

Nature, Nurture and the Power of Love

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Full Text: Headnote ABSTRACT: Leading edge research in cell biology reveals that "environmental signals" are primarily responsible for selecting the genes expressed by an organism. This new perspective is in direct contrast with the established view that our fate is controlled by our genes. The new emphasis on nurture (environment) controlling nature (genes) focuses special attention on the importance of the maternal environment in fetal development. In addition to the established role of maternal physiology, it is now recognized that maternal behaviors and emotions profoundly impact the child's physical development, behavioral characteristics and even its level of intelligence. The history of human civilization reveals a recurrent preoccupation with the notion of duality. Black and white, positive and negative, male and female, winner and loser and of course, the ever controversial, good and evil. Interestingly, even the nature of "duality" itself led to a fundamental splitting or duality of human civilization-East and West. In Eastern philosophy, all aspects of duality are recognized as representing an underlying unity. All is One, but from that One springs all of our perceived dualities. In contrast, Western civilization is entirely based upon a philosophy that emphasizes the distinct polarity inherent in dualism. Our pre-occupation with duality becomes quite volatile when we assign values to the polar extremes, especially the values of right and wrong. Polar views create "sides" and the sides usually compete to provide justification in support of their stance. Even the consequences of the resulting competition over dualistic points of view can be dualistic. Competition may become destructive, especially when its resolution leads to physical combat such as wars and revolutions. At other times, the competition over polar points of view are quite constructive, when resolutions lead to intellectual and technical advance. One of the more recent and most profound examples of a conflict resolution that advanced humanity is the Quantum Revolution of 1925. Prior to that event scientists vied over the fundamental nature of the units comprising the universe. Were they comprised of matter or of energy? Matter was characterized as being composed of discrete particles, while energy was perceived as intangible waves. Western logic emphasizes the dual, mutually exclusive, nature of these two states of existence. Particle or wave, but not both! The stunning and illogical resolution in quantum theory is that the elemental units of nature were both particles and waves. This fundamentally "Eastern" conclusion emphasizing "unity" of polarities rocked the scientific world and profoundly changed physics, chemistry and the fate of Western civilization. Interestingly, the concept of an inherent unity within "dualism" never fully penetrated the biological sciences, which still maintains a penchant of perceiving the biosphere in dualistic philosophy. Nowhere is this dualism more exemplified than in the ongoing debate between Evolutionists and Creationists. On the surface, evolution and creation represent mutually exclusive processes-polarizing concepts. Now, some seventy years after the Quantum revolution, major dualistic biological concepts are beginning to resolve themselves as parts of a whole-a unity. One such resolving biological dualism concerns the impact of nature versus nurture in the structural and functional expression of living organisms. Those polarized on the side of "nature" invoke the concept of genetic determinism, the idea that a plant or animal's characteristics and behavioral traits are defined by the genes at the moment of conception (i.e., internal control). The opposing polarized view endorses the role of "nurture," which recognizes environmental experiences play an essential role in shaping the characteristics of living organisms (i.e., external control). Such an argument becomes profoundly important when we consider the role of nature and nurture on human development. The supporters of "nature" suggest that characters of human physiology and behavior are genetically predetermined at conception. They argue that the fate of the child can only be influenced by the

external environment as it relates to the availability of nutrients. Obviously, malnourished fetuses are physiologically compromised and may not be able to fully express their genetically "predetermined" fates. Such a perspective suggests that the developmental fate of the fetus is impervious to all environmental influences, except for those related to nutritional management. Conventional medicine emphasizes the provision of nutrition as essentially the sole role of the mother in (in utero) human development. The alternative perspective, supported by a large number of lay people and a small contingency of scientists, extends the role of the mother in development. These "nurturists" contend that maternal attitudes and emotions have a fundamental impact on the developmental expression of the fetus. Until recently, this perspective has received little or no attention by conventional scientists that consider the fetus develops within a "closed" environment (the placenta), "isolated" from the mother's experiences. A resolution between the dualism of nature and nurture is illustrated in the case of the claims made by Charles Murray and Richard Herrnstein in their book, *The Bell Curve*. These authors stirred up the nature/nurture controversy recently when they invoked the naturists' party line to declare that human intelligence is determined by the genes. Their contention was that intelligence is based upon breeding and the world is dividing itself into a polarity of an intelligent and a less-intelligent population. Their racist hypothesis, which raises the specter of Nazi Germany, devalued the role of environment and concluded that "we" are victims of genetic fate. Fortunately, Murray and Herrnstein's conclusions have been challenged by Bernie Devlin and his co-workers who recently published their scientific assessment in the prestigious journal, *Nature* (Devlin, Daniels and Roeder, 1997). Their studies revealed that intelligence was only about 34% based on genes (nature), with a whopping 66% based upon environmental factors (nurture). Devlin's findings are highly relevant since they emphasize the significance of the prenatal environment as one of the primary factors influencing intelligence. Such results are more in line with the "quantum" idea that biological expression represents both nature and nurture. While the views of scientists are beginning to change, the mass of researchers still cling to biological concepts founded on the now outdated principles of Newtonian physics. Though seventy years late in recognizing the new principles of quantum physics, the philosophical foundation of conventional biology is beginning to radically change. Leading edge research in the field of cell biology now reveals that the naturists' dogma concerning genetic determinism is no longer valid. Biochemical studies show that genes are "not self-emergent," that is, genes are not capable of turning themselves on or off (Nijhout, 1990). Consequently, if a gene cannot regulate its own expression, then genes can not be invoked as the "controllers" of organismal expression. Rather than being "self-emergent," gene programs are controlled by "environmental" signals. The dogma of genetic determinism is giving way to a concept that recognizes living organisms as "dynamical systems," ones that are capable of actively reprogramming gene behaviors to accommodate environmental changes. Another recent and radical change in perspective concerns the conventional neo-Darwinian view that the gene blueprints can only be modified by the process of "random" mutations. Based upon the revolutionary studies of geneticist John Cairns (Cairns, Overbaugh and Hiller, 1988) published ten years ago, science is now considering the role of "adaptive" mutations (Beardsley, 1997). Cairns' hypothesis, which is now winning greater respect, reveals that through "instructive" interactions with the environment, organisms as primitive as bacteria, can actively rewrite existing genetic programs to accommodate environmentally-induced stresses. Consequently, organisms are far from being genetically determined: They may actively select, or in some instances, even rewrite gene programs as they experience and interpret environmental stimuli. The malleable aspect of gene expression is an extremely important point in terms of fetal development. In the uterus, the fetus is in a constant state of "downloading" genetic information required for human development, growth and protection responses. The cytological structures and molecular pathways required by cells to effect these processes are programmed by DNA "blueprints" known as genes. The complete set of gene instructions, known as the genome, is principally localized in the cell's nucleus. Within each nucleus there are two complete sets of genes, one full set derived from each parent. By mixing and matching specific genes derived from each of the two sets, individuals may exhibit a wide ranging repertoire of

structural and physiological characteristics. In spite of the overt genetic differences in characteristic traits within and among the divergent species in the biosphere, all biological organisms, from bacteria to humans, share one biological behavior—the will to survive. When the life of any organism is compromised, it will enact behavioral programs that will enable it to stay alive. This fundamental drive for survival, built into every organism, is referred to as a "biological imperative." The behaviors that collectively provide for organismal survival may be conveniently subdivided into two functional categories: behaviors supporting growth and those supporting protection (Lipton, Bensch and Karasek, 1991). Growth-related behaviors include activities associated with seeking nutrients and supportive environments for personal survival and the seeking of mates for species survival. Protection behaviors are those activities employed by organisms to avoid harm. Growth behaviors are associated with the character of attraction. Organisms are "attracted" toward elements of the environment that support their life (e.g., food, water, air and mates). In contrast, protective behaviors are most frequently associated with repulsion. Protection responses to life threatening stimuli are generally characterized by avoidance reactions. When confronting an inescapable life threatening situation, a fleeing organism may turn and become the aggressor. For example, a rat will take flight from a dog. When backed into a corner with no other recourse, that same rat will lunge at the dog and fight for its survival. In humans, the activity of the adrenal system is most important in controlling the protection-related "flight or fight" reactions. In single cells, growth and protective survival behaviors can readily be distinguished by observing the cell's motility. Cells expressing growth-related behaviors move toward life sustaining environmental stimuli (attraction). In contrast, cells expressing protection-related behaviors move away from life threatening stimuli (repulsion). Stimuli that do not influence organismal survival result in an indifferent response. At our level of perception, the behavior of single-celled organisms appears to be "digital": They either move toward specific positive (+) stimuli or away from specific negative (-) stimuli. Recent studies on molecular control mechanisms support this "digital" nature of regulating behavior. Cells possess "gang" switches which actively shunt growth pathways into protection behaviors in response to threatening environmental stimuli (see reviews by Raloff, 1997 and by Pennisi, 1997). Growth and protection appear to be mutually exclusive behaviors in single cells; apparently, individual cells cannot be in growth and protection at the same time. A similar growth/protection behavior occurs in the microvascular network in humans. Blood vessels can either support nutrition or inflammation (protection), but cannot provide for both functions at the same time (Lipton, Bensch and Karasek, 1992). The duality of survival behaviors in multicellular organisms, including humans, essentially reflect those exhibited by single cells. As you may recognize in your own life, humans are attracted to positive life-supporting stimuli, while they are repelled by life-compromising stimuli. Rather than the "digital" (on/off) nature of the response as observed in unicellular species, the additive responses of the individual cells comprising multicellular organisms create behaviors that are more "analog" or "graded" in their expression. The more relevant a stimulus is to the organism's survival, the more polarized (either + or -) the resulting response. In humans, the extremes of the two polarities might appropriately be described as love (+) and fear (-). As with every living system, the selection of growth or protection programs by the fetus is based upon its perception of its environment. The environment perceived by the fetus is the maternal blood from which it receives nourishment and "information." Nourishment is derived from the metabolites transported in the mother's blood. Environmental "information" is provided by signal molecules such as hormones, neuropeptides and cytokines (immune-related "hormones") which also circulate within the maternal blood. It is important to note that the environmental information observed by the fetus was not primarily intended for the fetus. The blood-borne information signals were deployed by the maternal nervous system in response to her perception of her environment. These signals, which directly impact growth and protection behaviors, were intended to regulate maternal organs, tissues and cells. If the mother's nervous system perceives that the environment is threatening to either her or her fetus' survival, it will release informational signals that will engage a protective response and prepare her for flight or fight. When the system's valuable energy resources are directed toward promoting protection behaviors, growth behaviors must

necessarily be compromised. These blood-borne information signals not only affect the maternal system, for the same signals cross the placenta and profoundly impact the genetics and behavior of the developing fetus. Initially, one might think that free passage of maternal signals through the placenta represents a "defect" in Nature's mechanism. Far from being a design flaw, the transfer of maternal environment-related signals to the fetal system is Nature's way of providing the baby with an advantage in dealing with the world it will soon enter. The old axiom, being forewarned is being forearmed, is appropriate to apply to this situation. Through the maternal system's ability to relay environmental information to the developing offspring, the mother's perceptions directly impact the selection of gene programs that may enhance the survival of her offspring, and ultimately that of the species (Pennisi, 1996). The down side of the story is that through a "misperception" of her environment, a mother can negatively impact the survival of her child. For example, a pregnant woman in an abusive environment will continuously relay distress signals which would shunt resources from growth-related behaviors to protection-related behaviors, in both herself and in her fetus. As has recently been established environmentally-directed maternal influences may impact more than just the subsequent generation. An observation referred to as the "grandmother effect" reveals Dutch women who were on starvation diets during the famine of World War II, produced smaller than normal babies. Interestingly, this pattern of stunted growth continued into the next generation (Vines, 1997). There are now many examples of how maternal observations of environmental exigencies profoundly alter the growth, phenotype (physiological expression), sex ratios and even the sexual maturation period of their offspring, all in an effort to ensure the survival of their species. The conclusions that can be drawn from science's leading front is as follows: Biological behaviors can be scored as growth-promoting or protection-related. The metabolic investment required to support protection responses comes at the cost of compromising growth. Selection of growth and protection behaviors is a dynamic process which is actively mediated by the organism in response to perceived environmental signals. Signals engendering threats of survival, that is, fear, shunt growth mechanisms. Signals relaying the existence of supportive environments, those emphasizing love, encourage the selection of growth-related genetic programs. These decisively important love/fear signals are relayed to the fetus via the blood-borne molecules produced in response to the mother's perception of her environment. Since the offspring will spend their lives in the same or essentially the same environment as they are born in, developmental "programming" of the neonate by the mother is of adaptive value in species survival (Liu et al., 1997). This is Nature's equivalent of a "head start" program. As we stand on the doorstep of the new millennium, we are releasing limiting ideas and replacing them with knowledge that will facilitate the survival of the human race. One important part of that new vision is turning away from the Darwinian notion of the "survival of the fittest" and adopting a new credo, the "survival of the most loving!"

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