Popper's philosophy of science: a practical tool for the working biologist

Sir,

Robin Holliday[1] asserts that Popper's "philosophy of science" is incompatible with genetics and molecular biology because the deep truths of genetics are either not falsifiable or not worth the bother of trying to falsify as they are manifestly true. From this basis, he goes on to argue that Popperian thinking is of no real help to planning experiments and analysing results. I believe that RH is not only mistaken on all counts, but fails to see just how useful Popperian analysis can be.

Holliday gets off on the wrong foot by writing that "One of Popper's main conclusions is that everything achieved by science is, in principle, falsifiable." This is a misrepresentation: Popper actually restricts his analysis to hypotheses, not observations, and the essence of his view is that scientific hypotheses can only be proven wrong, not right (and, indeed, that this provides the definition of what can be viewed as scientific).

The point is nicely made by the two examples cited by RH. The first is that of Mendelian inheritance, which is, he says, true. He then, however, goes on to mention that "there are many exceptions to Mendelian inheritance in various biological adaptations. . . ." He also says that his second example, the genetic code, is true but then adds that "there are minor differences seen in the code" (between mitochondrial and chromosomal DNA). True? As my American friends would say, "Give me a break!"

What these examples show of course is that one has to take care in extrapolating general rules to particular cases, and that, when one is analysing data, one has to realise that apparently general truths may be wrong in particular cases (older readers may recall that the original golden rule of molecular biology: "DNA gives RNA gives protein on a one-way conveyor belt" was only a golden rule until the RNA viruses were discovered).

One reason why Popper's approach is so helpful to the working biologist is that it provides a formal reminder that any concept can in principle be questioned, although in practice some apparent truths are far less likely to be false than others. Even these, however, cannot be taken for granted—as the above three examples show.

While Popper's views on falsifiability are important in showing biologists how to be critical, they go beyond this as they are, in my view, also highly relevant to the actual day-to-day business of doing biological experiments, and I simply do not agree with RH's opinion here. He says that, when one does an experiment to test a hypothesis, one either confirms the hypothesis or one shows it to be false—the experiment is the same and Popper's approach is irrelevant.

In a superficial sense, this may seem to be so, but closer analysis shows it is not. First, a positive result doesn't prove the hypothesis to be true as the results may also be compatible with another hypothesis (Popper's thesis). Indeed, by misunderstanding a famous result in modern physics, RH actually makes this point, albeit by accident. He says that the observation that light turns out to be bent by gravity proves that Einstein's (general) theory of relativity is right. In fact, all the observation shows is that photons (light) are subject to gravity and this of itself doesn't discriminate between Newton's and Einstein's models of how this force works.

Second, a negative result doesn't necessarily disprove a hypothesis, it may only disprove one leg of the platform on which that hypothesis is based (a point that was, I believe, originally made by Quine) and, without more work, it is not always clear which—and one wouldn't want to throw out a good hypothesis for what turns out to be a trivial reason.

But there is a deeper psychological point here: If one believes that one can prove a hypothesis to be true, then one looks for confirmatory evidence. If one believes, as Popper emphasises, that hypotheses can only be falsified, then, after having looked for supporting evidence to show that the hypothesis is well-founded, one is obliged to design experiments that test it to the limits. A hypothesis that can stand such attacks is far more solid than one for which only supporting evidence can be found (and, indeed, one can find supporting evidence for almost anything). This is not an arcane point as testing working hypotheses is the day-to-day stuff of all science, even genetics and molecular biology!

In short, Popperian thinking is not merely compatible with modern biology, it is of practical use to working biologists: Knowledge of the basis of scientific logic helps people design incisive experiments and analyse results thoughtfully—we ignore it at our peril.

References

1. Holliday R. The incompatibility of Popper's philosophy of science with genetics and molecular biology. Bioessays 1999;21:890–891.

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