Epilogue

The amazing discovery of the brain's plasticity—its ability to physically rewire itself to become smarter—makes mental stimulation, in the long run, more essential to the body than food.

That the brain thrives with good nourishment is a concept that has profound significance for individual achievement and for the way parents raise their children.

The brain's food is education. Just as the food we eat gives our immune systems the strength to fight off life-threatening infectious germs, education provides a type of protection against bad things happening to us. In effect, education acts like a vaccine that boosts our mental powers, making us more resistant to illness and premature aging. And it protects us from bad choices.

Education provides such strong immunity, in fact, that people who acquire more of it are living longer than ever before while those who don't have it are falling farther behind. It is the secret to a healthier, longer life.

Scientists have long known that income, occupation, and education are the most important predictors of people's health and how long they will live. But they had no way of telling which had the biggest impact.

Income had been the front-runner. Who can argue with the late singer Sophie Tucker's observation: "I have been rich and I have been poor. Rich is better." And a good job brings self-esteem and other rewards.

But it is education that is emerging as the most critical predictor of longevity and good health. It's what you don't know that can hurt you.

That comes as good news to public health experts who are desperately looking for ways to head off an approaching tidal wave of sickness and mental dysfunction that is facing a rapidly aging U.S. population.

For people who don't grab at the opportunity for education, the news is grim. They are on the wrong side of a widening gap between people who build more brain power and those who ignore it, and they are more likely to die younger.

Despite an overall decline in death rates in the United States since 1960, poorly educated low-income white males die at rates that are three to seven times higher than white men with better education or higher income, Dr. Gregory Pappas of the National Center for Health Statistics found in a 1993 study. The findings were reported in the *New England Journal of Medicine.*

This disparity increased between 1960 and 1986 as better-educated people were quicker to respond to the growing scientific evidence of the dangers of smoking, high-fat diets, and physical inactivity, and to adopt a healthier lifestyle.

The payoff has been remarkable. There are one-third fewer cigarette smokers, and the consumption of cholesterol and salt has declined dramatically. These lifestyle changes are largely responsible for a 53 percent decline in heart attack deaths since 1963.

Those who benefited the most were the better educated. During the twenty-six-year period in the Pappas study, the age-adjusted death rate for white male college graduates twenty-five to sixty-four years of age declined by 50 percent from 5.7 deaths per 1,000 men in 1960 to 2.8 deaths per 1,000 in 1986. Among white men who did not finish high school, death rates dropped by only 15 percent, from 9 to 7.6 per 1,000.

"If there were some infectious disease in the population that caused such a differential in mortality, it would be a national disaster," said Dr. Jack M. Guralnik of the National Institute on Aging.

"If a large proportion of the population had something that increased its mortality rate by these amounts, we'd say 'My God, this is horrendous,'" he said. "But nobody pays much attention to this. Certainly the medical establishment doesn't."

Unlike money, which is hard to come by, and professional status, which is difficult to achieve, education can be acquired by anyone. Its power lies in the mind—the ability to convert words, ideas, and new information into problem-solving actions.

"In all of the studies looking at lower mortality and lower morbidity rates, people who do much better are not an elite group," Guralnik said. "They're high school graduates. Just getting out of high school puts people in a category where it looks like their risks of morbidity and mortality are substantially lower." People with twelve or more years of education can look forward to nearly four more years of active life than those who are less educated.

The earlier education is acquired, the more impact it has against sickness and early death. But throughout life education acts like a continuing series of booster shots. Education works in two fundamental ways:

- Biologically, by laying down significantly more connections between brain cells that accompany learning. Memory, as a result, is increased and the additional connections also provide a buffer against the destructive forces of Alzheimer's disease.

- Behaviorally, by promoting positive values and attitudes about health, higher self-esteem, effective coping skills, access to preventive health services, and association with people who have similar views. At the same time, education reduces risky behaviors such as smoking.

The lack of education, though not as visible as an infectious disease, is far deadlier in the industrialized world. The death rate disparity that Pappas found between white men, women, and African-Americans occurred at a time when educational levels increased dramatically in some groups, while hardly budging in others.

The growing gap between the educated and less educated is reflected in literacy rates. In 1960 the U.S. government pronounced someone literate if he or she had an eighth-grade education.

That standard of literacy has become hopelessly out of date. Today

Clearly, being literate means more than just being able to read at an eighth-grade level. Information has to be sucked in and used. And while the number of formal years of education serves as an average predictor of how well a person will do, it really depends on how he uses his brain all of his life.

Just as some people fail to get vaccinated against common childhood infections, others fail to take advantage of the immunizing effects of education. Half of the high school students in Chicago and some other large cities, for instance, fail to graduate.

The toll this takes on the brain is staggering. Children born to mothers who have less than twelve years of education have a fourfold increased risk of mental retardation, said Dr. Marshalyn Yeargin-Allsop, a medical epidemiologist at the Centers for Disease Control and Prevention's (CDC) Division of Birth Defects and Developmental Disabilities.

"This is regardless of race," she said. "White children and black children had the same fourfold risk if their mothers didn't complete high school."

A CDC study of more than 1,000 children showed that mild retardation, defined as having an IQ between 50 and 70, occurs at the rate of nearly 1 in 100 children. The biggest risk factor for mild retardation is the mother's low educational level, which far exceeds the risk posed by poverty.

About 22 percent of all births in this country are to mothers with less than a high school education. These women often do not know how to provide stimulation—talk, toys, physical activity—to their infants, which can lead to stunting of the brain during the crucial first three years of life, Yeargin-Allsop said. "We're wasting a lot of human potential. It's astounding to think that almost a quarter of all children are being born to mothers with less than twelve years of education and are at risk for mild mental retardation."

Mild mental retardation is generally believed to be caused by a failure to provide the brain with the kinds of experiences from its surrounding world that it needs to develop to its maximum capacity.

ventable," Yeargin-Allsop said. "We can leapfrog over the risks if young people stay in school and get as much education as they can."

Based on these findings the CDC is planning to launch Project BEGIN, in which those children from birth to age three who are at risk for retardation will participate in intensive intervention programs. The children will be enrolled in full-day, year-round child development centers, and their families will have regular home visits by psychologists and social workers.

Having less than twelve years of education makes people more vulnerable to other risks, such as ad campaigns that increase risky behavior, said Stanford University epidemiologist Marilyn A. Winkleby. "Tobacco companies are savvy about this. They've developed all sorts of ads, as have alcohol companies. They've done their market research and target people with low education. Health professionals need to be as good about doing their market research to counter harmful lifestyles."

Some people, on the other hand, are on an information binge. The average newspaper reader, for instance, has an education level equivalent to one year of college.

The dramatic difference in mortality and morbidity between the educated and less educated occurs around the world. The disparity can be found in such countries as Sweden, Canada, and England, which have national health insurance, a benefit that presumably gives all citizens equal access to health care.

Johns Hopkins researchers were stunned to find the same thing in their own backyard. The biggest cause of blindness in Hopkins's East Baltimore low-income neighborhood is cataracts. Such blindness is easily reversed by simple surgery to remove the cataracts, yet these people did not know it was available at nearby Hopkins and that the cost would be covered by Medicare.

"They were blind," said Dr. Alfred Sommers, dean of Hopkins's School of Public Health. "We're not talking about having some difficulty reading. We're talking about people who couldn't see TV and couldn't read. A very large component has to be their educational

level, because that's what changes their motivation and understanding about what's going on."

Sociologists and public health experts have traditionally looked at money, job status, and education as the main determinants of health. They have even examined ethnicity, poverty, stress, crime, and other factors generally ascribed to social class differences.

For a long time many people believed that race accounted for the higher sickness and death rates among some groups. New research tends to dispel that connection as a major concern.

"Certainly there are cultural differences, but the big, big indicator is low educational attainment, regardless of ethnicity," said Winkleby.

Whites live longer than blacks primarily because proportionately more blacks have lower education and income levels, Guralnik said. When educated blacks are compared with educated whites, there's no difference. "Race is not what's important. It's socioeconomic status that is driving this. And independent of the other aspects of socioeconomic status—income and occupation—education, in and of itself, probably does play a positive role in improving health status," he said.

Education's pivotal role was underscored in a recent survey showing that median household income is rising for every American ethnic and racial group, except for the nation's 27 million Hispanics, for whom it declined. Sociologists blame this decline on falling education levels. Among Mexican-Americans whose families have lived in the United States for three generations or more, each generation has less schooling than the one before it.

Many scientists believe that education affects health because it helps people determine how to live their lives, and whether to choose to take risks or not.

Lifestyle risks account for half of the 2.2 million deaths that occur annually in the United States, according to Dr. Michael McGinnis of the U.S. Department of Public Health and Dr. William Foege of the Carter Presidential Center in Atlanta. In an eye-opening 1993 article published in the *Journal of the American Medical Association* the researchers described the deadly toll: tobacco, 400,000 annual deaths; bad diet and physical inactivity, 300,000 deaths; alcohol, 100,000; infections (mostly preventable), 90,000; toxic agents at home or in the workplace, 60,000; firearms, 35,000; unsafe sex, 30,000; motor vehicles, 25,000; and illicit use of drugs, 20,000.

"Lack of education is not only a very powerful risk factor, it's a modifiable risk factor," said Winkleby, who found that with each additional year of schooling there was a dramatic decrease in heart disease risk factors. "With education you learn how to navigate your world. You learn empowerment. You learn how to articulate your needs and to overcome potential barriers."

Those barriers can be formidable, as the first nationwide study to assess lifestyle risk factors by sex, race, ethnicity, and education recently found. The study, which involved more than 180,000 adults, was sponsored by the CDC.

Its chief finding hammered home the conclusion of smaller studies: as education levels rise, the risks of smoking, sedentary behavior, and obesity decline.

For white men, 25 percent of those with less than twelve years of schooling smoked compared to 17 percent of men with more than twelve years. Nearly three-fourths of the men with less than twelve years of education had a sedentary lifestyle compared to less than half of those with more than twelve years. Thirty-two percent of men with less than twelve years of schooling were overweight compared to only 17 percent of those with more than twelve years.

A similar pattern was found for white women, blacks, Native Americans, Alaskan natives, Asians, Pacific Islanders, and Hispanics.

"When you find study after study showing this relationship between health and education, then education becomes a defining factor," said CDC epidemiologist Nora Keenan.

What is it about education that makes a difference? When David S. Strogatz of the State University of New York and the New York State Department of Public Health put the question under his epidemiological microscope he found that education allowed people to recognize risks and do something about them.

The odds of college graduates being able to state their own blood pressure and to know that 140/90 mmHg or less is a "good blood pressure" were more than three times greater than for people who had not completed high school, he showed in a study of more than 3,000 people.

College graduates were more than three times more likely to know their own cholesterol level or to know that 200 mg|dl or less is a healthy cholesterol level. The odds of college graduates being current smokers were less than half as great as for those not finishing high school.

In contrast, when poor, rural Appalachian patients were asked why they didn't take advantage of blood pressure testing, cholesterol screening, Pap smears, mammography, and other preventive measures, 51 percent said it was because they didn't know why they should. Thirty-six percent listed cost as the reason.

Just how devastating the lack of education can be to health was graphically demonstrated in a Finnish study of heart disease. Among young men who started off in equally good health—with no early signs of hardening of the arteries (atherosclerosis)—those who had less schooling and income developed heart disease after four years at a much greater rate than men who had more education. The study is significant because it is the first to follow the yearly progression of atherosclerosis in poorly educated men as compared to men with better education.

The researchers used ultrasound to measure the buildup of fatty deposits in the carotid arteries, the two main vessels that supply blood to the brain. These vessels are easy to examine, and they provide an accurate indication of fatty accumulations in coronary arteries, which supply the heart. Blood-vessel disease progressed most rapidly among men whose highest level of education was primary school or less, followed by men who had some high school education. Those least affected by blood-vessel disease were men who had completed high school or who had gone on to college. Amazingly, the least educated men had three times the rate of atherosclerosis as the best educated men.

According to this study, poor education should be added to the list of other risk factors for heart disease—cigarette smoking, high-fat diet, high blood pressure, and physical inactivity. The reason: People with less education are far more likely to have the other risk factors, said John Lynch of the Western Consortium for Public Health in Berkeley, California.

People with less education also appear to be less happy than those with more education. White, middle-aged, suburban-dwelling, well-educated males—despite being downsized, socially vilified, and generally kicked around in recent years—are the happiest Americans. They seem to be clad in a psychological armor that makes them the least likely of all Americans to suffer from depression or other negative moods.

If happiness can be defined as the absence of bad feelings, then leading the pack overall are white males, who score the lowest on the negative mood scale at only 5.8 percent. Unhappiness rises rapidly for the rest of the population, climbing to 8.1 percent of white females, 10.7 percent of black males, and 16.4 percent of black females, a whopping 183 percent higher than white males.

When the federal government decided to find out what it is in people's lives that makes them either more resistant to depression or more prone to it, they found that psychological well-being can be measured by five factors—education, race, sex, age, and place of residence, in that order.

The single most important factor that appears to protect people from negative moods is education, said behavioral scientist Bruce S. Jonas of the National Center for Health Statistics.

The findings raise an intriguing question: Is happiness a state of mind or a station in life? The answer, it seems, is that happiness depends on things people can do for themselves, such as getting an education and choosing a place to live, as well as factors that are more difficult to deal with—race, gender, and age.

The center's study asked nearly 44,000 adults across the country if they had been depressed, restless, bored, upset, lonely, or anxious in the past two weeks. Among white males, white females, and black males, those with less than twelve years of education had twice the rates of depression than those who had more than twelve years of education. For black females, 20 percent of those who didn't finish high school had negative moods, compared to 14.6 percent who had completed some level of higher education. The most dramatic difference occurred among less-educated black females, who had more than four times the rate of negative moods as better-educated white males.

Education is directly linked to socioeconomic status: People with

worries, and you don't have as many means to cope with those stresses. You're depressed for good reason.

Knowing that less education can precipitate depression may encourage people to make changes in their lives. Acquiring more education, for instance, can go a long way toward insuring happiness.

Probably some of the same reasons that make education such a good protector against negative moods also apply to race. Minorities often don't have the same opportunities for education and advancement. But when they do, their happiness quotient soars. The study found that 14 percent of blacks reported bad feelings, 90 percent higher than the rate reported by whites. However, black males who went to college had a 50 percent lower rate of negative moods than those with less than twelve years of schooling. Black females who pursued higher education had a 37 percent lower rate of negative feelings than those who didn't complete high school.

Living in isolated rural areas or large cities is especially hard on people who have less education. They have twice the rate of negative moods as people living in similar conditions who have more education. Education provides a buffer against the social isolation of country living as well as the psychological stresses of urban dwelling.

If early education is like a vaccine against risk factors, then giving it to poor, deprived children should help protect them as they grow older. That's what David Weikart, president of the groundbreaking High/Scope Perry Preschool Study in Ypsilanti, Michigan, set out to prove in the late sixties.

Weikart randomly divided 127 black children ages three and four into two groups. The children were born in poverty and had a high risk of failing in school. One group received intensive preschool education 2.5 hours a day for thirty weeks. The other group, which received no intervention, served as controls.

"The educational program focused on getting kids to make choices between things that might either be good or bad for them and to invent solutions to the problems they were working on," he said.

Now, twenty-seven years later, the children who were in the intervention group have less than one-third the risk of being arrested for drugs as the controls, and girls in the program are one-third less likely to have babies out of wedlock than their peers in the control group. Those in the program are less likely to have been on welfare and more likely to own their own homes, have good jobs, and be in a stable marriage.

"For every dollar we initially spent on educating the children in the intervention group, the public is receiving $7.16 in savings from reduced crime, reduced welfare, reduced cost of education, and more tax payment on earnings," Weikart said.

Early intervention raises IQs. But are there some preschool programs that are better than others in providing children with not only higher IQs but better social skills as well? Again, Weikart wanted to find out. In 1967 he set up a trial with sixty-eight children born into poverty to compare a preschool program where teachers told children what and how to learn with a program where children were encouraged to be self-starters.

For two years, starting at age three, some of the children were taught through direct instruction: Teachers followed a script to directly teach children academic skills, enforcing their attention and rewarding them for giving correct answers. Teachers in this group typically would say "listen," "be quiet," "focus," "watch me," "do what I do." Reading was taught by a teacher pointing to letters. Math was taught by rote, "one plus one equals two."

In the self-starting group, teachers set up the classroom and the daily routine so children could plan, do, and review their own activities and engage in key experiences through active learning with materials, people, events, and ideas. Math, for instance, was learned when a child built a bigger tower than the day before and then said it was bigger because he or she had added four more blocks.

By the age of ten, IQ levels in both groups had climbed twenty-seven points from a borderline-impairment level of seventy-eight. But by the age of twenty-three, big psychological and sociological

emotional problems, compared to only 6 percent of the self-starter children. Thirty-nine percent of the direct-instruction group had been arrested for a felony, compared with 10 percent of the self-starters; none had married, compared with 31 percent of the self-starters; and 27 percent planned to graduate from college, compared with 70 percent of the self-starters.

What was it that caused the direct-instruction children to lean toward antisocial behavior and the self-starter group to be more inclined to prosocial behavior? The direct-instruction program made children loners: Not only were they told what to think and how to think it, but they did it by themselves. The self-starters in the child-initiated learning program, on the other hand, were able to be both active and interactive—to develop the skills and dispositions of decision-making, planning, getting along with adults, and getting along with other children.

"Put simply," says Weikart, "child-initiated learning activities support the development of positive social skills and dispositions, whereas direct instruction does not. The goals of early childhood education should not be limited to academic preparation for school but should also include helping children learn to make decisions, solve problems, and get along with others."

Just as Weikart set out to prove that early education can produce positive lifelong behavioral changes, David A. Snowdon, associate professor of preventive medicine at the University of Kentucky, wants to show that childhood educational experiences can biologically build a better brain.

One of the problems with assessing the impact of education on health is adjusting for things like smoking, drinking, access to health care, and other factors that can muddy results.

By studying 678 nuns, members of the School Sisters of Notre Dame, who were born in 1916 or earlier, Snowdon was able to eliminate most of the other risk factors. From the age of twenty on, the nuns shared the same environment, ate the same food, had the same access to health care, and didn't smoke or drink.

their career, such as teaching or housekeeping.

So far his findings are right on target. The more highly educated nuns live four years longer in good mental and physical health than those who have less than a bachelor's degree. The less educated sisters have twice the death rate at every age between twenty and ninety-five.

Childhood educational skills are a key to predicting which nuns will live the longest. How well the nuns wrote and used vocabulary early on in their lives indicated the level of intellectual capacity they had achieved, which showed their willingness to use their brains.

"We find that sisters who had a limited vocabulary when they were twenty are the ones at high risk of mental and physical disabilities sixty to seventy years later," Snowdon said.

Growing evidence indicates that early mental stimulation promotes the growth of synaptic connections between brain cells. The brain has trillions of these connections, which act as telephone lines that enable cells to talk to each other for the purposes of creating memory and intellectual prowess.

"So, building a better brain, keeping your brain active, particularly starting at a very young age, might offer you some protection against brain disease and disabilities later on," Snowdon said.

The sisters think it's worth finding out. All have agreed to donate their brains for study after their death to determine if the brains of the better-educated nuns actually have more synaptic connections than the brains of those who are less educated. So far, autopsy studies of the brains of nuns who have already died point in that direction.

"Sisters with less education have smaller brains at death," Snowdon said. Why? "It might be because they didn't lay down as many synapses early on as the sisters who were more intellectually stimulated."

One of the most remarkable examples of the brain's great capacity to learn is the explosive increase in IQ scores in the world's industrialized nations since the turn of the century. Since 1918, IQ scores have risen twenty-four points in the United States, although the tests used to determine IQ have remained basically unchanged.

Scores are periodically adjusted to keep the average at 100. If they weren't, Americans today would have an average IQ score of 124, compared to the average of 100 in the early 1900s.

One thing is clear, the tremendous rise in IQ scores is not due to genes. Genes do not mutate fast enough to make people smarter in such a short time. What most likely accounts for the increase are the dramatic changes in society since the Industrial Revolution, which have given people a lot more food for thought.

When the first IQ tests were given, people had few sources of information. The radio, for example, was a new gadget. Since then, we've been exposed to movies, television, computers, video games, and a plethora of newspapers, magazines, and books. At the same time, the world has become more technologically complex and, therefore, more intellectually demanding. We have healthier nutrition, better schooling, and improved socioeconomic status. All of these factors have probably played a role in the IQ surge.

Belying the implication of the "bell curve," that intelligence is basically determined by genes, the IQ explosion shows that nurture is just as important as nature. A similar phenomenon occurred with stature. The average height of Americans increased as their IQs rose. The rise in height was not due to new tallness genes that people suddenly inherited. It was simply due to the environment—more nutritious food allowed our bodies to reach their potentials for growth.

Each generation comes into the world with new advantages. A major predictor of a child's intelligence is the educational level achieved by his or her parents, which has steadily been increasing. Since 1973 the number of parents who have attended college has jumped 70 percent.

On a biological level, our increasingly complex world is forcing us to use our brains more. To accommodate this new learning, the brain builds more synaptic connections between its cells. Increasing IQ levels show us that instead of being fixed and immutable, intelligence is flexible and subject to great changes, both up and down, depending on the kinds of stimulation the brain gets from its environment.