T. C. Chamberlin's "Method of Multiple Working Hypotheses:" An Encapsulation for Modern Students

EDITOR'S COMMENT: *I first read this article by T. C. Chamberlin as a graduate student. Its message and relevance are strong 105 years after its presentation as an address to the Society of Western Naturalists in 1899. The address was subsequently published in* Science *and in* The Journal of Geology. *This recent encapsulation is reprinted with the gracious permission of L. Bruce Railsback, Department of Geology, University of Georgia.*

Introduction

Scientific study designed to increase our knowledge of natural phenomena can follow at least three different intellectual methods. These can be called the method of the ruling theory, the method of the working hypothesis, and the method of multiple working hypotheses. The first two are the most popular but they can, and often do, lead to ineffective research that overlooks relevant data. Instead, the method of multiple working hypotheses offers a more effective way of organizing one's research.

Ruling Theories and Working Hypotheses

Our desire to reach an interpretation or explanation commonly leads us to a tentative interpretation that is based on relatively hasty examination of a single example or case. Our tentative explanation, as such, is not a threat to objectivity, but if we then begin to trust it without further testing, we can be blinded to other possibilities that we ignored at first glance. Our premature explanation can become a tentative theory and then a ruling theory, and our research becomes focused on proving that ruling theory. The result is a blindness to evidence that disproves the ruling theory or supports an alternate explanation. Only if the original tentative hypothesis was by chance correct does our research lead to any meaningful contribution to knowledge.

Seemingly less insidious is the working hypothesis. The working hypothesis, we are told, is a hypothesis to be tested, not in order to prove the hypothesis, but as a stimulus for study and fact-finding. Nonetheless, the single working hypothesis can imperceptibly degenerate into a ruling theory, and our desire to prove the working hypothesis, despite evidence to the contrary, can become as strong as the desire to prove the ruling theory.

Multiple Working Hypotheses

The method of multiple working hypotheses involves the development, prior to our research, of several hypotheses that might explain the phenomenon we want to study. Many of these hypotheses will be contradictory, so that some, if not all, will prove to be false. However, the development of multiple hypotheses prior to the research allows us avoid the trap of the ruling hypothesis and thus makes it more likely that our research will lead to meaningful results. We open-mindedly envision all the possible explanations of the phenomenon to be studied, including the possibility that none of explanations are correct ("none of the above") and the possibility that some new explanation may emerge.

The method of multiple working hypotheses has several other beneficial effects on one's research. Careful study often shows that a phenomenon is the result of several causes, not just one, and the method of multiple working hypotheses obviously makes it more likely that we will see the interaction of the several causes. The method also promotes much greater thoroughness than research directed toward one hypothesis, leading to lines of inquiry that we might otherwise overlook, and thus to evidence and insights that single-minded research might never have encountered. Thirdly, the method makes us much more likely to see the imperfections in our knowledge and thus to avoid the pitfall of accepting weak or flawed evidence for one hypothesis when another provides a more elegant solution.

Possible Drawbacks of the Method

The method of multiple working hypotheses can have drawbacks. One is that it is impossible to express multiple hypotheses simultaneously, and thus there is a natural tendency to let one take primacy. Keeping a written, not mental, list of our multiple hypotheses is often a necessary solution to that problem.

Another problem is that an open mind may develop hypotheses that are so difficult to test that evaluating them is nearly impossible. An example might be where three of our hypotheses are testable by conventional field work, but a fourth requires drilling of a deep borehole beyond our economic resources. This fourth hypothesis need not paralyze our research, but it should provide a reminder that none of the first three need be true.

A third possible problem is that of vacillation or indecision as we balance the evidence for various hypotheses. Such vacillation may be bad for the researcher, but such vacillation is preferable to the premature rush to a false conclusion.

An Example

The field discovery of a breccia provides an excellent example of the application of the method of multiple working hypotheses. A breccia may form in many ways: by deposition as talus, by collapse after dissolution of underlying evaporites or other soluble rocks, by faulting, by bolide impact, or by other means. Each of the possibilities can be supported by various field evidence, for which we could look if we were evaluating all these hypotheses.

However, if we chose just one hypothesis, we might ignore other evidence more clearly supportive of a different hypothesis. For example, if we hypothesized that our breccia was the result of cataclasis during faulting, we might find that the breccia occurred along a fault. We would then accept our single hypothesis and quit looking for additional information. However, if we were using multiple working hypotheses and looked for evidence supporting or disproving all our hypotheses, we might also notice that the breccia was localized in a circular pattern along just one part of the fault. Further examination might show that it was accompanied by shatter cones. Armed with this additional information, we would be more inclined to an interpretation involving an impact that was by chance coincident with a fault. By looking for evidence supportive of a variety of hypotheses, we would have avoided an incorrect interpretation based on coincidence.

Summary

In using the method of multiple working hypotheses, we try to openmindedly envision and list all the possible hypotheses that could account for the phenomenon to be studied. This induces greater care in ascertaining the facts and greater discrimination and caution in drawing conclusions. Although our human tendencies lead us toward the method of the ruling theory, the method of multiple working hypotheses offers the best chance of open-minded research that avoids false conclusions. ■

T.C. Chamberlin and the Method of Multiple Working Hypotheses

The geologist Thomas Chrowder Chamberlin (1843-1928) was president of the University of Wisconsin, director of the Walker Museum at the University of Chicago, president of the American Association for the Advancement of Science, and the founder and editor of the *Journal of Geology.*

Chamberlin read his paper on "The method of multiple working hypotheses" before the Society of Western Naturalists in 1889, and it was published in *Science* in 1890 and the *Journal of Geology* in 1897. It was reprinted in several journals during the subsequent seventy years.

This is a short modern encapsulation of some of the ideas in Chamberlin's original paper, and it should not be considered an adequate substitute for the original paper. This encapsulation is based on a version of the original paper republished in *Science* in 1965.

Chamberlin, T.C., 1890, The method of multiple working hypotheses: *Science* (old series) v. 15, p. 92-96; reprinted 1965, v. 148, p. 754-759.

Chamberlin, T.C., 1897, The method of multiple working hypotheses: *Journal of Geology*, v. 5, p. 837-848.