mechanisms that make the form tick, while others, particularly portions of the Milton essay, seem to assume an audience well versed in scholars' disputes. Since the introductory tone predominates, this little volume is best taken as an invitation to the unversed reader to follow Vendler into wider fields.

—Amy E. Schwartz

Science & Technology

DREAMING: An Introduction to the Science of Sleep.
By J. Allan Hobson. Oxford Univ. Press. 170 pp. $22

In June, sleep specialists from around the world will gather in Chicago to celebrate the 50th anniversary of the discovery of rapid eye movement (REM) sleep, the state in which our most vivid dreams occur. At the University of Chicago in 1953, graduate student Eugene Aserinsky and physiologist Nathaniel Kleitman found that sleepers' eyes dart beneath closed lids roughly every 90 minutes. These episodes last only a few minutes early in sleep but close to an hour later on. People awakened during REM sleep usually report dreams with visual images and storylike narratives. Those awakened while their eyes are at rest seldom do, though they sometimes recall prosaic thoughts.

With the discovery of REM, Aserinsky and Kleitman revolutionized the scientific study of sleep. They showed that sleep is not, as previously thought, a uniform and passive state. The brain proves as active in REM sleep as in waking, sometimes more so.

Changes in the level of brain activation shape the content of our dreams, J. Allan Hobson contends in this book. A psychiatrist who directs the neurophysiology and sleep laboratory at Harvard Medical School, Hobson threw the sleep and psychoanalytic communities into a tizzy in 1977 when he and his colleague Robert McCarley proposed that dreams reflect the waking brain's efforts to make sense of randomly generated signals. This theory challenged the Freudian notion that dreams originate in disguised wishes. Hobson and McCarley were castigated for claiming that dreams lack meaning.

Not so, Hobson takes pains to emphasize here. Indeed, he maintains that dreams offer insight into our waking lives. He includes selections from some of the more than 300 of his own dreams he has recorded in the past 25 years, and discusses the events and feelings they depict. Understanding how we create dream stories, he writes, helps illuminate the nature of consciousness, "our most interesting human attribute."

In REM sleep, brain areas that control vision and emotions turn on. Positron emission tomography (PET) scans reveal increased activity in regions that generate hallucinations. At the same time, noradrenaline and serotonin—two chemicals critical to logical thinking, focusing, and memory—turn off. Their absence renders dream stories strange, implausible, and hard to remember (most of us recall dreams infrequently, and when we do, we may retain only one or two of the four or five dreams of a typical night). In REM sleep, the brain generates motor signals but squelches our ability to act on them. We may perceive that we fight

The Dream *(1932), by Pablo Picasso*

assailants, flee from danger, or make passionate love, yet we barely twitch in our beds.

Sigmund Freud thought the bizarreness of dreams allowed sleepers to avoid acknowledging subconscious wishes. But Hobson believes that the weird stories more likely reflect the brain's astounding ability to link a profusion of tangentially related ideas, which he terms "hyperassociation." We've all had dreams in which scenes change abruptly. In one experiment, Hobson and colleagues scissored apart 10 dream reports at the point of these dramatic scene shifts. They then spliced the fragments together, restoring half to their original form and making hybrids of the rest by combining the first part of one person's dream with the second part of another's. Even skilled psychoanalysts couldn't distinguish the real dreams from the hybrids. In trying to make sense of our dreams, Hobson believes, we search for causal ties where none exist.

Why do we dream at all? Through activation of the brain in sleep, Hobson suggests, we assimilate new information, master new skills, and prune out-of-date files. Babies get much more REM sleep than adults; intense activation may foster brain development early in life.

Freud initially aspired to unite psychology and neurology. In his *Project for a Scientific Psychology* (1895), he tried to construct a model of the human mind by describing its neurobiological workings. Since the neurological techniques of his time weren't up to the task, he concentrated on psychological theories. Today, PET scans and other sophisticated imaging tools open new windows to understanding how the brain functions. Contemporary neuroscientists can mine a trove of data that Freud could only dream of.

—Lynne Lamberg

UNCERTAIN SCIENCE, UNCERTAIN WORLD.
By Henry N. Pollack. Cambridge Univ. Press. 252 pp. $25

At the end of many a scientific assessment resounds the clarion call, "More research is needed." Admirably honest though this may be as far as science itself is concerned, it can look to outsiders like equivocation. When will the next earthquake hit Los Angeles? How fast is global temperature rising? We want answers.

Uncertainty, far from being a flaw, is an essential characteristic of science, says Henry N. Pollack, a geophysicist at the University of Michigan. Dogmatism is the enemy of progress. With the help of numerous examples, not all of them scientific (stock market fluctuations and the fabled hanging chads of Florida, among other things), Pollack illuminates the way scientists pick an often zig-zag course from ignorance to knowledge. They make guesses, judge likelihoods, evaluate probabilities. Scientific models of reality may be idealized, even simplistic, but their failings light the way ahead.

As a teacher, Pollack has a pleasant style and a light touch, though his writing doesn't always make it out of the classroom. He tends to overexplain his examples, and when it looks as if he is coming to a conclusion, he gives another example. He also has the inexplicable academic habit of ending each chapter by telling you what he just told you, and letting you know what he is going to tell you next, then starting the next chapter by—well, you know.

Still, the central chapters of the book offer an informative and enlightening account of how science works in practice and how scientists learn to be at ease in an uncertain universe. Pollack's particular concern is global warming, and in his last chapter he pulls a bit of a trick. Having convinced us that uncertainty in science is the name of the game, he argues cogently that the world needs to do something about the buildup of carbon dioxide and other greenhouse gases that cause global warming. How fast the planet is warming is uncertain, he contends, but that it is warming is now beyond reasonable doubt.

Pollack is right. Advocates for the petroleum industry (such as currently inhabit the White House) like to suggest that if there are doubts in scientific models of the world's climate, then maybe there is no problem after all. This is misguided at best, irresponsible at worst. As Carl Sagan used