Until recently, notes Rothstein, that ideal—gerontologists call it "squaring off the age curve"—received little taxpayer support. In 1973, for instance, federal contributions to cancer research amounted to about $2 for every U.S. citizen, versus only three cents for studies on aging. But since then, federal support for such studies has grown more than sixfold, to some $150 million per year. The hope is that researchers can learn enough about the causes and treatments of age-related disease in time to reduce the next geriatric generation's incidence of traumatic terminal illness or debilitating diseases such as Alzheimer's.

So far, scientists have yet to unlock the cellular and molecular keys to healthy longevity. Study of the aging process continues on many paths, such as the theory that the wanderings of "free radicals"—tiny bits of jetsam left in cells as by-products of cell metabolism—wreak cumulative damage on the heart and nervous system. While this and other natural phenomena probably contribute to aging, says Rothstein, "a more central cause" remains to be found.

It appears likely that diet can dramatically affect longevity, though at present there is no consensus on how it actually works. University of Texas researchers found that rats live 50 percent longer when their caloric intake is reduced by 60 percent (which would seem to correlate with the fact that certain mountain folk, such as the Hunza on the Sino-Pakistani border, live much longer than the average American on 1,000 fewer calories per day). Then again, studies at Baltimore's Gerontology Research Center have determined that, for middle-aged and older people, somewhat higher weights than those in the standard "ideal weight" tables would help foster a long and healthy life.

At present, Rothstein observes, "the odds of a major breakthrough" in squaring the aging curve are those of "a million-dollar lottery." All the more reason, he argues, to buy "lots of tickets"—i.e. continue supporting a wide range of investigations.

How Music Made Time

"The Origin of Time" by Geza Szamosi, in *The Sciences* (Sept./Oct. 1986), New York Academy of Sciences, 2 East 63rd St., New York, N.Y. 10021.

Historian C. P. Snow, who bemoaned the contemporary split between the humanities and the sciences in *The Two Cultures* (1959), might have buttressed his argument with an account of how science and music merged in medieval days to create the modern concept of time.

As Szamosi, a professor of physics at the University of Windsor, Ontario, points out, the ancients, who did not need to measure time exactly, had very vague notions of it. Plato held that time was a product of motion, governed by the sun and the planets; Aristotle conceived of time as variable, like the seasons and the human heartbeat. Such views held sway right through the Middle Ages. When clocks first appeared in the West during the 14th century, prominent dials represented the movements of the seven known planets; a small one told the time, with little precision.

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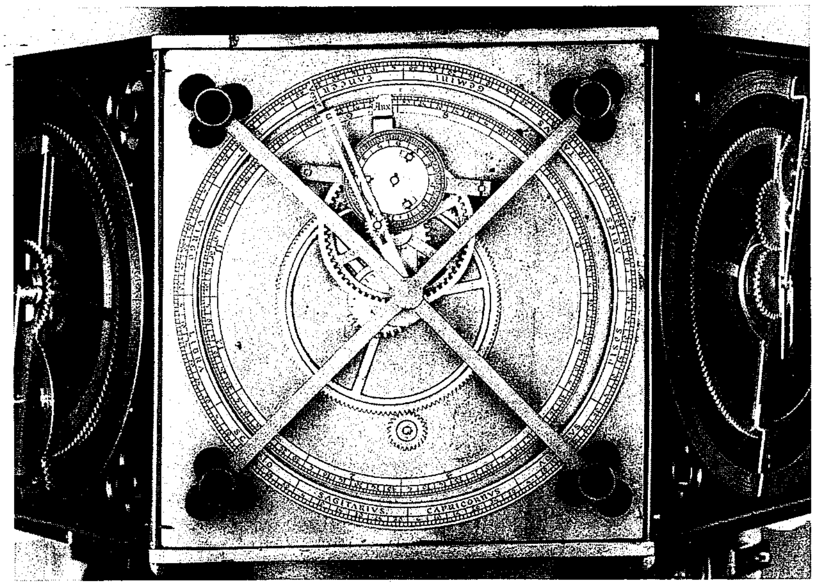

Medieval clockmakers had scant interest in the time. Here, a reproduction of the De 'Dondi Astronomical Clock (circa 1364), used to measure lunar cycles.

As late as the 1630s, when Galileo conducted his first experiments with time—including, it is said, attempts to measure how long it took cannonballs to drop to the ground from the tower of Pisa—most people reckoned time in terms of natural events such as the harvest or the cycles of the moon. Only music employed metric time.

The subtle polyphonic melodies of the early medieval Roman Catholic Gregorian chant, and the 12th-century style of singing known as melismatic organum (in which the durations of two sets of simultaneous notes remained constant while the melodies diverged), required careful temporal organization; intervals between notes had to be divided into equal or unequal parts and arranged in clearly defined relationships. Then, during the 14th century, musicians at the Notre Dame school in Paris developed a ground-breaking notation system of rhythmic modes, the precursors to the modern system (whole tones, quarter tones, etc.). Although primitive by today's standards, Notre Dame notation represented the first symbolic manipulation of measured time "independent of motion and detached from the environment."

Notre Dame's musicians were not motivated by scientific or philosophical goals. But they would soon benefit science and philosophy as much as art: Galileo's ideas undoubtedly related to the musical training he received from his father, a pioneer in new musical styles.

Today we are comfortable with, say, the idea that the Earth revolves around the sun once every 31,556,925.9747 seconds. But this perceptual ease does not come naturally. As Szamosi observes, until roughly age nine, children's temporal judgments amount to little more than disguised spatial judgments. "20th-century children are instinctive Aristotelians," he says. Like medieval man, they perceive the passage of time as the rhythm of their own concerns.

The Brain's Maps

"Neural Darwinism: A New Approach to Memory and Perception" by Israel Rosenfield, in *The New York Review of Books* (Oct. 9, 1986), 250 West 57th St., New York, N.Y. 10107.

Why do people remember a joke they heard in second grade, yet forget the howler they heard yesterday? Sigmund Freud viewed memory as a permanent record of past occurrences; but the record was unreliable, he thought, because emotionally charged events could be repressed.

Today, specialists do not believe that memories form a fixed record in the brain. But they underestimate the role of individual psychology in memory and perception, according to Rosenfield, a history professor at the John Jay College of Criminal Justice in New York City. It is our "individual needs and desires" that determine how we recall people and events.

Charles Darwin observed that the "typical" qualities we associate with humans and other animals are abstractions that conceal their true natures: biologically varied, genetically diverse, selected by the ability to survive difficult environments. If Darwin's theory of evolution holds, says Rosenfield, then Nobel Prize–winning neurophysicist Gerald Edelman has an intriguing explanation of memory's idiosyncrasies.

In 1978, Edelman suggested that the brain may be seen as a Darwinian system evolving through variation and selection. His task was to determine how, given a particular set of genes, enough variability could survive within the brain's overall structure. Early embryonic development provided Edelman with an answer. Studies of individual cells revealed that genes alone did not control their destinies; rather, they became liver cells, nerve cells, brain cells, or whatever, depending on where they were when specialization began. Thus brain function (and structure) appeared to depend on the activities of neighboring cells, as well as on the individual characteristics of the cells themselves.

Edelman's "neuronal group selection" theory holds that, in humans, groups of brain cells compete to record different sensations. For example, a man in a concert hall might hear someone say "nine o'clock," and recall a past nine o'clock event. One set of brain "maps" would locate the speaker while another enabled him to continue hearing the music. Months later, the man might have again forgotten the hour but suddenly recall it by humming the concert melody. His memory did not function by repeating past images; rather, the brain "recategorized" information when its mapping system was activated in another highly individual context.

Just as Albert Einstein replaced Sir Isaac Newton's theories with a larger view of space and time, Rosenfield argues, Edelman's ideas may yield a "deeper view of human psychology." At the very least, he says, neural Darwinism "challenges those who claim that science . . . is little concerned with the unique attributes of individuals."