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Introduction to the Special Issue on Brain Development and Caring Behavior

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The roots of caring behavior, altruism, and empathy, or of their opposites, have always been of immense interest to philosophers, psychologists, natural scientists, social scientists, and even theologians. They are the gateway to intelligent responses to a host of age-old questions of great social relevance: Where are the origins of good and evil in human behavior? Is cooperation or conflict between human beings or other animals a matter of genetics or environment or both? If it involves environment, how much of a role is played by the immediate family, and how much by larger institutions such as social and cultural customs, government policies, and mass media? These are problems that are of much more than abstract academic interest but concern social policy makers, educators, and clinicians as well.

This special issue gives a small sample of recent fresh approaches to the daunting problems of understanding caring and uncaring behavior as informed by rapid advances in neuroscience. The joint insights of researchers and thinkers in many disciplines argue against some of the folk-psychological false dichotomies that have held back progress in our understanding. Many biological and social scientists agree that how organisms characteristically act is not a matter of nature *or* nurture, not a matter of biology *or* culture, not a matter of chemistry *or* action. Authors in many disciplines and endeavors now call for replacing the question "Is it nature or nurture?" with the question "How does nurture selectively influence the expression of nature?" While mapping out the complete genetic sequences of humans has been a valuable expenditure of time and money, leading researchers in the Human Genome Project do not believe that genetics holds all the keys to what human behavioral patterns are expressed. Even less do they believe that there is a "gene for caring" or a "gene for cruelty."

Because the problems of interest for this issue involve dynamic interaction between genetics and environment, I invited authors from a wide range of disciplines. Many of the authors, in fact, are outside traditional academic boundaries altogether. Some authors are founders of nonprofit organizations devoted to interdisciplinary research along with pragmatic restructuring of human institutions.

Other authors are clinicians involved in treating victims of abuse or of toxic social environments. All of these people are dedicated to applying the most up-to-date scientific knowledge to bettering human conditions.

Still other contributing authors come from interdisciplinary academic areas such as behavioral and computational neuroscience. These authors contribute insights from studies of rodents as well as humans and other primates. Although rodent brains do not reach the information processing capacities of primate brains, such rodent species as mice and voles are complex enough to exhibit patterns of interrelationship between social relationships and neurochemistry that have lessons for human behavior.

Obviously, any studies of the biological roots of a type of behavioral patterns will involve evolution. Yet the evolutionary approach that tends to prevail in the articles of this issue is not the classical, neo-Darwinian or sociobiological, type that emphasizes competition and survival of the fittest. It is an approach based on the likelihood that mammalian brains often simultaneously contain templates for two or more conflicting behavioral patterns (such as those for caring and those for aggression), all of which can be explained as adaptations to evolutionary pressures. The brain also contains mechanisms for selective enhancement or inhibition of one or more of these patterns – in other words, for selective *gene expression* – which may be mediated, among other things, by social contexts. Hence, behavior of animals interacting with other animals of their species is not a one-way street from genes to social groups; the dynamics of social groups also have a strong influence on the very biochemistry of gene expression.

Darwin himself, as some of the authors (Cory, Eisler and Levine, and Loye) discuss, was profoundly concerned with the evolution of cooperation as well as competition. Particularly in his later works, such as *Descent of Man*, he traced our caring and altruistic capacities both to social pressures and to sexual instincts. These themes have also been taken up more recently by two living giants of behavioral neuroscience – Paul MacLean and Karl Pribram. MacLean and Pribram are not authors in this issue but have had profound influence on several of the authors and are extensively cited in the articles herein.

The introductory article by Eisler and Levine frames the general problem of understanding where caring behavior fits into the makeup of humans and other mammals. It points up the paradox of explaining altruistic behavior within a "survival of the fittest" framework, which Darwin had already noted. Yet, as Eisler and Levine develop, there is biochemical evidence for three major patterns of response to stressful or otherwise complex situations. Various researchers have given these patterns, all three of them explicable as evolutionary adaptations, the names fight-or-flight, dissociative, and tend-and-befriend. The authors review the incomplete evidence, based on several types of studies (lesion, clinical, behavioral, single-cell, and brain imaging) for cortical-subcortical interactions involved in all three of these response types. Then they ask how the brain "chooses" which of these response types to express in which contexts. For this selection they review

evidence that points to a major role for the orbital and medial prefrontal cortex, the same brain region celebrated by Antonio Damasio for its essential contributions to organized decision making and to acting appropriately in social settings.

Eisler and Levine conclude with implications of their theories for social interactions and institutions. They argue that even if the fight-or-flight types of responses are more prevalent in some groups of people than the caring responses, the caring responses remain available and might be disinhibited by supportive social settings. Drawing on Eisler's other writings about history and society, they show that social settings that disinhibit caring responses can in some times and places be generated either by formal policies or by informal customs or both.

The next article, by Gariépy and Rodriguiz, provides a specific example in mice of the plasticity of both aggressive and cooperative behavior. They report experimental data from a series of studies, ranging over a quarter century and begun by Robert Cairns, of mice with different genetic predispositions placed in environments that tended either to enhance or suppresses these predispositions. This work is informed by the evolutionary perspective of Gilbert Gottlieb, which is unorthodox in that it includes development as an essential part of understanding how genes are expressed in behaviors. Gottlieb's approach to evolution regards epigenesis not as a set of traits and behaviors predetermined by the genome, but as a set of probabilistic tendencies toward certain traits and behaviors. Consequently, as development and differentiation of the organism proceed, interactions between the genome and the environment lead to plasticity of the set of behaviors the organism expresses, a plasticity which gradually lessens toward adulthood.

In short, Gariépy and Rodriguiz bred two strains of male mice over at least thirteen generations, one bred to have a high level of intra-species aggression, the other a low level of aggression. The high-aggression mice tended to establish dominance hierarchies and particularly fight in the presence of female mice. The low-aggression mice tended, in groups of their own, to have a high degree of low-intensity, peaceful social contact. Yet each genetic strain could take on some of the characteristics of the opposite strain if placed in a social setting that tended to encourage those characteristics. High-aggression mice could develop low-aggression behavior if brought out of isolation and into groups; the authors also give evidence from their own experiments that this behavioral plasticity is mediated by one of the types of dopamine receptors. Low-aggression mice, on the other hand, could develop high-aggression behavior if brought into situations where they compete for territory with high-aggression mice.

The article by Perry reviews some of what is uniquely human about the interplay between environment and genetics – the abilities to adapt to an amazing range of environments and to reinvent both ourselves and our environments according to the requirements of elaborate belief systems. Yet, he reminds us, humans are as subject to the laws of nature as anyone else and ignore those laws at our peril. The brain's mandate is survival of the species, for which it has crucial neural systems dedicated to stress response, mate selection and reproduction, and protection and nurture of

the young. He goes on to discuss his primary work on the opportunity and vulnerability inherent in the genetic potentials of each child. He outlines in detail the different processes of neurodevelopment (neurogenesis, migration, differentiation, apoptosis, arborization, synaptogenesis, synaptic sculpting, and myelination). Then he develops core principles for both genetic and environmental influences on all of these processes. He notes that while chemical events driving development in the fertilized ovum are genetically determined, after birth the influence of environmental sensory cues on development is at least as important.

Perry discusses a variety of results on animals raised in either deprived or enriched environments, and of children who have been neglected in development – abused children studied in his own child trauma center, and children raised in orphanages (even if adequately fed) without emotional involvement or touch from adults. All these results point to severe brain damage if sensory or cognitive stimulation is absent, and the length and timing of deprivation periods makes a significant long-term difference. He goes on to discuss implications of all this for caring or empathic behavior. His studies and others point to the importance of attachment to a primary caregiver, and the enormous risk of violent behavior in those lacking secure attachments. But he stresses that the attachment bonds are not enough, that interactions with peers are also vital for children's development of caring. He concludes that while technology has raised opportunities for children (for example, by expanding literacy), society needs to address more recent social impacts of technology that are less healthy. For example, shrinkage of the number of adults a child interacts with in the home, and substitutions of television for family meals and of overscheduled activities for spontaneous interactions with other children, create a sense of isolation that is not optimal for developing the genetic potential of our brains.

The article by Embry deals with biological bases for clinical treatment of a variety of conditions that sometimes inhibit caring behavior, conditions such as attention deficit hyperactivity disorder (ADHD), sensation seeking, violent acting out, and substance abuse. Embry presents extensive evidence for a large heritable component to all these conditions, yet he is not a traditional "genetic determinist." Rather, like other authors in this issue, he regards the expression of behavior as a "dance" between genes and the environment. He argues that these conditions could be considered not as mental disorders, but as evolutionary adaptations to environments in which some of our ancestors lived. For example, the genes that promote ADHD are related to curiosity, restlessness, and exploration, all of which enhanced survival value during the confusing period several thousand years ago in which civilization was just emerging. And genes that promote violent self-defensive behavior enhance survival in a pastoral herding environment where rustling of animals is frequent. Yet Embry emphasizes that the emerging scientific view of behavioral genetics, including his own, differs from that of much of the popular press. The behavioral conditions he discusses are *polygenic* and not captured by a single gene for each; individual genes relate to particular capabilities rather than

to behavioral conditions. Hence the outward manifestations of these genes often differ substantially from parents to children, as he demonstrates in case studies.

As for therapy for those (particularly children and adolescents) with these conditions, Embry advocates keeping careful records of individuals' genetic makeup, which are starting to be obtainable. This can lead to educated assessments of what sorts of intervention can work in specific cases. In the case of ADHD, for example, behavioral control games are likely to be effective for children with some profiles, and intellectual challenges are more effective for children with other profiles. All these programs, he adds, are less expensive than the medications, which are much more widely used (though he believes there are certainly cases where medication is needed). Such therapy programs can be based in an emerging science Embry calls *braingenomics*: understanding each person's unique genetic makeup and actively structuring environments to bring out the best potential of their genes.

The article by Loye explores the question of what brain research can tell us about where and how morality functions as a guidance system for ourselves and society. The key pioneering work, he contends, is that of the "moral brain" research of Paul MacLean that has been comparatively neglected within the focus on other aspects of his triune brain theory.

Loye shows how point for point MacLean's research bears out the long neglected "higher" or moral component aspect of Darwin's theory of evolution. For Darwin the development of "the moral sense" came through the sequential emergence in evolution of the "sexual instincts," followed by the "parental instincts," the "social instincts," and emotion and then reason. Ranging from the hypothalamus up through the limbic system into the prefrontal brain, MacLean's work reveals the ascendency of a "neural ladder" precisely confirming Darwin's earlier intutition. Loye shows how the work of Karl Pribram further expands our understanding of the moral component of mind in terms of prefrontal executive decisional functioning. Building on this earlier work, he also offers his own theory of a morally-oriented "Guidance System of Higher Mind" composed of the processing within our brains of information screened by a sequence of systems, social, future, moral, developmental and managerial "sensitivities."

Cory's article extends these ideas of MacLean to detailed social and economic relationships. He notes that MacLean's triune brain contains the seeds of both our self-interested behavior patterns, from the brain systems involved in preservation of self, and of our altruistic behavior patterns, from the brain systems involved in preservation of species (that is, in sexuality and parenting). Successful cultures and economies require both self-interest and reciprocity. Cory reminds us that mainstream socioeconomic theory (often tied to a neo-Darwinian and ultra-rational model of human beings) overemphasizes self-interest. Yet reciprocity, the building of relationships in which people give and expect to receive something in return, is also fundamental to the exchange of goods, and needs to be integrated more fully into economic analyses.

Cory goes on to say that if a person neglects the claims of either self-interest or altruism for too long, a tension builds up that needs to be resolved by restoring the missing balance. If one has neglected self-interest for too long, one feels oppressed or exploited and needs to reassert one's rights to relieve that emotion. If one has neglected altruism for too long, one feels guilt, and so needs to be more generous to others to relieve that emotion. Again, in Cory's schema the prefrontal cortex plays the pivotal role of "deciding" where to redress the balance through its feedback connections with the subcortical self- and species-preservation loci. All these brain interactions are genetic, but the detailed expression of them requires acculturation. He discusses the implications of these interactions for child rearing, education, and structuring social and political institutions.

There are some common themes running as subtexts through all these articles. One is that caring behavior is tied to biological motivations other than mere survival or reproduction. Some of the authors ally themselves with the growing group of behavioral scientists who point to the importance of intrinsic motivations, at least in humans and other primates and probably in most mammals, for pleasure and positive affect. Since evolutionary psychology is largely preoccupied with the competitive advantages that traits provide for survival and/or reproduction, authors in this field frequently write as if there are no other motivations. Yet the existence of other motivations besides survival and reproduction need not be inconsistent with the theory of natural selection. Moreover, Loye documents that Darwin himself looked beyond survival of the fittest to the importance of cooperation, love, and bonding (and the relationship of these motivations to sexual ones).

The other common theme is that complex neural patterns are characterized by extensive plasticity. During the critical period of development, which varies between species (in humans it is up to about 7 years of age), new synaptic pathways are laid down, so the brain is literally shaped by experience. After that time there is much less growth of new pathways (although there appears to be some in the human prefrontal cortex all the way through adolescence), but existing pathways can be strengthened or weakened all through adult life. This was proposed by Donald Hebb in 1949 as a neural explanation for Pavlovian conditioning and other forms of learning. Yet many neurophysiologists did not believe in the plasticity of synapses until it was observed in the laboratory, first by Eric Kandel and Léon Tauc in the sea slug in 1965, then by Timothy Bliss and Terje Lømo in the rabbit hippocampus in 1973. The capacity for plastic change in the nervous system is an evolutionary adaptation that enables organisms to interact more effectively with a changing environment. Yet this capacity is what allows us and other mammals to learn when to turn other genetically derived traits and behaviors on or off, and thereby frees us from the tyranny of our genes.

While the theories of these authors are partly based on neuroscientific and neurobehavioral findings, the authors to varying degrees intersperse their findings with speculation. This is because, as many of the authors note, the relevant studies have been few in number. That is, there have been few scientific studies that have

specifically targeted the development of caring and altruistic behaviors. This may be the result of the hold of some neo-Darwinian paradigms that have led to an emphasis on selfish, aggressive, and fight-or-flight behaviors. There are now signs, though, that these paradigms are loosening their hold: such organizations as the Fetzer Foundation have started to finance academic research in the social and natural sciences directed toward the study of altruistic love.

While there is a move away from strict genetic determinism, there is still controversy about the extent to which it is possible for us to consciously direct human evolution so that the level of caring, not only toward our own species but other species and the planet as a whole, is markedly increased. Is the plasticity of brain pathways that create cultures sufficient that we can substantially alter our cultural standards for what level of caring or uncaring is accepted? This is the point of greatest applied as well as humanistic interest. We hope that this set of articles can make a small but significant contribution to this debate.