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The Scientist as Impartial Judge: Moral Values in Duhem's Philosophy of Science  
(Part of a book symposium New Perspectives on Pierre Duhem's *Aim and Structure of Scientific Theory* in *Metascience* (2011) 20(1): 1-25)

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Rereading Duhem's classic work in the philosophy of science is a true pleasure that I highly recommend. There is of course more in Duhem's work than can possibly be covered in a short review, so I will focus on his famous epistemological claims and the solution that Duhem proposes to them. My central thesis is that moral virtues are at the center of Duhem's philosophy of science, a point that is often overlooked or slighted as unimportant by those who follow his epistemology. After laying out Duhem's position, I will consider four possible objections. The following are some of the famous claims from the book, in Duhem's own words, expressing his empiricism (scientific anti-realism), the theory ladenness of observation, and his holism (the Duhem-Quine thesis):

"A physical theory is not an explanation. It is a system of mathematical propositions, deduced from a small number of principles, which aim to represent as simply, as completely, and as exactly as possible a set of experimental laws." (Duhem, 1954, p. 19)

*"Agreement with experiment is the sole criterion of truth for a physical theory."* (Duhem, 1954, p. 21 emphasis in the original).

"An experiment in physics is not simply the observation of a phenomenon; it is, besides, the theoretical interpretation of this phenomenon" (Duhem, 1954, p. 144).

"An experiment in physics can never condemn an isolated hypothesis but only a whole theoretical group" (Duhem, 1954, p. 183).

“A ‘crucial experiment’ is impossible in physics” (Duhem, 1954, p. 188).

In order to test a hypothesis, we devise an experiment that may falsify it. However, as Duhem pointed out, we never test hypotheses in isolation:

. . . the physicist can never subject an isolated hypothesis to experimental test, but only a whole group of hypotheses; when the experiment is in disagreement with his predictions, what he learns is that at least one of the hypotheses constituting this group is unacceptable and ought to be modified; but the experiment does not designate which one should be changed (Duhem, 1954, p. 187).

Rather than derive a simple prediction from a single hypothesis, we always make multiple assumptions and draw on other theories involved in setting up the test. We do not directly falsify a hypotheses, but rather we only know that we made a mistake somewhere in our system of beliefs. It is worth noting that Duhem thinks that this applies especially to physics because when setting up an experiment, physicists use parts of their own theory as auxiliary hypotheses to make sure that the experiment is working properly. In other sciences (Duhem uses physiology as his example) experimenters may rely on physics, but not on any aspect of the theory that is being tested. So physics is caught in a circle that other sciences may be able to avoid. Peter Kosso revived this line of thinking to argue for experimental realism, pointing out that even in cases of very indirect, heavily theory-laden observations, it is quite possible for the theory under test to be epistemologically independent of the auxiliary theories that are used to construct the observing instrument (Kosso, 1988, 1989).

Holism threatens to make testing impossible, yet Duhem believes that scientific consensus will emerge. While the pure logic of the testing situation leaves theory choice open, good sense does not. Duhem claims that the history of science shows that while there is controversy in science, there is also closure of scientific debates. He does not just leave the

scientist unable to decide between two empirically adequate theories, rather, he introduces the notion of ‘good sense’ by which the scientist properly chooses between theories.

In any event this state of indecision does not last forever. The day arrives when good sense comes out so clearly in favor of one of the two sides that the other side gives up the struggle even though pure logic would not forbid its continuation (Duhem, 1954, p. 218).

Duhem emphasizes the choice of the scientist as a judge of theory as a moral agent who must decide where the problem lies when a scientific experiment comes out negatively (Duhem, 1954, p. 216). According to Duhem, we always have two choices when faced with negative evidence: timidity, holding on to our existing theories and changing auxiliary assumptions to accommodate the new facts, or boldness, replacing the old theory with a fundamentally different one that accounts for the new facts and the old ones too (Duhem, 1954, p. 217). Thus both choices are rational necessitating good sense to make a judgment about which path to take, since there is no formal method by which to make a decision. In Duhem's account of scientific theory choice, there is openness, since strict rules do not apply, but also objectivity. The source of this objectivity is the epistemic agent — the scientist who acts as an impartial judge and makes a final decision.

The source of Duhem's view is Pascal, in particular Pascal's discussion of types of minds. The geometric mind, often rendered as the mathematical mind in the English translation, is narrower, abstract and logically rigorous. The *esprit de finesse*, the supple, penetrating, or intuitive mind, by contrast, “consists essentially in the aptitude to see clearly a very large number of concrete notions, and to grasp simultaneously the whole and the details” (Duhem, 1954, p. 61). Good sense belongs to the *esprit de finesse*.

Indeed, this kind of good sense is used throughout science, not just in the special case of underdetermination. Duhem also introduces the notion of an ‘experimental sense’.

The estimation of the degree of approximation of an experiment is, therefore, an extremely complex task. It is often difficult to hold to any logical order in this task; reasoning should then make way for that rare and subtle quality, that sort of instinct or flair called the experimental sense, a pennant worn by the penetrating mind (*esprit de finesse*) rather than by the geometrical mind (Duhem, 1954, p. 163).

So not only in comparing empirically adequate theories do we need good sense, but in all experimental science. The point that I want to emphasize here is not only the pervasiveness of good sense but also its ethical component. Duhem could hardly be clearer on the role of ethical values in theory choice, a point he attributes to Claude Bernard, but with which he completely agrees:

The sound experimental criticism of a hypothesis is subordinated to certain moral conditions; in order to estimate correctly the agreement of a physical theory with the facts, it is not enough to be a good mathematician and skillful experimenter; one must also be an impartial and faithful judge (Duhem, 1954, p. 218).

It is very important to note that scientific judgment is *subordinated* to moral conditions, that is Duhem makes the moral status of the agent primary. To be a competent judge in science, you must not only learn the theory in question, but you must also have the right kind of mind (*esprit de finesse*) and the right intellectual and moral virtues.

In his book *German Science*, Duhem elaborates on the ethical dimension of good sense. Here as before, Duhem is explicit in linking epistemic virtues to moral qualities, referring specifically to the writing of history, but generalizing the point to all sciences.

In the realm of every science, but more particularly in the realm of history, the pursuit of the truth not only requires intellectual abilities, but also calls for moral qualities: rectitude, probity, detachment from all interest and all passions (Duhem, 1991, p. 43).

In another passage in *The Aim and Structure of Physical Theory*, Duhem also specifically links the moral conditions and the demands put on the scientific experimenter:

he must, if he does not wish to be accused of scientific bad faith, establish an absolute separation or watertight compartment between the consequences of his theoretical deductions and the establishing of the facts shown by his experiments. Such a rule is not by any means easily followed; it requires of the scientist an absolute detachment from his own thought and a complete absence of animosity when confronted with the opinion of another person; neither vanity nor envy ought to be countenanced by him. As Bacon put it, he should never show eyes lustrous with human passions. Freedom of mind, which constitutes the sole principle of experimental method, according to Claude Bernard, does not depend merely on intellectual conditions, but also on moral conditions, making its practice rarer and more meritorious (Duhem, 1954, p. 182).

Along with the ethical component, there is a further aspect of good sense which deserves attention. Duhem introduces his central notion of "good sense" precisely because he considers logic to be insufficient for theory choice in experimental science:

If the mathematical mind owes to the rigor of its approach all the force of its deductions, the penetration of the intuitive mind belongs entirely to the spontaneous suppleness with which it moves. No unchangeable principle determines the path which its free endeavors will follow. At one moment we see it, with an audacious leap, clear the abyss which separates two propositions. (Duhem, 1991, p. 83 also see p. 126)

Good sense is attractive not only because it helps explicate the normative aspects of epistemology, but also because it permits the flexibility of non-rule governed explanations of epistemic choice.

In a previous article (Stump, 2007), I linked Duhem's emphasis on moral values with contemporary virtue epistemology, which can be introduced as follows: "Just as virtue theories in ethics try to understand the normative properties of actions in terms of the normative properties of moral agents, virtue epistemology tries to understand the normative properties of beliefs in terms of the normative properties of cognitive agents" (Greco, 2004). The key point about virtue theories is that there is a change in what is taken to be primary in analysis of ethical terms. Virtue theorists argue that moral or epistemic virtues are basic. Rather than define a virtuous person as one who conforms to principles of morality, the virtue theorist defines a right

action as that which would be done by a virtuous person. Likewise in epistemology, the strong form of virtue epistemology would define justified true belief in terms of what an intellectually virtuous person would believe (Blackburn, 2001, p. 16).

Like contemporary virtue epistemologists, Duhem also takes knowledge to be dependent on the virtues of the knower. Scientists must have intellectual and, indeed, moral virtues in order to reach scientific knowledge, especially when choosing between empirically adequate theories. There is no doubt that the bottom line for Duhem is the ethical condition of the scientist. Scientific judgment frequently comes down to the use of good sense and its use requires both epistemic and moral virtues, as well as the right kind of mind.

Now let us consider some possible objections, both to Duhem's position and to my interpretation of his position. First, there are two ways of undercutting Duhem's solution to the problem of underdetermination. One is simply to deny that there really is a problem of empirically equivalent theories in the first place. One could claim that it will always be possible to find some empirical difference between theories or that one can block the revisionary moves necessary to maintain a theory in the face of negative evidence by testing auxiliary assumptions and by blocking the introduction of *ad hoc* hypotheses. This first response denies that the Duhem-Quine problem is real. It is beyond the scope of this paper to reply; for my purposes it is enough to say that Duhem clearly thinks that the problem is real and demands a solution. A second kind of response is to accept the Duhem-Quine thesis while denying that there are any further virtues that allow us to decide between theories. Duhem himself sometimes seems close to this conventionalist or relativist alternative, as he argues in "Physics of a Believer", printed as an appendix in *Aim and Structure of Physical Theory*:

No doubt the physicist will choose between these logically equivalent theories, but the motives which will dictate his choice will be considerations of elegance,

simplicity, and convenience, and grounds of suitability which are essentially subjective, contingent, and variable with time, with schools, and with persons; as serious as these motives may be in certain cases, they will never be of a nature that necessitates adhering to one of the two theories and rejecting the other, for only the discovery of a fact that would be represented by one of the theories, and not by the other, would result in a forced opinion (Duhem, 1954, p. 288).

According to conventionalists, there is simply no cognitive way to decide between empirically equivalent theories. Despite the fact that Duhem is sometimes read this way, I maintain my reading on the basis of quotes given earlier that show that a scientist with good sense will choose between competing theories, despite the fact that it is possible to continue to defend a theory with sufficient adjustments to auxiliary assumptions. Duhem seems confident that scientific controversies will always be settled eventually, because good sense will weigh so heavily on one side that no one will be able to maintain the other. In the passage quoted above, Duhem maintains that the objectivity of the theory selection rests with the scientist as an epistemic agent, not with nature. Such a choice by a scientist with good sense will result in genuine knowledge of physical theory, according to Duhem.

Second, one could claim that it is common sense, not values, that determines the choice made by good sense. Indeed Duhem does praise common sense highly as a source of truth (1954, p. 104) and there are times when he seems to imply that it is all that we need, neglecting to mention good sense:

It is quite correct, then, to declare that physical science flows from two sources: one the certainty of common sense, and the other the clarity of mathematical deduction; and physical science is both certain and clear because the streams which spring from these two sources run together and mingle their waters intimately (Duhem, 1954, p. 267).

However, he says elsewhere that while common sense plays a role in mathematics, where axioms are founded intuition or common sense and one must have good sense to know when deduction leads one astray, in experimental science there are no taken for granted axioms, only

approximate truths founded on experimental results (Duhem, 1991, p. 81-82). While it is true that the *esprit of finesse* is connected more closely to ethics in *German Science* than it is in *Aim and Structure of Physical Theory*, the quotes given above are direct and clear. In fact, Duhem thinks that we need both common sense and intellectual and moral virtues in order to be good scientific judges.

Third, one might say that Duhem had different aims from those of the virtue epistemologists and that it is not helpful to associate him with them (Ivanova, 2010). It is certainly true that Duhem does not share all the views of contemporary virtue epistemologists. Indeed, contemporary virtue epistemologists are not a homogeneous group and Duhem came at the issues from a very different context. My point, however, is that on two key issues, there is an overlap between Duhem and the virtue epistemologists — making values primary and rejecting rule based decision procedures. The fact that Duhem may have been a structural realist, for example, is completely compatible with his being a virtue epistemologist. While Duhem may turn out to have developed a unique form of virtue epistemology, he still shares these core features with others in that group. If nothing else, thinking about Duhem in this way reminds us that he is far from the Logical Empiricists who adopted him in the twentieth century.

Finally, one might say that Duhem's notion of 'good sense' just cannot be taken seriously given that it is far too subjective and loose. I would respond that Duhem is not Quine, so while he introduces the problem of holism, he does not leave us there. He offers a solution to the problem of underdetermination and argues from the history of science that science does in fact reach consensus. There is no doubt he thinks these scientific decisions are rational, but of course to accept this, one must agree to a theory of rationality that does not require that all judgments can be reduced to rules and algorithms. I do not think that one has to accept virtue

epistemology to make a claim that scientific choices are rational, but it is interesting to read Duhem as taking such a stand.

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