al brilliance, morally blind. He attributes much of the philosopher's erratic, unconscionable behavior to an extraordinarily painful chronic physical ailment, trigeminal neuralgia, from which he believes Peirce to have suffered. As he says, "When free of pain [Peirce] was often pleasant, considerate, cheerful, loving, charming, and good company, but when the pain was on him he was, at first, almost stupefied and then aloof, cold, depressed, extremely suspicious, impatient of the slightest crossing, and subject to violent outbursts of temper." The pain drove Peirce to distraction, despair, and drugs.

Brent makes a good case as a medical detective. He has less success as an anatomist of the heart—probably because his sources are less revealing—in explaining the public love affair that Peirce launched while still married to his first wife Melusina (Fay) with a mysterious French woman, Juliette Pourtalai (probably not her real name), who eventually became his second wife. This scandalous behavior, more than anything else, ruined Peirce's career. It guaranteed his exile from the precincts of the American university and won him powerful enemies. Most notable of these was the prominent astronomer Simon Newcomb, who got Peirce fired from Johns Hopkins in 1884, engineered his dismissal from the Coast Survey in 1891, and in 1903 deprived him of a grant from the Carnegie Institution that would have enabled him to finish his life devoting himself full-time to philosophy rather than book reviews for *The Nation*.

Brent's book will prove less satisfying to those in search of an account of the development of Peirce's thought. He has surprisingly little to say about the philosopher's ideas, and what he does say is often allusive and elliptical. Because Brent keeps his nose so close to his documents, especially correspondence, he has much more to say about Peirce the experimental scientist at work within the coils of the Coast Survey bureaucracy than about Peirce the pathbreaking logician toiling alone in his study. We learn little of the intellectual context in which Peirce worked and less of the wider social and cultural circumstances in which his thought took shape.

This paucity of intellectual and cultural history is especially regrettable, because Brent gives every evidence in his final, all-too-brief summary chapter of having both a firm grasp of Peirce's system and some provocative things to say about it. Most notably, he supplements his medical argument for Peirce's character flaws with a provocative assessment of the ill effects of his exclusive commitment to the narrow virtues of truth-telling and the circumscribed community of scientific inquiry. For much of his life, Peirce believed that outside this community individuals were morally incorrigible—a belief that, as Brent says, authorized his own shortcomings.

At the end of his life, Peirce had second thoughts, and his philosophy took a decidedly ethical and religious turn. His system built its way toward God. "All science must be a delusion and a snare," he contended, "if we cannot in some measure understand God's mind." It was thus fitting that it was the recalcitrant absolute idealist Josiah Royce, alone among Peirce's contemporaries, who penetrated the complexities of his thought, and fitting as well that Royce should have made best use of this philosophy in his great late book, *The Problem of Christianity*. Though Peirce is widely admired in our own time among scientists and philosophers, facts such as this, as Brent says, are "likely to be disconcerting to most scientists and to many philosophers."

Robert B. Westbrook
Department of History,
University of Rochester,
Rochester, NY 14627

■

Emotion and Memory

Affect and Accuracy in Recall. Studies of "Flashbulb" Memories. EUGENE WINOGRAD and ULRIC NEISSER, Eds. Cambridge University Press, New York, 1992. x, 315 pp., illus. $44.95 or £30. Emory Symposia in Cognition, 4. From a conference, Feb. 1990.

The term "flashbulb memories" was coined by Roger Brown and James Kulik in a definitive paper published in 1977. Brown and Kulik intended it to refer to unusually detailed and durable memories of the circumstances under which one first learned of an event. Events that generate flashbulb memories are usually very surprising and emotionally arousing and are perceived by the subject as personally consequential. Using as the prototype of the class the assassination of John F. Kennedy, Brown and Kulik found that all the subjects they tested had highly detailed and vivid memories of learning of the assassination, which had occurred ten years prior to the time of testing. Moreover, they found interesting variations in the incidence of flashbulb memories; for example, many more black than white Americans had flashbulb memories of the assassination of Martin Luther King. This finding seemed to confirm their belief that level of personal consequentiality of an event influences how it is remembered. In order to explain these findings Brown and Kulik controversially proposed that a "special" memory mechanism (they even speculated as to the underlying neuroanatomy) "fired" in response to high levels of personal consequentiality and emotional arousal, creating a detailed, accurate, and long-lasting memory.

By no means all memory researchers agree with this "encoding" account of flashbulb memory formation. Ulric Neisser has probably been its most steadfast opponent. The contribution of Neisser and Nicole Harsch to this collection of papers on the phenomenon reports on what they call "phantom flashbulbs," or false recollections of hearing the news of an event (in this case, the space shuttle Challenger disaster). Phantom flashbulbs are detected when an individual gives radically different accounts of learning of an event when asked to describe these circumstances immediately after the occurrence of the event and again months or years later. In Neisser and Harsch's study many subjects gave completely different accounts when retested after a delay of over a year. This phenomenon has led Neisser to conclude that "flashbulb memories" are actually created over a period of time as a result of subsequent retelling of the circumstances surrounding an event, either to oneself or to others. With each (covert or overt) "rehearsal" certain details that otherwise might have been forgotten are reinforced in the subject's memory and thereby preserved, leading to a highly detailed and vivid memory. On the other hand, with each retelling errors can be introduced into the memory. Minor elaborations gradually become part of the actual memory, and eventually the memory, though highly detailed and vivid, may bear little resemblance to the original recollection. In this way false "flashbulb memories" come into being.

The phenomenon of phantom flashbulbs appears fatal for the "encoding" account of flashbulb memory formation, for according to the encoding theory a permanent and static record of the personal circumstances surrounding learning of an event is created. If erroneous flashbulb memories arise through the evolution of an inaccurate "story" or narrative of these circumstances, then the encoding theory must be wrong. Such, indeed, is the conclusion of Neisser and Harsch, and it is lent support by other contributions to *Affect and Accuracy*, including that by Bohannon and Symons and that by Warren and Swartwood, which document a low incidence of flashbulb memories of the Challenger disaster.

Quite obviously these findings demonstrate that memories can be inaccurate and that events can be forgotten. We know that this happens with most memories of inconsequential and mundane events. But do the findings in fact challenge the encoding theory of flashbulb memories as Neisser and Harsch suppose? In order to make this case it is critical to establish that the Challenger

disaster was of a level of personal consequentiality likely to initiate flashbulb memory formation. Yet none of the Challenger flashbulb memory studies, including that by Neisser and Harsch, made any attempt to measure the level of consequentiality of the event for the subjects who took part in the studies. Indeed, the word "consequentiality" does not even appear in the index of *Affect and Accuracy*, even though it is a critical aspect of Brown and Kulik's theory. This key omission calls into question the basic argument running through the book, for if the Challenger disaster was low in personal importance, despite being highly surprising, then according to Brown and Kulik's model the incidence of true flashbulb memories of the event would be low—exactly the finding of many of the Challenger studies. Thus the findings of the symposium participants do not automatically disprove the encoding theory of flashbulb memory formation.

Affect and Accuracy is nevertheless an important book that will be used extensively by researchers concerned with memory in natural circumstances. It contains excellent reviews of the effects of emotion on memory, developmental aspects of flashbulb memories, and the neurobiology of memory and concludes with spirited discussion of methodological and theoretical issues. It is only when the contributors use their findings to discredit Brown and Kulik's theory of flashbulb memory formation that some caution must be exercised. I suggest that the reader keep a copy of Brown and Kulik's original paper close by.

Martin A. Conway
Department of Psychology,
University of Bristol,
Bristol B58 1TN, United Kingdom

■

Quarks Bottom to Top

Heavy Flavours. A. J. BURAS and M. LINDNER, Eds. World Scientific, River Edge, NJ, 1992. xvi, 785 pp., illus. $103 or £73; paper, $58 or £41. Advanced Series on Directions in High Energy Physics, vol. 10.

In 1964 Gell-Mann and Zweig proposed that neutrons and protons were made up of more elementary constituents, which they called "quarks." Remarkably, the denizens of the zoo of "elementary" particles produced by accelerators could be broken down into three basic constituents, which (for lack of better terms) were called "up," "down," and "strange." Clearly a new technical term was needed to convey the fact that there are different types of quarks. The word "flavor" was chosen for this purpose. Quarks were said to come in three flavors until 1974, when the existence of a fourth flavor, the "charmed" quark, was confirmed. With the advent of more powerful accelerators it became possible to manufacture new flavors of heavier quarks, and the "bottom" quark was discovered in 1977. Theoretical considerations then required the existence of a sixth flavor, but the "top" quark so far has eluded direct detection.

The quark model was a prelude to the formulation of the Standard Model, a successful theory of elementary particles. With this theory it is possible to deduce the mass of the top quark; it is predicted to be roughly 150 times that of the proton. Thus it seems inevitable that experiments currently under way at Fermilab will soon lead to direct detection of the top quark. Particle physicists eagerly await this discovery, which could occur within the next two years.

Heavy Flavours is an excellent compilation of work on heavy flavor physics by investigators who have made major contributions to the field. Its 13 chapters were written specifically for the volume. Buras and Lindner, the book's editors, have contributed chapters on the role of the top quark in the Standard Model and beyond. Other outstanding contributions include a detailed treatment of the mass prediction and the anticipated phenomenology of the top quark and an introduction to the heavy quark effective field theory recently pioneered by Isgur and Wise and its application to the physics of bottom quark systems. For the most part, the material covered in this book has not yet been incorporated into textbooks. Moreover, the authors clearly have intended their chapters to serve a pedagogical purpose. As a result, this volume will meet the needs of graduate students in particle physics as well as more senior particle theorists and experimentalists who wish to keep abreast of the most recent advances in heavy flavor physics.

Howard E. Haber
Santa Cruz Institute for Particle Physics,
University of California,
Santa Cruz, CA 95064

■

Other Books of Interest

The Sexual Brain. SIMON LEVAY. MIT Press, Cambridge, MA, 1993. xvi, 168 pp. $22.50 or £14.95. A Bradford Book.

In this small book Simon LeVay, whose 1991 report in *Science* of a finding of hypothalamic differences between presumed homosexuals and heterosexuals generated a new round of debate on the subject, expounds for general readers evidence for the biological basis of human sexuality. LeVay presents the subject in a series of chapters each of which takes its title from a phrase appearing in the works of Shakespeare—"Time's millioned accidents" for the consideration of evolutionary factors, "For a woman wert thou first created" for the treatment of development, and so on through basic principles of brain organization, the functions of the hypothalamus, processes involved in sexual intercourse, courtship and maternal behavior, brain circuits for sexuality, factors in brain development, sex-differentiated behaviors that are not sexual in the strict sense, sexual orientation, and gender identity and transsexuality. In the opening chapter and elsewhere in the book LeVay makes clear his view that "the scientific evidence presently available points to a strong influence of nature, and only a modest influence of nurture" on sexual development and orientation, but the tone of the writing is nonpolemical, with explanations of some basic biology and attention to methodological aspects of some of the studies drawn on, which include behavioral studies of nonhuman species as well as neurobiological investigations. At the end of the book appear a bibliography of "sources and further reading," averaging about eight entries for each chapter; a glossary including not only such terms as "androgens" and "proceptive behavior" but also Shakespearean usages such as "child-changed," meaning "changed by one's child" and used in the title of the chapter on maternal behavior; and an index. —***Katherine Livingston***

Gregor Mendel's *Experiments on Plant Hybrids*. ALAIN F. CORCOS and FLOYD V. MONAGHAN. Drawings by Maria C. Weber. Rutgers University Press, New Brunswick, NJ, 1993. xxii, 220 pp., illus. $34; paper, $15. Masterworks of Discovery.

In an enterprise of "combin[ing] the scientific quest for the roots of things with the humanistic endeavor to make the dead letter come alive in a thoughtful mind," this volume inaugurates a series, edited by Harvey Flaumenhaft of St. John's College, Annapolis, of "guided studies of great texts in science." The more specific purpose of the series is "to foster the reading of classic texts in science, including mathematics, so that readers will become more thoughtful by attending to the thinking that is out of sight but still at work in the achievements it has generated." The example of such thinking that has been chosen for the first volume is Mendel's paper of 1866 that prepared the way for our current "easy talk about the