

Explaining Scientific Change: The Formation and Development of the Bacterial Theory of Ulcers

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The central concern of my research over the past two decades has been to contribute to understanding of the development of scientific knowledge. From a variety of perspectives - philosophical, historical, psychological, computational, and sociological - I have attempted to describe the nature of the discovery, development, and acceptance of scientific ideas. Historical case studies of important developments in science, such as Lavoisier's oxygen theory and Darwin's theory of evolution have provided material for reflection on how science grows. However, even the extensive publications and notebooks of such scientists provide a limited record of their work, and much reconstruction is required. I am now examining closely an important scientific development that has taken place very recently: the formation and discovery of the bacterial theory of ulcers.

In 1979, Dr. J. Robin Warren of the Royal Perth Hospital in Australia discovered bacteria in the biopsies of stomach tissue taken from patients with digestive complaints. His colleague Dr. Barry Marshall followed up on Warren's work and found the bacteria in many patients with stomach inflammation and peptic ulcers (Warren and Marshall, 1984). When Marshall claimed at a medical conference that bacteria are the principal cause of peptic ulcers, his remarks were rejected as preposterous. It was widely believed that the human stomach's caustic gastric juices made it too antiseptic for bacteria to survive for long. Moreover, alternative explanations of the principal cause of ulcers were available, focusing on excess acidity and emo-

tional stress. Stung by rejection of his theory and failure of animal experiments, Marshall resorted in 1984 to drinking the bacteria himself, and underwent endoscopy and biopsy to show that his stomach had indeed become inflamed.

Although Marshall's hypothesis that peptic ulcers are caused by bacterial infections seemed wildly implausible, it was easily tested, and evidence began to mount that the bacteria, eventually named *Helicobacter pylori*, were indeed prevalent in people with ulcers. They have also been implicated as a cause of stomach cancer. In February, 1994, a panel convened by the U.S. National Institutes of Health recommended that antibacterial agents be added to the conventional treatments for ulcers (Yamada, 1994). In just a decade, the reception of Marshall's hypothesis has changed from derisive rejection to near-universal acceptance (Graham and Go, 1993). I am now investigating how this dramatic shift in beliefs came about. How did the bacterial hypothesis arise, how was it developed, and why was it accepted? I have previously constructed cognitive answers to these questions for seven of the most important revolutions in the history of science: Lavoisier's chemical revolution, the Darwinian revolution in biology, the geological revolution (plate tectonics), and the Copernican, Newtonian, Einsteinian and quantum revolutions in physics (Thagard, 1992). More recently, I have also been considering social aspects of such developments (Thagard, 1993). The triumph of the bacterial theory of ulcers provides an unprecedented opportunity for analysis, since all the major par-

ticipants are still alive.

Various hypotheses about the development and acceptance of the bacterial theory of ulcers are suggested by my previous work on scientific revolutions. I would expect that the suggestion that bacteria cause ulcers arose from what researchers in philosophy of science call abductive inference, inference that forms an explanatory hypotheses (Thagard, 1993). I also expect that the acceptance of the bacterial theory came about because it possessed more explanatory coherence than previous views (Thagard, 1992). Although I conjecture that such psychological factors were important in the development of the new views, I also expect that social factors can be identified that were also important (Thagard, 1994). In approaching the case of the new theory of ulcers, however, I plan to test these conjectures against historical record as revealed not only by published journal articles but also by the recollections of the major participants.

By interviewing researchers such as Barry Marshall and David Graham who played central roles in the development and acceptance of the bacterial theory, I am assembling a wealth of historical, psychological, and sociological information. Aside from an article in the *New Yorker* (Monmaney, 1993), the history of this important medical episode has yet to be written. But my goal is not just to describe the triumph of the new theory, but to explain it, using whatever psychological, sociological, or philosophical means are most appropriate for the case. Psychological issues include how the bacterial hypothesis was first formed and why there was so much resistance to it. Sociological issues include how the social structure of science, for example Marshall's situation in Australia, affected the acceptance of his views. Philosophical questions include whether the initial rejection and eventual acceptance of the new theory can be viewed as rational, as well as what standards of rationality are appropriately applied to this case.

I met with Barry Marshall in Virginia in

September and have assembled much material on the ulcer-bacteria hypothesis. I am now working on a preliminary computational analysis of how the hypothesis was formed and developed.

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