beauty," *Philosophical Forum* 18 (1986): 21–39.
19. McAllister, "Two Erroneous Views," in *Beauty and Revolution*, 67–68.
20. McAllister, "The Inductive Construction of Aesthetic Preference," in *Beauty and Revolution*, 78.
21. *Ibid.*
22. Hilary Putnam, "Fact and Value," in *Reason, Truth, and History* (Cambridge: Cambridge University Press, 1981), 131.
23. Thomas Kuhn, *The Essential Tension: Selected Studies in Scientific Tradition and Change* (Chicago: University of Chicago Press, 1977), 321–22.
24. W. V. O. Quine and J. S. Ullian, *The Web of Belief* (New York: Random House, 1978), 64–82.
25. James McAllister, "Truth and Beauty in Scientific Reason," *Synthese* 78 (1989): 26–27.
26. *Ibid.*, 31.
27. W. V. O. Quine, "Two Dogmas of Empiricism," in *From a Logical Point of View* (Cambridge, MA: Harvard University Press, 1961), 42.

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