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Nature and Nurture

From Past to Present

Most animals begin life with all or most of their survival systems functional. Their independent life thus begins immediately or shortly after birth. Humans are a notable exception. We're basically helpless at birth and for a long time afterwards. The principal reason is that, because our three-pound adult brain is much larger than our mother's birth canal, we're born with a one-pound basic brain that can traverse the canal, but can't regulate an independent life.

During its initial 20-year post-birth development, our brain adds two pounds of mass and accompanying capabilities. This moves us from being not much more than a wet noisy pet in infancy to the functional autonomy that's characteristic of adults. A variety of cultural systems that range from the informality of parenting to the formality of classroom instruction nurture this extended development.

We've long been curious about the nature and proper maintenance of life and about the relative roles that our genetic heritage and early experiences play in determining what we become. The commonly used terms for these factors are *nature* and *nurture.* Nature tells us how to *become* a human being. Nurture shapes our environment and development—and so tells us how to *behave* like a human being. The two concepts thus combine species membership with cultural and individual identity.

As these related issues are central to understanding childhood, and are the subject of considerable scientific research, let's begin our exploration of childhood with them.

The Nature of Life

Life is an elusive concept—except that it exists in space and time and requires energy to maintain it. Although space, time, and energy seem like simple, straightforward concepts deeply embedded within human language, all three create contentious cultural controversies related to our understanding of the nature and maintenance of life.

Space in human life is basically about objects and locations. We mentally represent these as nouns, qualify them with adjectives, and locate them with spatial prepositions (such as *under, over,* and *within*). A key current spatial issue in biology focuses on where life exists. Is it a property of the entire organism, or does it reside within organs, tissues, cells, or complex molecules such as **DNA**?

Time in human life is basically about events. We mentally represent these as verbs, qualify them with adverbs, and locate them with temporal prepositions (such as *before, during,* and *after*). Key current temporal issues in biology focus on the beginning and ending of life. Are embryonic stem cell research and cloning appropriate? Are capital punishment and assisted suicide appropriate?

Energy in human life is basically about nutrient intake and cognitive arousal and focus beyond basal levels. Our **emotion** and attention systems process arousal and focus. A key current issue focuses on the source of life's energy. Is it centered within self-organizing biological systems that seek and process nutrients, or does it involve such disembodied concepts as mind, spirit, soul, and/or god? Further, is life a discrete variable—something that either exists or doesn't—or is it a continuous spectrum defined by some properties, such as circulation and respiration, that are functional at birth, and others, such as walking and talking, that emerge later?

The Cell

We can think of the cell as the basic structural and functional unit of an organism. The cell provides a space-time-energy identity to a discrete packet of biological information that would otherwise float around aimlessly. The functional concept of *cell* also provides us with an intriguing metaphor for understanding life at several levels, including childhood.

A cell is functionally composed of (1) a protective semipermeable membrane that envelops internal cellular materials but that also contains channels that allow for the selective in-out movement of nutrients and cell products, (2) the cell's nutrient material (cytoplasm), and (3) various processing and regulatory structures—principally a nucleus that contains the cell's long, coiled DNA molecule that provides the genetic directions for **protein** synthesis. The human body has an estimated 100 trillion cells.

Various cellular processes regulate an organism's metabolism. They break down food into useful nutrients that they then use to construct body parts and provide our brain with the chemicals it needs. Cells that are functionally related to each other combine to form tissues and organs. Some of these multicellular systems serve structural or protective roles (e.g., bones, skin, fingernails, kidneys), some process nutrients (e.g., lungs, intestines, liver), and some move nutrients and information (e.g., blood vessels, **neurons**).

From Cell to Body. An entire body has functional parallels to a cell. Our body's version of a cell's semipermeable membrane is our six-pound, 22-square-foot mantle of skin that keeps our insides in place, heat in, and infection out. A cell's membrane has channels that regulate the input and output of materials—and our body has selective sensory and immune systems that recognize external dangers and opportunities, selective digestive and genital systems that serve as in-out conduits for nutrient and reproductive materials, and a language system that receives and sends psychological information.

The constant need for nutrients is a problem for both a cell and an organism, so both tend to take in more than they currently need. The excess is stored for later use—within cellular cytoplasm, for a cell, and within our body as fat and as nutrients that circulate within our bloodstream. Our brain similarly stores experience as retrievable memories and potential problem-solving strategies.

Genetic processes (such as DNA and **RNA**) regulate cellular activity. Their principal tasks are to maintain the cell and build proteins out of the nutrient materials that enter the cell, and then to distribute cellular products for appropriate body use. Our brain is our body's equivalent of these cellular regulatory processes. It receives initially meaningless sensory information, organizes it into an integrated, coherent model of what's occurring inside and outside our body, and then determines an appropriate response.

From Cell to Classroom. A classroom similarly parallels this simple biological model. For example, a classroom's version of a cell's semipermeable membrane includes the walls, windows, doors, faucets, outlets, and so on that surround the inhabitants and regulate the in-/outflow of students and information. Its cache of *nutrients* includes currently used and unused equipment and materials—and hopefully eager-to-learn students (think analogously of **amino acids** in a cell waiting to be organized into proteins so that they can leave the cell and do something useful). The metaphoric equivalent of the cellular nucleus is the teacher and curriculum that combine to organize the school lives of students so that they will personally and intellectually move well beyond their current developmental level.

Childhood as a concept similarly has protective parental and cultural shields around it that help determine what can and should enter into the lives of children. What enters are various controlled forms of nutrient and sensory information that the child's body and brain must organize for immediate or long-term use. Parenting and various forms of teaching help children understand the otherwise confusing positive and negative inputs they receive. What goes out of a child is behavior that is hopefully appropriate and has at least some adult oversight and direction.

What we thus have is a simple but excellent universal model for biological systems. It functions from the level of individual cells to the level of social groups, and it incorporates antecedents (nature) and immediacy (nurture): a protective semipermeable membrane, an extensive collection of potentially useful but currently unorganized and unused materials, and an efficient organizing agent. Life itself!

Biological Range

Life exists within ranges, which makes it much more interesting than if everything was identical and unchanging. For example, the hundreds of leaves on a maple tree are easily identified as maple leaves, but no two of them are identical in size, shape, or color. Nor are the arrangements of branches and roots of several nearby maple trees identical. Similarly, all dogs are biologically related, but breeds and individual dogs vary considerably.

Humans function within biologically possible and culturally appropriate ranges. For example, Olympic track records identify the current upper end of the human running range, and posted traffic speeds identify the upper end of the appropriate automobile speed range.

One advantage of having an extended childhood and adolescence is that it allows young people to develop their various capabilities at an individual rate within broadly acceptable ranges. Schools typically work with groups of students, so it's simpler for educators to organize students into developmentally similar groups. Schools use age as the principal grouping criterion during childhood, and interest and capability as the principal criteria during adolescence—but the assumption is that variation within a range will exist and is developmentally appropriate. Grades assess and report how students perform within such assumed ranges.

Conversely, parents focus principally on their own child's development, providing both the **genes** and jeans, as it were. They informally assess such development through observations of their child's peers and through the lens of conventional wisdom about the capabilities of children at various levels of development. I suspect that many also compare their child to their own adult capabilities and to recollections of their own childhood capabilities.

What emerges therefore are two legitimate perspectives: (1) the school's view of the students as members of a peer group and (2) the parents' view of their child as an individual student within a group. Nature provides us with the basic similarities that define a group, and nurture provides us with the striving that characterizes individuals.

Nature and Nurture

Our parents' initial gift to us at conception is the set of about 30,000 **genes** that assemble and regulate our body. Parental egg and sperm combine at conception to produce a long, convoluted, periodically split, ladder-shaped molecule within the initial cell's nucleus—a molecule that is then replicated in all subsequent body cells (except egg, sperm, and red blood cells). It's called deoxyribonucleic acid, DNA for short. DNA is divided into discrete segments called genes, and each functional gene prescribes the length and sequence of the chain of amino acids that make up a specific protein. Proteins provide the scaffolding and machinery of our body's cells, and so they define much of our physical self.

Twenty different kinds of amino acids are all that's needed to make an infinite variety of proteins, just as only 26 letters can construct the 500,000 (and counting) words in the English language. The sequence of amino acids or letters and the length of the chain determine the information, and not the limited numbers of amino acids or letters themselves. The completely different words *do, dog, god, good,* and *goods* demonstrate how this marvelously adaptable coding system creates complex information out of a few simple elements.

This sequential coding system is also used in the small number of tones in musical scales that can create an infinite number of melodies, in the 10 digits of our numeration system that can represent limitless quantities, and in the relatively small number of basic movements that can create many complex actions (such as in the sequence: reach, grasp, elevate, retract, tip, drink).

Just as sequences of words make sentences, stories, and songs, so various genetic combinations result in such basic but complex human properties as gender; body shape; skin, hair, and eye color; and temperament. About nine months after conception, parents discover how their combined genetic directions turned out, and they're usually pleased. We love our babies, who tend to resemble us, but who definitely depend on us to take care of them.

Thirty thousand genes are enough to direct the development and initial operation of a basic birth body, but they're not enough to provide specific directions for living out our complex extended life. Parents must thus provide their child with a second set of instructions—how to transform genetic beginnings into a qualitative cultural life. Their child's extended family, peers, schools, and mass media assist in this nurturing task, and language (with its functional similarities to the genetic code) plays a central role in this process.

As indicated above, the nature/nurture issue revolves around the relative levels of influence that genetic inheritance (nature) and our life experiences (nurture) play in determining our traits and capabilities—in effect, the person we become.

Genetics (nature) activates such conditions as Down syndrome, and it influences such body properties as height and shape; however, the mother's dietary behavior during pregnancy (nurture) and a person's diet and exercise throughout life can alter such basic genetic plans. Genes similarly regulate the development of brain structures, so such cognitive functions as movement, language, and memory also have a genetic base, but experience constantly alters the current organization of a brain's networks and its synaptic connections.

Further, the nature/nurture issue has political overtones. Those who believe that nature is the primary influence in who we become are typically less inclined to support massive programs that hope to improve human conditions they feel can't really be changed. They say, in effect, "Accept your abilities and limitations, and we'll do our best to create a broad accepting society that can accommodate a wide range of capabilities and personalities."

Those who believe that nurture is the primary influence in a person's maturation and lifestyle typically support social service and education programs, especially those that help folks at the lower ends of various human attainment scales. They say, in effect, "Imagine a goal, strive toward it, and our society will help you to achieve it."

What scientists now understand is that neither extreme position is correct. Some human properties, such as height and skin color, are genetically determined and almost impossible to change, but other properties, such as the language we speak and the cultural rituals we follow, are almost entirely based on experience.

One could generalize that genetics is probably more important early in life and environment in later life. However, as suggested above, a woman's use of alcohol and other drugs during pregnancy can affect the development of the fetus (as in fetal alcohol syndrome), and a genetic predisposition to an illness (such as Huntington's disease) could activate later in life regardless of how the person has lived.

Gender orientation has become politically and culturally contentious in recent years, and it's also typically a concern of parents as they observe their children mature. Five to ten percent of the population identify themselves as homosexual. The major current issue is whether the rights and benefits that automatically accrue to married heterosexual couples should also be extended to bonded homosexual couples who wish to marry. Implicit in this is whether our gender orientation is genetically determined or freely chosen.

The scientific evidence currently suggests that, like many other complex human behaviors, some portion of our gender identity is biologically determined, but it's not yet certain what the division is—and how much of it is genetic and epigenetic (affected by hormonal action during pregnancy).

It's also not certain what difference such a determination would currently make, as cultural acceptance occurs much more slowly than the related developments in science and technology. For example, during my elementary school years, teachers vigorously (but ineffectively) urged my left-handed classmates to become right-handed, because a strong cultural bias toward right-handedness existed. Educators no longer do this.

Heritability

Scientists use a measure called heritability that statistically estimates how much nature and nurture contribute to the individual variation observable in a trait. For example, are differences in susceptibility to an illness more related to family lineage or to environmental factors (such as diet or environmental pollutants)? Scientists compare the total amount of variation in susceptibility within a population with the level of susceptibility within specific families. If relatively few people in the general population are susceptible to the illness, but those within certain family groups are much more susceptible, the vulnerability to the illness would be considered heritable.

On the other hand, if you are a member of a family of loggers, your chances of being injured in a logging accident are higher than in the general population, but that type of susceptibility wouldn't be considered heritable. Fingerprint patterns are thus considered heritable, but calluses are occupational (or environmental).

If a trait is said to be 70% heritable, it means that 70% of the observed variation in that trait within a specific sample of people can be attributed to genetic variations among individuals.

It's probably best to think of genes as phenomena that enable rather than constrain behavior. Genes provide the mechanisms for biological *possibility,* but the challenges we confront and the decisions we make determine which genes are expressed to facilitate our responses—and so to affect such human properties as character and intelligence. Ridley (2000) suggests that we thus might better replace the conventional nature *versus* nurture perspective with a more collaborative nature *via* nurture perspective.

Parents and educators can't change the genetic history of a child, but they can do the kind of nurturing that will provide the child with the best possible adaptations of whatever nature provided.

They can also become part of the extended *nurturing* process that needs to occur at the societal level. Most people don't understand the subtle complexities of genetics, but we're all increasingly drawn into moral and political controversies over genetics-related issues. Indeed, recent developments in such areas as **stem cells** and cloning will certainly exacerbate an already contentious discussion of the cultural appropriateness of such research. The resolution of such nature/nurture issues in our democratic society will involve many voters and politicians who unfortunately don't really understand the underlying science implicit in the decisions they'll have to make. Developing a biologically literate society won't occur immediately, but if we delay the beginning, we'll also delay the completion of this important task.

Begin with the children you nurture.