

the observer in creating what is observed.” Now, physicists are haunted by the same dilemma. “Einstein’s relativity and the oddities of quantum mechanics both drew attention to the inescapable involvement of the act of measurement with what is measured,” McNeill notes.

Cosmologists, he continues, now debate whether the universe of their surmise may be forced “to conform to what human minds and humanly created instruments are capable of observing. The resulting epistemological dilemma is acute, even though practicing scientists usually prefer to disregard it. But the notion, propagated in the 17th century, that physical science,

relying on the certainties of mathematics, could achieve accurate predictability and an unambiguous description of external reality is no longer very plausible.”

At every level of intellectual organization—whether physical, chemical, or biological, or at the level of humanly invented verbal and mathematical symbols—complexity is giving rise to new and surprising sorts of behavior, McNeill points out. The natural and social sciences, he concludes, have begun to converge around a “grand evolutionary worldview.” He predicts that this congruence of the sciences will prove to be “the primary intellectual achievement of the 20th century.”

Why Rest?

“The Quest for the Essence of Sleep” by Alexander A. Borbély and Giulio Tononi, in *Daedelus* (Spring 1998), 136 Irving St., Cambridge, Mass. 02138.

Sleep is as necessary to human beings as food and drink, and most people spend one-third of their lives in this unconscious state. Yet, despite decades of research, the purpose of sleep remains obscure, notes Borbély, a professor of pharmacology at the University of Zurich, and Tononi, a Senior Fellow at the Neurosciences Institute in La Jolla, California.

Scientists have been studying sleep by measuring brain waves since the 1920s, but it was only in 1953 that researchers discovered that there are two kinds of sleep: the traditional “quiet” sort and an “active” type in which the eyes move rapidly beneath their closed lids while the body’s heart rate, blood pressure, and breathing fluctuate. Sleep, Borbély and Tononi say, seems to be not a unitary state but “a complex dynamic process” in which “active” and “quiet” slumber cyclically alternate. Active (or “rapid eye movement”) sleep typically accounts for 20 to 25 percent of adult rest.

Not everyone needs the same amount of rest, the authors observe. Some people, like Albert Einstein, spend up to 10 hours at a time in bed, while others, like Thomas Edison, need only four to six hours. One 70-

year-old retired nurse found by English researchers needed only one hour of sleep a night.

Most people believe that sleep serves to renew the whole human being, body and brain. However, it is clear to scientists that people sleep for the benefit of the brain, say Borbély and Tononi. If a person lies awake but motionless overnight, in the morning the body’s muscles are relaxed but the mind is not—and the “sense of well-being is lost.” But exactly what function sleep serves for the

brain is unknown. Some scientists speculate that sleep has a restorative function; others theorize that it offers stimulation, much as, in the womb, a fetus’s “active” sleep helps the brain to mature. Still other researchers suggest that during sleep a person may replay and thus “consolidate” memories

of activities that occurred during the day—or else erase memories, so as to prepare the brain circuitry for a new day.

Understanding how sleep works could have practical benefits. In the United States alone, sleep loss leads to 25,000 deaths and 2.5 million injuries on the road and elsewhere every year, at an estimated cost of \$56 billion.



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