Confirmation for a Modest Realism

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In the nineteenth century, William Whewell claimed that his confirmation criterion of consilience was a truth-guarantor: we could, he believed, be certain that a consilient theory was true. Since that time Whewell has been much ridiculed for this claim by critics such as J. S. Mill and Bas van Fraassen. I have argued elsewhere that, while Whewell's claim that consilience can *guarantee* the truth of a theory is clearly wrong, consilience is indeed quite useful as a confirmation criterion (Snyder 2005). Here I will show that, even when consilience gives evidence for a theory that turns out to be false, there is an important sense in which consilience shows that the theory has captured something correct about the natural-kind structure of the physical world. Whewell was therefore correct to claim that consilience provides a "criterion of reality" (Whewell [1847] 1967, vol. 2, 68). Consilience provides this by giving justification for the claim that we have really 'cut nature at its causal joints', to adapt Plato's famous phrase. Because of this, consilience can play a role in an argument for scientific realism.

1. Natural Kinds and Essences. In his *Philosophy of the Inductive Sciences,* Whewell described his confirmation criterion of consilience by explaining that a hypothesis should "explain and determine [phenomena] of a *kind different* from those which were contemplated in the formation of" it (Whewell 1858, 88). By referring to 'different kinds' of phenomena, Whewell indicated a connection between his notion of natural kinds and consilience, one which has been mostly ignored by other commentators.[1] However, to understand Whewell's test of consilience, and to see its value as an argument for realism, we must understand the relation between consilience and natural kinds.

Whewell first discussed his notion of natural kinds in his 1828 work *An Essay on Mineralogical Classification and Nomenclature*, in which he

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1. The exceptions to this are Herschel 1841; Ruse 1976; Harper 1989.

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discussed the controversy between proponents of natural and artificial systems of classifying mineralogical specimens.[2] Agreeing with those who endorsed natural systems, Whewell claimed that the mineralogist should seek the "natural and true arrangement of minerals" (1828, i). According to Whewell, the grouping of things into classes in science is meant to be expressive of an actual ordering in nature. In his later work, the *Novum Organon Renovatum*, Whewell explained that "there are classifications, not merely arbitrary, founded upon some *assumed* character, but natural, recognized by some *discovered* character" (1858, 17). Thus Whewell held that natural classes are discovered empirically, not formed a priori.[3]

Whewell noted that we are directed to natural kinds by resemblances, or shared superficial properties, between individual things. The 'properties' to which Whewell referred are superficial properties; thus, as one of the properties shared by the members of the kind gold, Whewell noted that gold "is ductile in a certain degree" (1860, 366). Some of these superficial properties direct us to natural groupings. But of course, not every superficial resemblance is relevant to classifying things into natural kinds ([1847] 1967, vol. 1, 486–487). This is because the superficial properties are not themselves definitive of natural groupings. In addition to sharing observable properties, certain individuals also share underlying traits, or essences. These essences are taken by Whewell (like many modern writers on natural kinds) to be causally responsible for some of the observable properties of individual members of the kind. For example, the superficial properties typically exhibited by members of the kind 'water' are these: liquidity at room temperature, colorlessness, odorlessness, tastelessness. Yet there is also an underlying trait, shared by all members of the kind, which we now understand to be the chemical structure H_2O. These superficial properties of water are a result of the chemical structure of water.[4] Other superficial properties of a given sample of water—such as its weight and temperature—are not a result of that chemical structure, and so are not properties shared by all members of the natural kind 'water'.

What, then, are the underlying 'essences' of natural kinds, according

2. As Hacking (1991) notes, Whewell did not use the term 'natural kinds'; John Venn introduced this term in his 1888 *Logic of Chance*. Whewell used instead the terms 'natural classification' and 'natural groups of kinds'.

3. Whewell's view of natural kinds, like that of most writers today, is derived from Locke's discussion in Book III of the *Essay Concerning Human Understanding* ([1689] 1979). Locke there defined natural kinds by the sharing of a real essence, in the sense of some underlying structure or trait causally responsible for the superficial properties of a thing (see Book III, Chapter VI, Section 2, 439). Yet Locke (unlike Whewell) believed that real essences are unknowable to us; thus we can never have knowledge of real or natural kinds (see Book III, Chapter, VI, Section 9, 444–445).

4. Kornblith also makes this point; see 1993, 37.

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to Whewell? In his *History of the Inductive Sciences* Whewell explained that, in the case of plants and other organic beings, the essence is the "general structure and organization" of the being, especially those organs most important for the preservation of life ([1837] 1857, vol. 3, 281). In his *Philosophy,* Whewell suggested that reproductive relations between individuals are also important ([1847] 1967, vol. 1, 505). Thus a natural kind of organism appears to be defined by a number of intrinsic properties, including the general structure and organization of the particular members, and their reproductive relations. These intrinsic traits are causally responsible for the production of the superficial shared properties (see Whewell [1837] 1857, vol. 3, 196–197).

In addition to the natural kinds that are comprised of objects or substances, Whewell also spoke of natural classes of events or processes, such as the class of planetary motion and the class of optical diffraction (see [1847] 1967, vol. 2, 65–68). The members of these classes are individual cases of planetary motion (e.g., the orbit of Mars) and individual instances of optical diffraction. Individual cases of optical diffraction are recognized as belonging to this kind by their superficial properties, that is by the fact that they involve light appearing to bend around obstacles. But they also share a kind essence. Whewell was rather less explicit on the question of what constitutes the kind essence for classes of events or processes than he was about classes of minerals or organisms. But if we take what he did say about natural object kinds and apply it to natural event kinds, we can reconstruct the following view. Individual cases of optical diffraction share a set of properties which make each case a member of the kind 'optical diffraction'. These properties include the kind(s) of substance(s) involved in the process, and the kind(s) of changes that occur.[5] These properties, in turn, are linked inextricably to the *cause* of optical diffraction. Thus, in the case of event kinds, the kind essence can be seen as being constituted by the cause or causes of that event or process. The kind essence 'determines', as Whewell put it, the similarity of observed properties in each case of optical diffraction. A natural event kind is therefore defined by a number of intrinsic properties, including the cause of the process involved. The fact that a group of events constitutes a natural event kind can be inferred even before it is known what the essence of the kind is, just as we can be alerted to the existence of an object kind by shared superficial properties, even before we know what underlying

5. In unpacking Whewell's implicit view of event kinds, I follow (to some degree) Ellis's view of such kinds as expressed in Ellis 2000 and elsewhere. Like Ellis, Whewell can be described as a scientific essentialist, who saw laws of nature as being metaphysically necessary in a certain sense. I do not go so far as to suggest that Whewell would agree with the dispositional element of Ellis's essentialism, however.

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trait(s) constitute the essence of the kind. For instance, gold was assumed to be a natural kind, even before its chemical composition was known. Whewell would say (were he being explicit about this) that the class 'planetary motion' was assumed to be a natural kind, and not just a conventional one, even before its essence was known.

2. Consilience and the Unification of Event Kinds. Whewell also characterized consilience as a 'jumping together of inductions', which occurs when an induction arrived at from one kind of phenomena 'coincides with' an induction obtained from a different kind. He illustrated this jumping together of inductions with the example of Newton's law of universal gravitation. According to Whewell, Newton used the form of inference Whewell characterized as 'discoverers' induction' in order to reach his universal gravitation law, the inverse-square law of attraction. Part of this process is portrayed in Book III of the *Principia*, where Newton listed a number of 'propositions'. These propositions are empirical laws that are inferred from certain 'phenomena' (which are described in the preceding section of Book III). The first such proposition or law is one that was inferred from the phenomena of 'satellite motion': namely, that "the forces by which the circumjovial planets are continually drawn off from rectilinear motions, and retained in their proper orbits, tend to Jupiter's centre; and are inversely as the squares of the distances of the places of those planets from that centre." The result of another induction, this time from the phenomena of 'planetary motion', is that "the forces by which the primary planets are continually drawn off from rectilinear motions, and retained in their proper orbits, tend to the sun; and are inversely as the squares of the distances of the places of those planets from the sun's centre." Newton saw that these laws, as well as other results of a number of different inductions, coincided in postulating the existence of an inverse-square attractive force as the cause of various phenomena.[6] According to Whewell, Newton saw that these inductions "leap to the same point"; i.e., to the same law (1858, 88). Newton was then able to bring together inductively (or 'colligate') these laws, and facts of other kinds (e.g., the event kind 'falling bodies'), into a new, more general law,

6. As McMullin notes, the notion of the 'attractive force' was problematic for Newton; he was never satisfied in his search for an 'agent cause' of gravitational behavior, a 'cause of gravity', as Newton put it. But Newton did succeed in causally unifying disparate phenomena by the concept of this attractive force (see 2001, 296). It is this aspect of Newton's theory that Whewell pointed to as the hallmark of consilience.

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namely the universal gravitation law: "All bodies attract each other with a force of gravity which is inverse as the squares of the distances."[7]

In terms of natural kinds, what Newton found was that these different event kinds—including satellite motion, planetary motion, and falling bodies—share an essential property, namely the same cause. Newton discovered that what makes 'the orbit of Mars' a member of the class 'planetary motion' is that it is caused to have the properties it does by an inverse-square attractive force of gravity between Mars and the other bodies in the universe. He also found that other event kinds share this kind essence. What Newton did, in effect, was to subsume these individual event kinds into a more general kind comprised of subkinds sharing a kind essence, namely being caused by an inverse-square attractive force. Consilience of event kinds thus results in *causal unification*. More specifically, it results in unification of natural kind categories based on a shared cause. Phenomena that constitute different event kinds, such as 'planetary motion' and 'falling bodies' were found by Newton to be members of a unified, more general kind, 'phenomena caused to occur by an inverse-square attractive force of gravity' (or, 'gravitational phenomena').[8] In such cases, according to Whewell, we learn that we have found a 'vera causa', or a 'true cause', i.e. a cause that really exists in nature, and whose effects are members of the same natural kind (1860, 191). Moreover, by finding a cause shared by phenomena in different subkinds, we are able to colligate all the facts about these kinds into a more general causal law. Whewell claimed that "when the theory, by the concurrences of two indications . . . has included a new range of phenomena, we have, in fact, a new induction of a more general kind, to which the inductions formerly obtained are subordinate, as particular cases to a general population" (1858, 96). He noted that this is the means by which we effect the successive generalization that constitutes the advancement of science ([1847] 1967, vol. 2, 74).

Note that consilience is importantly different from the type of reasoning known as 'inference to the best explanation', even when the 'best expla-

7. Newton then saw that he could extend this law to the class 'tidal activity'. When a law that has resulted from several different inductions, and thus exhibits consilience, can be extended to a new class, without ad hoc modification, we have a case of what Whewell called 'coherence' (see [1847] 1967, vol. 2, 68–74).

8. As most writers on natural kinds allow, kinds may be subsumed under more general kinds, as long as there is no partial overlap; indeed, taxonomical systems such as those found in biology and mineralogy are systems of arranging things into nonoverlapping kinds and subkinds. The event kinds 'planetary motion' and 'falling bodies', although they share the same cause, are different subkinds in virtue of the other intrinsic properties shared by their members.

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nation' is defined as a causal hypothesis.[9] The causal law expressing the essence of different event or process kinds is not one postulated merely because it explains or accounts for these different classes of facts. Rather, in the case of each class, the law has emerged from a process of inductive reasoning (which, for Whewell, includes various kinds of ampliative inference, including causal, analogical, and eliminative inference).[10] Thus the causal law is not imposed from above as a means of tying together different event kinds. Instead, it wells up from beneath in each separate case. What is important, in the case of consilience, is not merely that a single causal mechanism or law can explain or account for different event kinds, but rather that separate lines of induction lead from each event kind to the same causal mechanism or law, that there is a convergence of distinct lines of argument. At each step, there is inductive warrant for the causal law besides its explanatory utility. That is, Whewell would say that Newton had rational grounds for inferring the inverse attractive force between the satellites of Jupiter and Jupiter, and also for inferring the same force between the planets and the Sun. He did not merely hypothesize that such a force would account for the actions of these bodies, and then go about trying to test whether such a force existed.

3. Consilience's Value as an Argument for Realism. I will argue briefly here that Whewell's confirmation criterion of consilience provides an argument for a modest form of realism. The type of realism consilience supports is defined by the claim that a consilient theory gives (at least) strong reason for believing that it has pointed to really existing natural classes or kinds. Thus this form of realism can be called 'natural kind realism'. This form of realism is modest, in that it remains agnostic about the ontological status of the particular theoretical entities postulated by our theories, and leaves open the possibility that we are wrong about the particular kind essences our theories assert. Yet it is not overly modest; it does not claim that it is *impossible* to gain knowledge of these theoretical entities and essences.[11] This modest realism claims only that we have good

9. Numerous commentators on Whewell have interpreted his view as a form of 'inference to the best explanation' or as the related view of abductive or retroductive inference, including Peirce [1865] 1982; Laudan 1971; Fisch 1991, 168, note 13; McMullin 1992.

10. For more on Whewell's view of induction, see Snyder 1997, 2006.

11. Thus, my modest realism rejects Poincaré's claim that it is *impossible* to have knowledge of the theoretical entities postulated by scientific theory: "still things themselves are not what [science] can reach as the naive dogmatists think, but only relations between things. Outside of these relations there is no knowable reality" (cited in Psillos 1999, 150).

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grounds for believing that we have knowledge of this natural kind structure, better grounds than for believing in the reality of the specific theoretical entities postulated by theories. Put another way, this position asserts that we can gain knowledge of how things are causally grouped in nature, even without knowing the fine details of the things themselves or of the particular causes that group them. I propose this form of realism in the spirit of a modest epistemic effort to provide a foothold for further arguments in favor of realism, even stronger forms of realism.

Consilience provides two ways to argue for this modest realist position, and hence for realism itself. These two arguments mirror the strategies used by Whewell in arguing for consilience's value for confirmation. First, Whewell claimed that consilience is "a criterion of reality, which has never yet been produced in favour of falsehood" (1858, 90). He can thus be seen as making an inductive argument in favor of the confirmation value of consilience: namely, since consilient theories in the past have always turned out to be true, we can infer that (probably) all consilient theories are true, and thus that our current consilient theories are (probably) true. This argument is, as numerous critics have noted, problematic for his claim that consilience is a truth-guarantor, given that Newton's theory turned out to be false. Newton's theory employs conceptions that, it turns out, are not true of the world, such as absolute space and absolute time. The cause postulated by the theory, the inverse-square attractive force of gravity propagated through space and time, is also nonexistent (it is not a vera causa). However, the theory does seem to have been correct in bringing together event kinds that belonged to a more general kind, showing something true about the causal order or structure of nature, even though it was wrong about what the shared kind essence was. Newton showed that the phenomena of free fall, pendulum motion, lunar acceleration, satellite motion and planetary motion share a cause,[12] and in this way constitute a general event kind. This insight has not been proved false, although the particular shared cause he postulated has been rejected. Einstein's general theory of relativity proposed instead that the cause of these phenomena (and others) is the curved structure of space-time. It may well be that this proposed cause will be replaced by another (quantum gravity?); but it seems unlikely that a later theory will separate these different phenomena and attribute to each of them different causal structures or mechanisms. These event kinds do seem to be subkinds of a more general kind that is connected in nature. Those who ridicule Whewell for his belief that consilience never has and never could give evidence for a false theory do not give him the credit that is due, by recognizing that

12. For a related treatment of this point, see Forster 1988.

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the one truly consilient theory touted by Whewell is still considered to have got things right, at least in terms of the natural kind structure of the physical world. Because of this, the inductive argument for the value of consilience can be useful as an argument for realism, in the following way.

This inductive argument can help defeat the so-called 'pessimistic induction' used by Laudan against the realist position. The most intuitively powerful argument in favor of realism—advanced with great effect by Richard Boyd and others—is the success of our best theories. This 'success' has been characterized in various ways: as success in explanation, prediction, or novelty. But the intuition is the same: the success of science would be difficult, if not impossible, to account for, unless mature scientific theories were at least approximately true (as Putnam said, it would be a 'miracle'.)[13] This intuition was dealt a blow by Laudan's 'pessimistic induction', that is his assertion that the history of science contradicts this intuition. In fact, Laudan claimed, since most of the 'successful' theories of the past turned out to be false, probably *our* successful theories will turn out to be false as well.[14] However, one conclusion we can draw from this discussion is that if success is defined as consilience, then success is not defeated by this pessimistic induction. Theories that have been fully consilient (such as Newton's theory), according to Whewell's notion, and even those that have been only partially consilient (such as the wave theory of light),[15] have been supplanted by other theories, yet have not been completely overturned. Parts of these theories have been retained, specifically the natural kind or causal structure postulated by the theories.[16] Indeed, there has been a striking amount of continuity over the history of science at the level of basic causal structure in this sense of grouping together natural kinds whose members share the same cause. (Whewell himself referred to this kind of continuity when he claimed that the history of science has consisted in successive generalizations and increasing levels of consilience.) By using Whewell's notion of consilience as supplying the criterion of 'success', it is possible to defeat Laudan's pessimistic induction

13. See Boyd 1984; Putnam 1975, 1978; Carrier 1993; Kornblith 1993.

14. See Laudan 1981, 1984. Mary Hesse (1976) had made a similar point earlier.

15. For an explanation of the claim that Whewell believed the wave theory of light to be only 'partially consilient', see Snyder 2005, 2006.

16. Similar strategies for arguing against Laudan have been employed by Worrall 1989; Kitcher 1993; Psillos 1996.

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as an argument against the form of realism I have proposed.[17] Thus the strong intuition in favor of realism is not itself defeated, at least in the case of a modest form of natural-kind realism.[18]

Whewell also used a form of reasoning known as 'common cause inference' to justify the value of consilience as a confirmation technique. It is possible for the realist to use this type of inference to argue that consilience gives a good reason for thinking that our consilient theories do accurately depict part of the natural kind structure of the physical world. Roughly, the common cause argument asserts that the coincidence of results that occurs with consilience (the same causal law inferred from facts about different event kinds) is most probably the result of a shared cause. Since there is no observed cause for this correlation, it must be that there is an unobserved cause. (We might, of course, be wrong; a common cause inference licenses only that it is *reasonable* to infer the existence of a common cause, not that a common cause is *entailed* by the correlation.)[19] Further, we have reason to believe that this unobserved cause for the correlation is an underlying causal structure of the physical world, a structure that we have gained insight into. Our reason is that each of our inductions has led to the conclusion that it is probable that there is such a structure, and that it has a certain form.[20] It remains possible, certainly, that we are wrong about what the common cause is for the coincidence of results. Nevertheless, we have reason to believe that we are right, and that we have found a common causal structure in nature.

17. Since I am not here arguing for a strong type of realism in which the theoretical terms of our best theories are taken to refer to really existing unobservable entities, it may be that Laudan would claim that my natural kind realism is a form of 'realism without the real'. Obviously I disagree. See Laudan 1984, a response to Hardin and Rosenberg 1982.

18. This argument, however, relies on an intuition which is grounded in a type of reasoning considered suspect by many, especially as a means of arguing for realism, namely an 'inference to the best explanation'. Some have argued that it is invalid to use this form of reasoning to argue for realism, since the very validity of this form of reasoning is what is being questioned by the antirealist (see Fine 1996; Laudan 1981; van Fraassen 1980; Lipton 1991). Others disagree (see Boyd 1984; Niiniluoto 1999; Psillos 1996; Leplin 1982, 1987). This dispute will not be solved here. Rather, I will now briefly show that consilience provides an additional way to argue in favor of natural kind realism, one that does not depend on the disputed form of argument.

19. For a proof of this claim, see Sober 1984. In this paper Sober criticizes Salmon 1984 for claiming that such correlations entail a common cause. Bas van Fraassen gives a nice formulation of the principle of the common cause, which he rejects (see 1980, 28).

20. To a certain degree, this strategy is similar the one Salmon 1984 described for Jean Perrin in his inference to the reality of molecules. For a criticism of this 'empirical argument for realism', see Achinstein 2001, 248–251.

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Thus consilience provides a common cause argument for the type of natural kind realism I have proposed.

Further historical work will, I believe, increase the stock of theories that are seen as being consilient, and thus add to the evidence for both the inductive and common cause arguments for realism. This is, indeed, one important role for the history of science in the philosophy of science. The realist should try to determine whether there are other cases of scientific theories that satisfy Whewell's notion of consilience, and to what degree the causal or natural kind structure these theories have postulated have been retained in the later theories which have succeeded them. Faraday and Maxwell's consolidation of electricity, magnetism and optics is a good candidate for such examination. (It is surely no coincidence that Whewell was extremely interested in Faraday's work, suggesting terminology and experiments for him to perform, and that Whewell's philosophy was an important influence on Maxwell.) After Maxwell, it seems likely that any future theory of electromagnetism will also need to colligate optics. There are, no doubt, other cases as well. Whewell's criterion of consilience will then be recognized as not only a method for testing scientific theories, but also a way to argue for scientific realism.

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