FROM MACLEAN'S TRIUNE BRAIN CONCEPT TO THE CONFLICT SYSTEMS NEUROBEHAVIORAL MODEL: THE SUBJECTIVE BASIS OF MORAL AND SPIRITUAL CONSCIOUSNESS

by Gerald A. Cory Jr.

Abstract. This paper builds upon a critically clarified statement of the triune brain concept to set out the conflict systems neurobehavioral model. The model defines the reciprocal algorithms (rules of procedure) of behavior from evolved brain structure. The algorithms are driven by subjectively experienced behavioral tension as the self-preservational programming, common to our ancestral vertebrates, frequently tugs and pulls against the affectional programming of our mammalian legacy. The yoking (*zygon*) of the dual algorithmic dynamic accounts for the emergence of moral and spiritual consciousness as manifested in the universal norm of reciprocity and in the work of such thinkers as Martin Buber and Paul Tillich.

Keywords: Martin Buber; conflict systems neurobehavioral model; Paul D. MacLean; reciprocal algorithms of behavior; Paul Tillich; triune brain.

MacLean and Subjective Experience

All significant experience of humankind is processed through the brain. This is true whatever the source of the experience, internal or external to the body. The brain structures our experience of reality by its evolved algorithms of perception, motor response, and motivation. Our subjective experience, like all aspects of our consciousness and behavior, is likewise structured by the brain's evolved algorithms. No researcher has focused more on this subjectivity than neuroscientist Paul MacLean. The first

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chapter of MacLean's landmark opus *The Triune Brain in Evolution: Role in Paleocerebral Functions* (1990) is entitled "Toward a Knowledge of the Subjective Brain." He notes the neglect of the subjective self in the neuropsychological sciences and says it is important to correct that situation. MacLean suggests *epistemics* as an appropriate term to encompass the interdisciplinary study of the subjective self (1990; 1992). The subjective self is of course fundamental to the study of consciousness, because consciousness inevitably implies subjectivity. In fact the two terms may ultimately be inseparable or even interchangeable. MacLean's emphasis on the brain mechanisms for subjective experience provides a foundation for the study of moral and spiritual consciousness. To understand this foundation, we must look to MacLean's interconnected, modular concept of the triune brain.

MacLean's triune brain concept has been one of the most influential ideas in brain science since World War II (see Durant in Harrington 1992, 268). Nevertheless, it has also been criticized by some neuroscientists.[1] Although some of this criticism has recently been shown to be inaccurate and based on misinterpretations of MacLean's position,[2] in this paper I try to accommodate those criticisms for which clarification is needed. In his thoroughgoing, encyclopedic summary of the last fifty years of brain research, MacLean (1990) documents the human brain as an evolved three-level interconnected, modular structure. This structure comprises a self-preservational maintenance component inherited from the stem reptiles of the Permian and Triassic periods, called the protoreptilian complex, a later modified and evolved mammalian affectional complex, and a most recently modified and elaborated higher cortex.

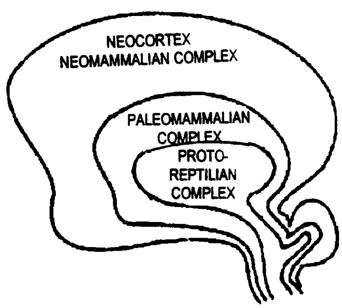

Fig. 1. A simplified, modified sketch of the interconnected modular triune brain structure. After MacLean. As represented here, the three brain divisions do not constitute distinct additions but rather modifications and elaborations of probable preexisting homologues reflecting phylogenetic continuity.

As brain evolution progressed in the branching vertebrate line ancestral to human beings, simple protoreptilian brain structure was not replaced, but provided the substructure and homologues for subsequent brain development while largely retaining its basic character and function. Accordingly, the brain structure of early ancestral vertebrate life-forms (early fishes, amniotic anapsid reptiles) became the substructure and provided the homologues for the mammalian modifications and neocortical elaborations that followed and which have reached the greatest development in the brain of humankind. Appreciating the qualitative differences of the three levels is important to understanding the dynamics of human subjective experience and behavior.

MacLean proposes that the protoreptilian brain tissues in human beings, as in the stem vertebrates, govern the fundamentals, or the daily master routines, of our life-support operations: blood circulation, heartbeat, respiration, basic food getting, reproduction, and defensive behaviors—all functions and behaviors that were also found in the ancient stem reptiles. Located by MacLean in what are usually called the hindbrain and the midbrain (the brain stem), as well as in certain structures at the base of the forebrain (the basal ganglia), this primal and innermost core of the human brain made up almost the entire brain in ancestral fishes, amphibians, and amniotes (although it does not necessarily in their modern representatives).

The next developmental stage of our brain, which comes from rudimentary mammalian life and which MacLean called the *paleo-*, or *old*, mammalian brain, is identified with the structures designated collectively as our limbic system. Developing from homologues preexisting in the protoreptilian brain, these newly elaborated limbic tissue clusters included such physiological structures as the amygdala, the hypothalamus, the hippocampus, the thalamus, and the limbic cingulate cortex. Behavioral contributions to life from these modified and elaborated paleomammalian structures, or limbic system, included, among other things, the mammalian features (absent in the stem vertebrates) of warm-bloodedness, nursing, infant care, and extended social bonding. These new characteristics were then neurally integrated with the life-support functional and behavioral circuitry of the protoreptilian brain tissues to create the more complex life-form of mammals.

The neocortex, which MacLean called the *neo-*, or *new*, mammalian brain, is the most recent stage of brain modification and elaboration. This great mass of hemispherical brain matter that dominates the skull case of higher primates and human beings, by elaborating the preexisting homologues present in the brains of early vertebrates, overgrew and encased the earlier (paleo-) mammalian and protoreptilian neural tissues but did not essentially replace them. As a consequence of this neocortical evolution and growth, these older brain parts evolved greater complexity in support of the new tissue structures and in response to the behavioral adaptations necessary to life's increasingly sophisticated circumstances.

Toward a New Subjective/Behavioral Model

The unique features of the human brain evolved over a period of several million years in a primarily kinship-based foraging society in which sharing or reciprocity was essential to survival and which reinforced the adaptive evolution of the mammalian characteristics of self-preservation and affection.[3] Ego and empathy, self-interest and other-interest, are key features of our personal and social behavior. To relate these to MacLean's concept we need a subjective/behavioral rather than a neurophysiological vocabulary, one that will express what the presence of our protoreptilian and paleomammalian brain structures means with regard to our day-to-day, subjectively experienced, behavioral initiatives and responses to one another and the world we live in. In computer-related vocabulary, familiar to us through cognitive psychology and artificial intelligence, I use the software designer's vocabulary of programs and programming. I will speak of our three developmental brain levels as behavioral programs or sets of programs that subjectively drive and generate specific and objectively observable behaviors.[4]

From the predominantly survival-centered promptings of the ancestral protoreptilian tissues, as elaborated in the human brain, arises the motivational source for egoistic, surviving, self-interested subjective experience and behaviors. Here are the cold-blooded, seemingly passionless, single-minded behaviors that we generally associate with the present-day lizard, the snake, and that most maligned of fishes, the shark.[5] Here is a world revolving almost exclusively around matters of self-preservation. The protoreptilian brain structures, then, will be referred to as our *self-preservation programming.*

From the infant-nursing, caregiving, and social bonding initiatives and responses of the mammalian modifications and elaborations arises the motivational source for nurturing, empathetic, other-interested experiences and behaviors. Here are the warm-blooded, passionate, body-contacting, bonding behaviors that we identify with the lion, the wolf, and the primates.[6] Here is a world in which nearly single-minded self-preservation is simultaneously complemented and counterpoised by the conflicting demands of affection. The early mammalian modifications, then, will be referred to as our *affectional programming.*[7]

Before I go on to discuss the neo-mammalian neocortical structures in behavioral terms, I consider how these first two sets of programs function together.

Our Evolved Brain and the Sources of Subjective/Behavioral Conflict. These core behavioral program modules, composed of (or served by) sets or subsystems of modules, of our brain structure serve as dynamic factors of our behavior. They are energy driven by our cellular and overall bodily processes of metabolism as mediated by *hormonal, neurotransmitter, and* *neural architecture.* Each is an inextricable part of our makeup, because each is 'wired' into our brain structure by the process of evolution. The degree of genome control seems, however, to vary with the mechanism. Older brain parts such as the hindbrain and parts of the limbic system, phylogenetically old and necessary for survival, seem to be under closer genetic control. Other more recent tissues in the neocortex depend also on development and environmental experience. Damasio (1994) uses the term *preorganized*, apparently (and appropriately, I think) to avoid the implication of an overly deterministic prewiring in some brain regions. Behavioral conflict exists, then, simply by virtue of the presence of these two large-scale energy-driven modular program sets in our lives—up and running even prior to birth. Their mere physiological presence sets us up for a life of inner and outer struggle, as we are driven by and respond to their contending demands.[8] Conflict is more than an externalized, objective ethical, moral, or decision-making dilemma, however. Subjectively, feelings of satisfaction occur when we can express our felt motives, whereas feelings of frustration occur when either our self-preservational or our affectional impulses cannot be expressed in the behavioral initiatives and responses we wish to make.

Behavioral tension then arises. Experienced as subjectively defined variants such as frustration, anxiety, or anger, behavioral tension occurs whenever one of our two fundamental behavioral programs—self-preservation or affection—is activated but meets with some resistance or difficulty that prevents its satisfactory expression. This subjective tension becomes most paralyzing when both programs are activated and seek contending or incompatible responses *within a single situation*. Caught between "I want to" and "I can't"—for example, "I want to help him, but I can't surrender my needs"—we agonize. Whether this tension arises through the thwarted expression of a single impulse or the simultaneous but mutually exclusive urgings of two contending impulses, whenever it remains unresolved or unmanaged it leads to a worsening condition of behavioral stress.

The Blessing of Tension and Stress. The evolutionary process by which the two opposite promptings of self-preservation and affection were combined in us enhanced our ability to survive by binding us in social interaction and providing us with the widest range of behavioral responses to our environment.[9] Our inherently conflicting programs are a curse, then, only to the degree that we fail to recognize them as a blessing. Our self-preservation and affection programs allow us a highly advanced sensitivity to our environment, keeping our interactive social behaviors within survival limits as well as enabling us to perceive and appreciate the survival requirements of others. Ironically, the accompanying behavioral tension—even the stress—is an integral part of this useful function, for it allows us to more immediately evaluate (a subjective function) our behavior and the effect it is having on ourselves and others.[10]

Behavioral tension serves as an internal emotional compass that we can use to guide ourselves through the often complicated and treacherous pathways of interpersonal relations. Behavioral stress tells us that we are exceeding safe limits for ourselves and others, and for our larger social, economic, and political structures.

Behavioral tension and stress are, perhaps needless to say, inherently and necessarily subjective. But of course all of this requires a certain level of consciousness, perhaps best designated self-aware consciousness, coupled with the ability to generalize our internally experienced motives. If all we possessed were the conflicting programs of self-preservation and affection, we would, of course, be among the life-forms whose behaviors are governed by instinct. We would be driven by the urgings of fight, or flight, or bondedness; and every so often—like the legendary mule who, thirsty and hungry, looked back and forth between water and hay, unable to move—we would be caught in indecision.

But whether or not other mammals with paleomammalian brain structures, with self-preservation and affection programming, experience conscious conflict from these two behavioral priorities, we certainly do. We can reflect and generalize not only on our choices but also on the meanings they have for our personal as well as our species' existence and significance. And it is in that capacity to reflect, to self-consciously experience, generalize, and decide on the tug and pull of our conflicting urgings, that we come to the third stage of brain development in MacLean's model: the neomammalian brain structures, what I have designated the executive programming.

The Conflict Systems Neurobehavioral (CSN) Model

The neural substrate of consciousness is still a matter of considerable speculation and debate (see Tonomi and Edelman 1998; Damasio 1994; Searle 1997). Although the mechanisms are still unclear, I follow the position here that there is no homunculus (little person) or other Cartesian dualistic process involved. Nevertheless, it seems that our expanded and elaborated neocortex (or isocortex), anchored in and interconnected with our earlier mammalian and protoreptilian brain systems, is part of the "dynamic core" (Tonomi and Edelman 1998; cf. Dennett 1998) necessary to our self-aware or self-reflective consciousness. The neocortex also provides us with the evolutionarily unique and powerful ability to use verbal and symbolic language to create concepts and ideas by which to interpret our consciousness—to describe the feelings, motives, and behaviors that arise within us and in response to our social and environmental experiences.[11] It is with this so-called executive programming that we acquire the ability to name, to comment on, to generalize,[12] and to choose between our contending sets of behavioral impulses: self-preservation, commonly called, at a high level of cognitive generalization, *egoistic*, or *self-interested*, behavior;

and affection, which we call, at an equally high level of cognitive generalization, *empathetic*, or *other-interested*, behavior. Empathy allows us the critical social capacity to enter into or respond emotionally to another's self-interest as well as other emotional states.[13]

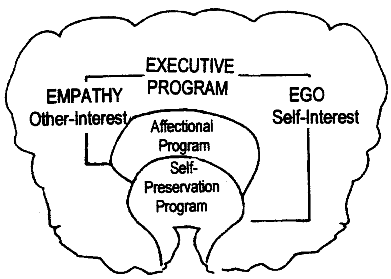

Fig. 2. The conflict systems neurobehavioral model. A simplified cutaway representation of the brain showing the behavioral programs and the derivation of ego/self-interested and empathy/other-interested motives and behaviors.

Although in figure 2 the positioning of ego and empathy (facing the reader) is primarily for illustrative purposes and is not intended to suggest a definitive lateralization, there is some evidence to suggest that the right hemisphere is favored for emotion and the left for more analytical self-preserving behaviors (see Damasio 1994; Tucker, Luu, and Pribram 1995; Brownell and Martino 1998). However, Heller, Nitschke, and Miller (1998), after noting that it is well established that particular regions of the right hemisphere are specialized to interpret and express emotional information, argue that the total experience of emotion is not lateralized but involves dynamic interactions between forward and posterior regions of both hemispheres as well as subcortical (limbic) structures. Such complex, highly generalized capacities as ego and empathy may more safely be thought of as engaging the interaction of both hemispheres. Davidson (1995), for example, hypothesizes that the left and right anterior regions of the brain are key components of an affective regulatory system for approach and avoidance behaviors.

In other words, our executive programming, especially our frontal cortex,[14] has the capability and the responsibility for cognitively representing these limbic and protoreptilian brain connections and inputs and making what may be thought of as moral as well as rational choices among our conflicting, impulsive, and irrational or nonrational motivations. This self-conscious, generalizing, choosing capacity—accompanied, of course, by language—is what differentiates us from even closely related primate species and makes findings in primate behavior, although highly interesting and unquestionably important, insufficient in themselves to allow us to fully understand and account for human behavior.

EXECUTIVE PROGRAMMING, NEURAL NETWORKS, AND NEURAL GLOBAL WORKSPACE

Bernard Baars of the Wright Institute and his colleagues have proposed a Neural Global Workspace Model (GW), which combines the concepts of attention, working memory, and executive function into a theater metaphor. Baars and his colleagues (Newman, Baars, and Cho 1997; cf. Harth 1997) review other neuroscience and neural network models that deal with attention, binding, resource allocation, and gating that share significant features with their own GW model for conscious attention. (For an alternative model based on an evolutionary and clinical approach that draws on MacLean's triune brain concept, see Mirsky 1996[15]). The authors acknowledge that the models they present implement only partial aspects of their GW theory. Notably neglected are the influences of memory and affective systems on the stream of consciousness (Newman, Baars, and Cho 1997, 1205). Other cognitive metaphors compatible with GW theory, like Minsky's society theory (1979) and Gazzaniga's social brain (1985), remain cognitive in their treatment of sociality, although they may be taken to imply affective mechanisms. The CSN model presented in this paper attempts to incorporate the affective (generalized into empathy) neural substrate necessary to initiate and maintain sociality.

It is noteworthy that distributed artificial intelligence (DIA) models more closely approximate interpersonal behavior, in that they seem to reflect an effort at intelligent balance between the competitive self-interest and cooperation that is necessary for the operation of complex social organizations (Newman, Baars, and Cho 1997, 1196; Durfee 1993). Underpinning the CSN model, the neural substrate for self-survival (generalized as ego) mechanisms may proceed from circuits in the basal ganglia and brain stem (protoreptilian complex) through connections with the amygdala, other limbic structures (early mammalian complex), and probable cortical representations which add emotion or passion (see Kandel, Schwartz, and Jessell 1995, 595–612), ultimately to be gated into the frontal cortex by thalamocortical circuitry (see LaBerge 1995; Crick 1994; Baars 1988; 1997).

Likewise, the mammalian nurturing (affectional) substrate and its associated motivation, a fundamental component underlying empathy, may originate in the septal and medial preoptic limbic areas (see Fleming, Morgan, and Walsh 1996; Numan 1994; Numan and Sheehan 1997), proceed through hippocampal and other limbic structures, as well as neocortical representations, and in turn be gated into the frontal cortex by neuromodulating thalamocortical circuits (to include the cingulate cortex), where the conflict with egoistic inputs is resolved in the executive or global workspace of conscious self-awareness. The neuromodulating and gating of *affect*, as well as cognition by the thalamocortical circuitry, is supported by neurologists Orrin Devinsky and Daniel Luciano, who report that the limbic cingulate cortex, a cortical structure closely associated with the limbic thalamus, can be seen as both an *amplifier* and a filter, which joins *affect* and *intellect* interconnecting the emotional and cognitive components of the mind (Devinsky and Luciano 1993, 549). Tucker, Luu, and Pribram (1995) speculate that the network architecture of the frontal lobes reflects dual limbic origins of the frontal cortex. The authors speculate that two limbic-cortical pathways apply different motivational biases to direct the frontal lobe representation of working memory. They suggest that the dorsal limbic mechanisms projecting through the cingulate gyrus may be influenced by hedonic evaluations, *social attachments*, initiating a mode of motor control that is holistic and impulsive. On the other hand, they suggest that the ventral limbic pathway from the amygdala to the orbital frontal cortex may implement a more restricted mode of motor control reflecting the adaptive constraints of *self-preservation* (1995, 233–34). This is consistent with the CSN model, in which ego and empathy represent conflicting subcortical inputs into the cortical executive. Several researchers have posited the dynamic of conflicting modules vying for ascendancy in behavior and consciousness (Tonomi and Edelman 1998; Edelman 1992; Dennett 1998; Pinker 1997).

Although it is beyond the scope of this paper to deal with the as yet only partially understood detailed electrochemical physiology of such egoistic/empathetic conflict, it is appropriate to acknowledge that such behavior is made possible in part by the complex electrochemical excitatory and inhibitory interactions among groups of interconnected neurons (see the discussions in Cowan, Jessell, and Lipursky 1997; Fuster 1997, 102–49; Gutnick and Mody 1995). The role of hormones and neurotransmitters must also be acknowledged in any complete analysis. For instance, from the egoistic perspective, testosterone is associated with competitiveness and power urges. Serotonin levels in humans seem related to confidence and self-esteem. On the empathetic side, oxytocin, arginine vasopressin, and prolactin are important to pair bonding and to maternal as well as paternal caring behavior. Opioids (endorphins and enkaphalins) seem important to positive social relationships. For readers interested in more detail, two recent and wide-ranging volumes update the research focusing specifically on affiliation and affection: *The Integrative Neurobiology of Affiliation* (Carter, Lederhendler, and Kirkpatrick 1997) and *Affective Neuroscience* (Panksepp 1998). Panksepp, especially, speculates on the contrast between testosterone-driven power urges and oxytocin- and opioid-mediated affectional behavior (1998, 250–59). Damasio reminds us, however, that there is a popular tendency to overemphasize the efficacy of hormones by themselves. Their action depends upon neural architecture, and their effects may vary in different brain regions (Damasio 1994, 77–78).

The Algorithms of Reciprocal Behavior

The two master, inclusive, and modular programs of self-preservation and affection that have been wired into our brain structure operate dynamically according to a set of *subjectively experienced* and *objectively expressed* behavioral rules, procedures, or algorithms. Understanding the workings and applications of these algorithms is the key to grasping the role of dialectical conflict and stress in our personal and interactive lives.

The major ranges of the conflict systems neurobehavioral behavioral model (fig. 3) illustrate the features of this ego-empathy dynamic. In the display, subjectively experienced internal as well as interpersonal behavior is divided from right to left into three main ranges called the egoistic range, the dynamic balance range, and the empathetic range. Each range represents a varying mix of egoistically and empathetically motivated behaviors. The solid line stands for ego and pivots on the word *ego* in the executive program of our brain diagram. The broken line stands for empathy and pivots on the word *empathy* in the diagram.

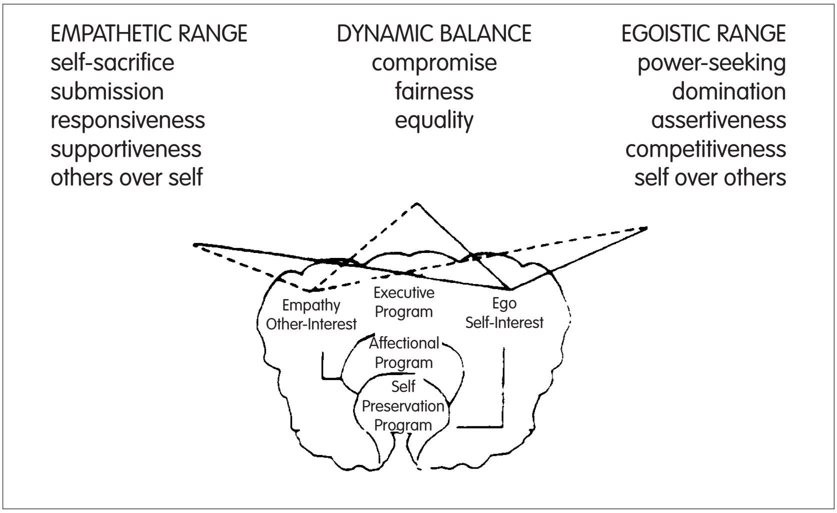

Fig. 3. The major ranges/modes of behavior. For the purpose of simplifying the graph, the three points are intended to mark the center points of each range, with varying mixes of ego and empathy on either side of each point. The graph thus intends to communicate not a zero-sum, either-or set of behavioral options or expressions but a spectrum of the increasing or decreasing (depending on direction of movement) proportions of ego and empathy in behavior. Other scholars (for example, Jencks 1990) have also seen behavior as a mix of selfishness and altruism along a spectrum. The graph, of course, represents only what may be thought of as central tendencies of interactive behavior and is far too simple to represent all the shadings of emotion and motivation.

The Egoistic Range. The egoistic range represents behavior dominated by self-preservation programming. Because the two behavioral programs are locked in inseparable unity, empathy is present here, but to a lesser degree. Behavior in this range is self-centered or self-interested and may tend, for example, to be dominating, power-seeking, or even attacking, where empathy is less. When empathy is increased, ego behavior will become less harsh and may be described more moderately as controlling, competitive, or assertive. As empathy is gradually increased, the intersection of the two lines of the diagram will be drawn toward the range of dynamic balance. Ego behavior will be softened as empathy is added. But the defining characteristic of the egoistic, self-interested range is *self-over-others*. Whether we are blatantly power seeking or more moderately assertive, in this range we are putting ourselves, our own priorities, objectives, and feelings, ahead of others. We are subjectively experiencing ourselves, as well as communicating to others, "me first."

The Empathetic Range. The empathetic range represents behavior weighted in favor of empathy. Ego is present but is taking a back seat. When ego is present to a minimal degree, empathetic behavior may tend to extremes of self-sacrifice and submission. When ego is increased, empathetic behaviors become moderated and may be described as supportive, responsive, or any of a variety of others-first behaviors. As the influence of ego becomes greater, empathetic behavior will approach the range of dynamic balance. In the empathetic range, the key phrase to remember is *others-over-self*, or "others first." Whether we are at the extreme of self-sacrifice or more moderately responsive, we are putting the priorities of others ahead of our own.

The Dynamic Balance Range. The range of dynamic balance represents a working balance between ego and empathy. At this point our behavioral programs are operating in roughly equal measure. I speak of *working*, *rough*, or *dynamic* balance because the tug and pull between the two programs continues ceaselessly. The dynamic nature of the programming means that perfect balance may be a theoretical point, unattainable in practice. Our more balanced behavior tends to be characterized by equality, justice, sharing, and other behaviors that show respect for ourselves and others. In fact, respect for self and others is the keynote of the range of dynamic balance.[16]

Energy or Activity Level. The extent to which the programs of self-preservation and affection, ego and empathy, are out of balance, or pulling against each other, is a measure of behavioral tension. We experience this tension both internally and between ourselves and others, in any relationship or interaction. Unmanaged or excessive tension becomes, of course, behavioral stress. But that's not all. The degree of energy we give to the interaction or the relationship is also important. The amount of energy we put into any activity depends mostly on how important we think it is or how enthusiastic we feel about it. In competitive sports or contests, qualitative differences in energy are easily observed. In intellectual contests, like chess, the energy may be intense but less obvious.

The Proposed Operating Algorithms of Interpersonal Behavior

From the dynamic interplay of ego, empathy, and activity level come the following algorithmic rule statements, which may be considered a research program to be tested empirically.

1. Self-interested, egoistic behavior, because it lacks empathy to some degree, creates tension within ourselves and between our selves and others. The tension increases from low to high activity levels. And it increases as we move toward the extremes of ego.

   Within ourselves, the tension created by the tug of neglected empathy is experienced as a feeling of obligation to others or an expectation that they might wish to "even the score" with us.

   Within others, the tension created by our self-interested behavior is experienced as a feeling of imposition or hurt, accompanied by an urge to "even the score."

Children often reveal the dynamic of such behavior in a clear, uncomplicated form. Imagine two children playing on the living room floor. One hits the other. The second child hits back, responding in kind. Or the children may not hit each other at all. Instead one calls the other a bad name. The second child reciprocates, kicking off a round of escalating name-calling. One child may eventually feel unable to even the score and will ask an adult to intervene. Most of us have experienced such give-and-take as children and have seen it in our own children and grandchildren. Similar behavior is embarrassingly observable among adults—in husband-and-wife arguments, bar fights, hockey games, political campaigns, and even in sophisticated lawsuits. The rule operates not only in such highly visible conflict situations but also in very subtle interactions—in the small behavioral exchanges, the ongoing give-and-take of all interpersonal relations.

Suggestive of a mutually reinforcing feedback relationship, the reactions that build in ourselves and others do so potentially in proportion to the behavioral tension created by egoistic, self-interested behavior. That is, the harder I hit you, the harder you hit me in return. Or the fouler name you call me, the fouler name I call you in return. Or perhaps with more sophistication, I resolve the tension in me by an act of visible superiority: I ignore you—although I *could* call you an even fouler name if I chose to.

Behavior on the other end of the scale is described in the second rule statement:

2. Empathetic behavior, because it denies ego or self-interest to some degree, also creates tension within ourselves and others. This tension increases as activity levels increase and as we move toward extremes of empathy.

   Within ourselves, the tension created by the tug of the neglected self-interest (ego) is experienced as a feeling that others "owe us one" and a growing need to "collect our due." This tension, especially if it continues over time, may be experienced as resentment at being exploited, taken for granted, not appreciated, or victimized by others.

   Within others, the tension created is experienced as a sense of obligation toward us.

   The reactions that build in ourselves and others, again, are in proportion to the behavioral tension created. And again, the unmanaged or excessive tension is experienced as behavioral stress.

When we do things for others—give them things, make personal sacrifices for them—it can make us feel righteous, affectionate, and loving. But we *do* want a payback. That's the tug of self-interest. It can be very slight, hardly noticeable at first. But let the giving, the self-sacrifice, go on for a while, unacknowledged or unappreciated (that is, without payback to the ego), and see how we begin to feel. The tension, the stress, starts to show. We complain that others are taking advantage of us, taking us for granted, victimizing us. Self-interest cannot long be shortchanged without demanding its due. We may eventually relieve the stress by blowing up at those we have been serving—accusing them of ingratitude, withdrawing our favors, or kicking them out of the house. Or we may sandbag the stress, letting it eat away at our dispositions and our bodies.

On the other hand, when we do things for others, they often feel obliged to return the favor in some form to avoid being left with an uneasy sense of debt. Gift giving notoriously stimulates the receiver to feel the need to reciprocate. Think of the times when you have received a holiday gift from someone for whom you had failed to buy a gift. Sometimes the sense of obligation prompted by the empathetic acts of others can become a nuisance.

The third rule statement describes the relative balance between the contending motives:

3. Behavior in the range of dynamic balance expresses the approximate balance of ego and empathy. It is the position of least behavioral tension. Within ourselves and others, it creates feelings of mutuality and shared respect.

For most of us it is an especially satisfying experience to interact with others in equality, with no sense of obligation, superiority, or inferiority. To work together in common humanity, in common cause, is to experience behavioral dynamic balance. Of course, there are many versions of the experience of dynamic balance: the shared pride of parents in helping their child achieve, the joy of athletes in playing well as a team, the satisfaction of coworkers in working together successfully on an important project.[17]

The Reciprocal Nature of Behavior. These algorithms of behavior operate in the smallest interactions of everyday personal life. The dynamic of behavioral tension dictates that for every interpersonal act there is a balancing reciprocal. A self-interested act requires an empathetic reciprocal for balance. An empathetic act likewise requires a balancing self-interested reciprocal. This reciprocity goes back and forth many times, even in a short conversation. Without the reciprocal, tension builds, stress accumulates, and either confrontation or withdrawal results.

Reciprocity through Conflict. These, then, are the proposed basic interpersonal algorithms of our three-level brain. These algorithms show how we get to reciprocity through conflict. I propose that they shape the conflict and reciprocity, the give-and-take, at all levels of our interactive, social lives.

> Overemphasis on either self-interest or empathy, exercise of one program to the exclusion of the other, creates tension and stress in any social configuration—from simple dyadic person-to-person encounters up to and including interactions among members of the workplace, society at large, social groups, and entire economic and political systems.

The Question of Science: Physics Versus Social

The algorithmic rules of reciprocal behavior proposed here operate very imperfectly. I suspect that this will be true of any behavioral algorithms or principles proposed at this level of generalization. The proposed algorithms, then, can approximate but not fully achieve the precision of the laws of classical physics or even quantum mechanics. This is in part because they are achieved through the process of organic evolution (which involves some random processes and natural selection) and therefore do not operate as immutable universal physical laws but as generalized algorithms with degrees of variation.

The idealized, or rather statistically generalized, tug and pull of ego and empathy presented here may be further probabilized in actuality by genetic, gender, and developmental, individual experience and learning, and other environmental shaping and reinforcing factors. In other words, genetically speaking, given the individual differences in genetic inheritance that we see in such things as hair, skin, and eye color, some individuals may be *behaviorally* more or less strongly wired or preorganized for self-preservation and affection than others. But granting *gender* and *developmental* differences, all human beings are nevertheless similarly wired or preorganized with the fundamental brain architecture unless they have very serious genetic defects indeed. Influential developmental psychologists such as Jean Piaget ([1932] 1965) of Switzerland and Lawrence Kohlberg (1984) of Harvard, operating from a behavioral perspective, have constructed and tested theories of childhood moral development. In the theories of both men, moral stages of development emerge much the same in all cultures if the child experiences anything approaching a normal family life. Such generalized moral stages could not be found across cultures if they were not genetically based on the species-wide brain structure and its associated behavioral potentialities.

From the standpoint of individual learning, socialization, and other environmental factors, modifications in biological structures and potentialities occur in early development and throughout life. Individual life experiences may facilitate, suppress, strengthen, or otherwise channel the expression of these inherited biological programs. Environmental factors, including physical constraints as well as our socially and scientifically accepted institutions and paradigms, also may shape and reinforce the expression of the evolved algorithmic dynamic. Individual learning experience or environmental factors of the individual life cannot, however, eliminate the genetic structure and programming of the brain, that is, not without radical injury or surgical or genetic intervention. And the behavioral tension will be there to both resist the changes and shape the experience, even shape the environment itself, in a dynamic manner.

Because of these factors, the behavioral algorithms are *statistical*, in much the same way as are the second law of thermodynamics and the quantum theory of physics. That is, they do not allow precise prediction of specific behavior at the basic unit of analysis—the individual, molecular, or subatomic level, respectively—but only on the aggregated basis of statistical probability. The proposed algorithmic rules of reciprocal behavior, as here presented, may nevertheless very well prove to be equally as valid and useful to social science as the laws of physics are to physical science. They do not and cannot, however, have the immutable quality of physical laws such as gravity. As products of organic evolution and developmental processes, they inevitably involve more probabilities because of individual differences, genetic and learned, in the evolved basic units.

An admittedly loose but perhaps interesting analogy can be made between the inclusive spectrum of possible behaviors of the conflict systems neurobehavioral model and the particle-wave function of quantum physics. As the wave function of a particle is defined to include all the possible values of a particle according to probability, the "wave" function of behavior can be considered to include all possible internal and interpersonal behavioral probabilities (mixes of ego and empathy) extending across the egoistic, empathetic, and dynamic balance ranges. Externally, observed behavior is predictable from the model, as is quantum behavior, only on a probability basis specified by the metaphorical wave function. The behavioral wave function, like that of particle physics, collapses or reduces to one behavior in a decision, action, or observation. If it doesn't collapse, we see frustration, tension, and indecisiveness, ambiguous behavior stalled in uncollapsed wave form.

When observed externally, the wave function of behavior can be considered to collapse to a specifically observable behavior on the part of the individual, and that is the end of it. But this would be an overly simplistic 'objective' perception somewhat more characteristic of the now largely superseded radical behavioristic perspective. Internally, subjectively, we experience a much more complex process, because we have conscious access to the dynamic. We know in our conscious awareness the tension, the difficulty, the struggle we go through in important issues of ego and empathy conflict. Even in the surely much simpler processes of quantum physics we still do not fully understand what set of dynamics leads to the wave function collapse.[18] In behavior, the dynamic lies in the complexities of subjective preconsciousness and/or self-aware consciousness.

The Universal Norm of Reciprocity: A Manifestation of Moral Consciousness

The norm of reciprocity has been a major theme in anthropology and sociology for the better part of a century (see Gouldner 1960; van Baal 1975). This universally observed norm, found in all societies, primitive and modern, has been accounted for, or shown to be possible, in evolutionary theory by such concepts as kin selection, inclusive fitness (Hamilton 1964), reciprocal altruism (Trivers 1971; 1981; Alexander 1987), and game theory (Maynard Smith 1982; Axelrod and Hamilton 1981). These efforts draw upon gene-centered perspectives, which see such reciprocity as basically selfish. More recently, extensive reciprocity seen as based not on selfishness but empathy has reportedly been observed in the behavior of rhesus monkeys (de Waal 1996). Frans de Waal's approach is a welcome departure that tries to escape the selfishness of gene-centered approaches and looks to the implied motivational mechanisms. All these approaches, however, including de Waal's, have been based on the external observation of behavior. They have not attempted to identify or even speculate about the neural mechanisms within the organism that the evolutionary process must necessarily have selected for in order to motivate, maintain, and reward such observed reciprocal behavior.

I suggest it is now time to consider fully what the newer findings of neuroscience add to the discussions from the gene-centered and ethological perspectives. I think that it has been established beyond any reasonable doubt by the work of Hamilton, Trivers, Alexander, Maynard Smith, and others that even from the most hard-core selfish gene perspective the basis for the closely related behaviors of reciprocity, cooperation, and altruism has, from the Darwinian or neo-Darwinian perspective, been established in the human genome (see the summary in Corning 1996). The presence of these behaviors has been further confirmed by quantities of observational data in primates, even in studies of early protohuman hominids (Isaac 1978), and by extensive anthropological and sociological observation.

In other words, we now know that we must have, wired into our brain and nervous system, the neural mechanisms that make such behaviors possible. It is time, therefore, with the full emergence of neuroscience, to make every effort to identify and specify these brain mechanisms and extrapolate the implications of their presence and functioning for our personal and social lives. This is, in fact, the thrust of the emerging subdiscipline of evolutionary psychology (Cosmides and Tooby 1989; Tooby and Cosmides 1989; Barkow, Cosmides, and Tooby 1992).

Understanding the neural reward systems and the internal dynamic of our evolved brain structure is critical to properly understanding our human social life, because the dynamic of such reward systems provides the subjective motivational basis for our choices in behavior as well as the entire texture and meaning of our lives. This subjective motivation and experience, although it is the most important aspect of our lives, has been almost completely ignored by the externalized gene-centered perspective. It is time to acknowledge more fully this subjective motivation, along with its objective manifestations, and give it its due place in our lives.

THE INEVITABILITY OF CONFLICT AND THE EMERGENCE OF MORAL CONSCIOUSNESS

The reciprocal algorithms of behavior can be viewed as high-level brain algorithms built up from a nested hierarchy of interconnected lower-level algorithmic modules.[19] The reciprocal algorithms underpin the inevitability of conflict, the tendency to reciprocity, and the accompanying emergence in self-awareness of moral consciousness.

There has never been a human society without conflict. Some have more, some have less, but none is without it. And the central and indelible presence of conflict in human life has not been lost on our greatest thinkers or systems of thought.

- Socrates saw human nature as made up of two winged steeds, one noble, one ignoble, harnessed to a single chariot and struggling against the control of a charioteer.

- Hillel, experiencing tension between two opposing promptings in his life, wrote, "if I am not for myself, who will be for me? But if I am for myself alone, what [good] am I?" (Wigoder 1989, 341)
- Christ, acknowledging the conflict, admonished us to struggle to love our neighbor as ourselves.

Religions have projected the struggle between good and evil on the cosmos. From Taoism to Buddhism, from Judaism to Christianity, our central moral themes have arisen from and examined the dualities posed by the tug and pull between preservation of self and affection for others. Conflict, then, and the resolving tendency toward reciprocity, is in the nature of humankind, pervasive and inevitable. The eternal moral and ethical dilemma—Hillel's question: Do I serve myself or others?—is wired irrevocably into our human nature and carried with us into almost every aspect of our daily lives.

Buber's I and You: The Inner and Outer Dynamic of the Reciprocal Algorithms

The reciprocal algorithms, the tug and pull of ego and empathy, defined by our triune modular brain structure, are proposed, then, as the basis as well as the dynamic of the social life and moral consciousness of human beings, the highest mammalian life-form. The energy-driven algorithms keep us in almost constant internal conflict as ego and empathy tug and pull against each other in our daily lives, moment by moment, as we interact with each other.

The dynamic that originates internally within each of us becomes externalized in our social interactions because of the effects of the behavioral tension produced in each of us as a result of these interactions. These are the mechanisms of our social evolution (which interact with other variables when we shift academic perspectives). We evolved through millions of years of social interaction, with these mechanisms becoming increasingly sensitive and refined in foraging societies, which demanded sharing and reciprocity.

The outcome is that each of us who has a fully formed, developed, human brain has what may be thought of as the equivalent of two persons within us, an *I* (ego) and a *You* (empathy). The *I* within us pulls us to respond first to our own needs; the *You* within us impels us to respond to the needs of others.

The conflict systems neurobehavioral model illustrates well this *I* and *You* within. Egoistic behavior is *I* behavior. Empathetic behavior is *You* behavior. Wherever empathy is engaged through its roots in affection, we subjectively experience the warmth of feeling, the caring, the attachment that flows from our mammalian brain structure. Where *I* and *You*, ego and empathy, come into dynamic balance or close to it, we may experience both the subjective feelings and the objective expressions of what is called love. We may in effect achieve the maxim, Love your neighbor as yourself.

Of the numerous twentieth-century thinkers who sensed and worked to articulate this internal and external struggle, which I have defined as the reciprocal algorithms, the most perceptive was arguably Martin Buber (1878–1965), whose work had profound influence on postwar Europe.

BUBER: I AND THOU

Buber's best-known work, translated into English as *I and Thou*, was first published in 1922.[20] The German title *Ich und Du*, however, means simply "I and You." The German pronoun *du* is the second person familiar form used among family members and friends. It does not carry the lofty, abstract connotation of the English pronoun *thou*. Buber, then, came to English already somewhat misrepresented. His intent was to communicate simply and intimately. This intent got muddled, if not lost, in the translation and has tended to cause Buber to be seen primarily as a somewhat abstract mystic with the lofty *thou* being construed as a mystical term implying the Deity even when it referred to relations among ordinary folk.

According to Buber, our interactions with the world are all driven by dialectical (in my terms, behavioral) tension within and without. The two primary ways to interact with the world are from positions of I-It and I-You. Each hyphenated word combination is seen as a word pair entity. There is a tension or dynamic that binds them. Buber sees the I-It word

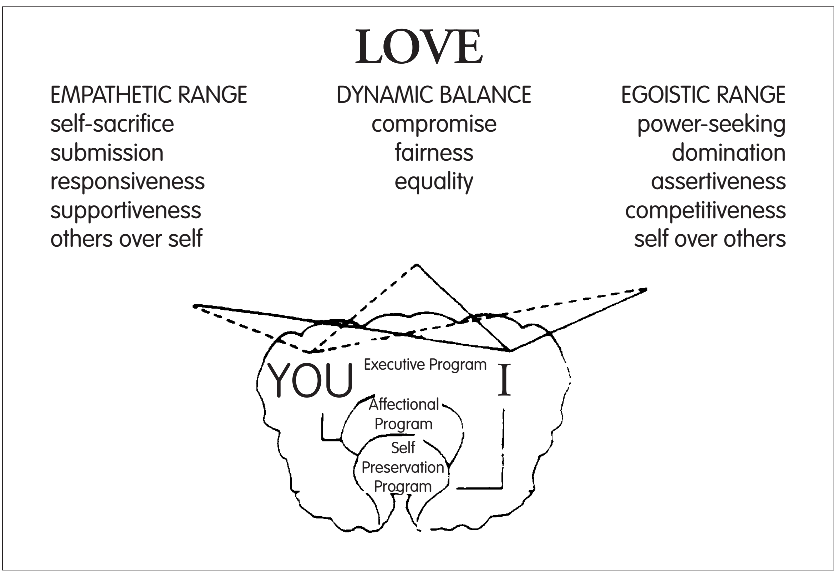

Fig. 4. The major ranges of behavior reflecting Buber's I-Thou concept.

pair as the position we take when we relate to nature, other creatures, and people as objects—objects to be used. He sees the word combination I-You as establishing the world of relationship. One does not exploit or use in such relationship but rather connects and experiences.

The I-You relationship occurs in three spheres, or at three levels. (1) When with the I-You we look to nature—animals, trees, rivers, mountains, and the like—we do not use them as objects; rather we connect with them in relationship. (2) When with the I-You we turn to other humans, who like us share speech and concepts, we also connect with them in relationship. And we can speak to each other using the terms *I* and *You*. (3) When with the I-You we approach the spiritual level, we do not communicate with words but become nonverbally aware of *relationship*, to which we respond with thoughts and acts.

Buber's is plainly a dialectic driven by tension, and because he sees love as the experience of meeting between the *I* and *You*, in a state of tension, he is clearly describing the same process that has here been described as the algorithms of reciprocity.

The Reciprocal Algorithms in the Theology of Paul Tillich: Love, Power, and Justice

The theology of Paul Tillich (1886–1965), like that of Buber, shows very clearly the dynamic of the reciprocal algorithms. One of his later works, *Love, Power, and Justice* (1954), is the clearest exposition of the algorithm's elements and dynamic.

Love, Power, and Justice by its very title reveals the intuitive perception of the tug and pull of ego and empathy as they tend toward dynamic balance. From the perspective of the reciprocal algorithm, power is an expression of ego, which incorporates or appropriates things to itself. Love, as conceived by Tillich, comes out of affectional programming and expresses concern for others. As ego and empathy tug and pull toward a dynamic balance of self- and other-interest, what we describe as justice emerges.

Justice in figure 5 emerges at the confluence of power and love, of ego and empathy, or I and Thou. This again follows the graph of the major ranges of behavior, where the dynamic balance of ego and empathy produces respect for self and others, fairness, equality, and the motivation for the concept of *justice* in our behavior, subjective experience, and legal and ethical thought.[21]

Toward Forgiveness and Spiritual Reach

The tug and pull of ego and empathy, proceeding from our earlier brain complexes, driven by behavioral tension/stress, represented in and negotiated by the neocortex, may seem mechanistic, leaving no room for free will and the higher reaches of morality and spirituality. Is our only hope, then,

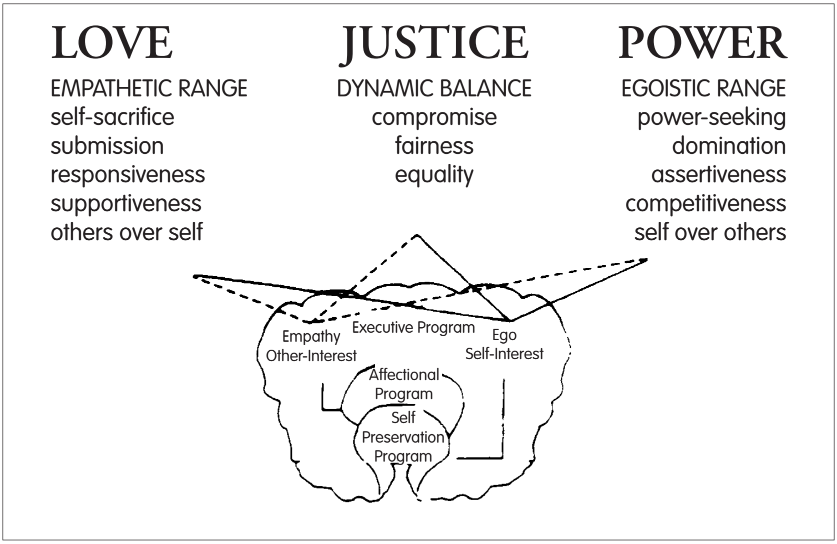

Fig. 5. Tillich's concept of the interaction of power, love, and justice as expressed by the major ranges of behavior. Note the difference between this figure and fig. 4, which represents the *I and Thou* of Buber. Although there are minor differences in the definitions of love, the warmth, comfort, nurturing, and caring of the mammalian affectional mechanisms characterize virtually all descriptions of love, and the experience is dependent on these mechanisms.

to move from inevitable conflict to a condition of relatively mechanical and drab reciprocity?

I think not. The dialogue that takes place in the neural network architecture of the frontal cortex is one of choices. Choices imply a measure of free will. The concept of a *theory of mind*, favored today by many researchers, requires both a theory of a mind of self (ego) and a theory of mind of others (empathy).[22] The emergence and development of both aspects of mind, as well as their dynamic balance, are tuned neuronally and enhanced by moral socialization and education. The theory of mind is inevitably linked somatically to the self-preservation and affection emotional substrates of neural architecture, including the related functioning of hormones and neurotransmitters. Such a somatic marker theory of mind (in the manner of Damasio 1994) may allow for the conscious management of the behavioral tension and stress resulting from the conflicting impulses of the two motivational systems. From such conscious management may well emerge the all-important quality of *forgiveness*, which facilitates the release of behavioral tension, enhancing personal well-being and the resolution of conflict, both internal and interpersonal, at a higher moral and spiritual level. Drawing on the known amplifying qualities of the thalamocingulate gateway,[23] the frontal cortex may blend and amplify the essentially conflicting motives into an experience of love of self and others that may be extended to all humanity, indeed all creation.

Such is the direction that all our great teachers East and West have beckoned us toward. It is the dynamic that such recent thinkers as Buber and Tillich strove to articulate. If the conflict were not there in our human nature and our evolved brain structure, there would be no virtue, no challenge, and no spiritual achievement in transcending it.

Conclusion

MacLean's emphasis on subjective experience in his exposition of the interconnected, modular triune brain concept provides the foundation in brain science for the study and explication of the all-important human characteristic of moral consciousness. The extrapolation of the three-level brain concept into the realm of psychology by the subjective/behavioral conflict systems neurobehavioral model, as presented here, defines the basic algorithmic reciprocal dynamic of ego and empathy as driven by behavioral tension. This reciprocal dynamic of our evolved brain structure, enhanced by elaboration of the neocortex and the development of language, allows us to account for the emergence of moral consciousness. Moral consciousness is reflected in the universal norm of reciprocity as well as in humankind's loftier philosophical and spiritual abstractions and expressions. The conscious, intentional yoking (*zygon*) and transcending of the dual algorithmic dynamic responds to the exhortations of Hillel, Christ, and other great figures of humanity to value and love self and others as one and is, further, the moral and spiritual challenge facing our species in the quest for a subjectively experienced and objectively manifested world of unity in diversity that affirms all humankind inclusively.

I propose multidisciplinary linkages in the emergence of moral consciousness. The linkages are rooted in neuroscience and bridge cognitive and motivational psychology, extending further into the social sciences and ultimately into the higher aspirations of humanity expressed in our philosophical and spiritual yearnings.

Notes

I wish to express my appreciation to two anonymous referees whose thoughtful and generous comments and criticisms have helped to make this a better paper.

1. See Reiner 1990 and Campbell 1992. A great deal of unreflective and inaccurate criticism of MacLean's position by Reiner and Campbell is obviated by a close reading of MacLean's recent work.
2. Cory (1998; 1999) documents in detail the inaccuracies and misrepresentations of MacLean's work in the reviews by Reiner (1990) and Campbell (1992), which have been relied on by other writers, especially in the psychological and social sciences. Cory concludes that the triune brain concept, when properly represented, is soundly grounded in evolutionary neuroscience and, with some clarifications, is the most useful concept we have for linking neuroscience with larger, more highly generalized concepts of the social sciences. The developmental transitioning from stem

reptile to mammal is clearly established in taxonomy. Although MacLean's concept may lack the desired precision for some neurophysiological researchers, as modified in this paper it is totally adequate and useful for the behavioral propositions put forth here.

3. For example, see Humphrey 1976; Isaac 1978; Erdal and Whiten 1996; Cummins 1998; and Tooby and DeVore 1987. Cosmides and Tooby surmise that cognitive development in human beings allowed a widening and diversification of items of social exchange (1989, 59).

4. For earlier versions of the behavioral model developed here see Cory 1974; 1992; 1996. Also compare the model of human communication by Dingwall (1980) based in reflexive (striatal or reptilian), affective (limbic or paleomammalian), and cognitive (neocortical or neomammalian). Dingwall draws upon Lamendella 1977. See also Leven 1994.

5. Experimental work with animals as diverse as lizards and monkeys shows that the reptilian complex is involved in displays of agonistic and defensive social communication. It is also noteworthy that partial destruction of the reptilian complex eliminates the aggressive, territorial display (MacLean 1993, 108).

6. The division of function between the protoreptilian complex and the limbic system is not clear-cut but rather entangled. The lower structures of the limbic node have been shown to augment the self-preservational behavior of feeding, fighting, and self-protection (MacLean 1990; 1993, 109), adding passion or emotion to them (Kandel, Schwartz, and Jessell 1995, 595–612). The newer structures in the upper half of the limbic node, especially the septal, including the medial preoptic area, and thalamocingulate division, are involved in affectional, family-related behavior (Numan and Sheehan 1997; Fleming, Morgan, and Walsh 1996; MacLean 1993, 109).

7. Positing the affectional programming draws on not only current neuroscience but also the extensive literature on the concepts of social bonding and attachment, especially the work done on higher primates and human beings. For fundamental work on lower animals, see the pioneering work of the Austrian ethologist and Nobel prize winner Konrad Lorenz (1970–71). Particularly relevant here would be the work of psychologist Harry F. Harlow on the nature of love and attachment in rhesus/macaque monkeys (1965; 1986). Harlow described five affectional systems in monkeys: maternal, mother-infant, age-mate, heterosexual, and paternal (1986). In this paper I have proposed one all-inclusive affectional program. It is personally interesting to me that Crews (1997) argues that affiliative behaviors evolved from reproductive behaviors. This is a position that I took in 1974 in the first version of the conflict systems neurobehavioral model (Cory 1974) presented in this article. There has been a recent resurgence of interest in the evolutionary biological basis of affection and empathy, especially in primates (e.g., Goodall 1986; de Waal 1996). In the case of human beings, the work of Spitz (1965) and British psychiatrist John Bowlby (1969; 1988) is of special interest. All the foregoing reflect field observations, experimental behavioral observations, and clinical work. None of them penetrates the brain itself. More recent work in computer modeling of neural processes has focused primarily on cognition and has avoided dealing with the more complex issues of affiliation and emotion. For example, Churchland and Sejnowski in their extensive and well-known work on the computational brain acknowledge the neglect of these critical areas (1992, 413). From the standpoint of neuroscience, it is also notable that Kandel, Schwartz, and Jessell, authors of the most widely used text on introductory neuroscience (1995), also show this neglect. Extensive research has been done on the role of the amygdala in emotion, but such research has generally focused on the emotion of fear (LeDoux 1997). The neglect is not difficult to explain. Research on such complex pathways within the brain, in spite of great progress in recent years, is still in its very early stages. The unknowns are still vast. Currently the best summaries of research in neuroscience on nurturing, caring, and family-related behavior are contained in Panksepp 1998; Numan and Sheehan 1997; Fleming, Morgan, and Walsh 1996; and MacLean 1990, 380–410, 520–62).

8. In cognitive neuroscience brain modules are commonly seen as competing and also cooperating (see Crick 1994; Baars 1997). The possibility of competing or conflicting modules causing behavioral tension is also acknowledged by Pinker (1997, 58, 65).

9. The evolution of the neocortex, our big brain, was in all probability greatly enhanced by the tug and pull of our conflicting programs. Humphrey (1976) sees the intellect as providing the ability to cope with problems of interpersonal relationships. See also the discussions in Masters 1989, 16–26, and Erdal and Whiten 1996. Cummins (1998) argues that interpersonal relationships—competing and cooperating with conspecifics for limited resources—is the chief problem confronting social mammals. Cummins concentrates on dominance hierarchies, which she sees as dynamic rather than static.

10. Damasio's "somatic marker" hypothesis, by which emotions become connected by learning to certain behavioral scenarios, is an example of a functional mechanism for producing behavioral tension or stress (1994, 165–201). Also see the comment on chronic mental stress (pp. 119–20). Tension and stress are mediated by hormones and neurotransmitters acting within neural architecture rather than through the so-called hydraulic pressure model of earlier psychodynamic models.

11. A language module did not, of course, pop out of nowhere and appear in the neocortex. The capacity for spoken language involved modifications of supporting anatomical structures including the laryngeal tract, tongue, and velum (which can seal the nose from the mouth), and the neural connections that tied in with the motor areas necessary for the production of speech. These all evolved at about the same time from the hominid ancestral line and, combined with the elaboration of the neocortical structures of thought and syntax, made language possible. This example of the complexity of language development provides a caveat to avoid overly simplistic one-for-one specialized module for specific behavioral or functional adaptation positions. The work of Philip Lieberman, a linguistic psychologist at Brown University, is especially relevant for the understanding of this very complex language capability. See the up-to-date treatment of these issues in Lieberman's *Eve Spoke* (1998).

12. The ability to self-consciously generalize is apparently a unique gift of the neocortex, with its billions of neurons interconnected into hierarchical networks. The level-of-generalization issue in all our disciplines likely springs from this. That is, we can move from parts to wholes in generalizing and from wholes to parts in analyzing freely up and down throughout our neural networks. Generalizing (and implicitly analyzing) has been recognized by scholars in many disciplines as perhaps the defining characteristic of the human brain (Hofstader 1995, 75; Einstein 1954, 293). This generalizing capacity loosens up the tight wiring of the routines and characteristics of earlier brain structures and allows us to manage and to some degree overcome the mechanisms that we inherited in common with kindred species (see Panksepp 1998, 301). In other words, the generalizing, analyzing capacities of the neocortex change the rules of the game for us human beings by freeing us from the blind tyranny of primitive mechanisms. This capacity must always be weighed when trying to apply findings in even, for example, primate ethology to humans. One of the reasons our feelings and motives are so difficult to verbalize and communicate to others is probably that the earlier evolved brain (reptilian and limbic) systems are nonverbal. Their input enters the neocortex through neural pathways as inarticulate urgings and feelings. It falls to the neocortex with its verbal and generalizing ability to develop words and concepts to attempt to understand, represent, and convey these inarticulate urgings. MacLean states that the triune brain structure provides us with three inherited mentalities, two of which lack the capacity for verbal communication (1992, 58).

13. My use of the term *empathy* here includes the affectional feelings of sympathy that depend on empathy, plus cognitive aspects (Hoffman 1981). Losco has noted that empathy, amplified by cognitive processes, could serve as an evolved mediator of prosocial behavior (1986, 125). *Empathy* and *sympathy* are frequently used inclusively, especially in more recent writing (Eisenberg 1994; Batson 1991). The positing of the ego and empathy dynamic goes back to the historical juxtaposition of self-interest or egoism and sympathy or fellow feeling of in the thought of David Hume, Adam Smith, and Schopenhauer (Wispe 1991). The present articulation goes back to my doctoral thesis (Cory 1974). The conflict systems neurobehavioral model was applied in several programs that I authored for corporate management training through the education and consulting corporation United States Education Systems during the period 1976–85. Roger Masters (1989) also has noted the possible innate roots of contradictory impulses that include selfishness and cooperative or altruistic behavior in human nature. Trudi Miller (1993) has also drawn our attention to this historical duality and suggested its applicability for today. Hume, Smith, Schopenhauer, Wispe, Masters, and Miller, however, did not attempt to articulate a model of behavior based on this duality, or, as MacLean calls it, "triality," acknowledging the role of the neocortex in articulating the otherwise nonverbal urgings (1993).

14. The frontal neocortex especially has long been recognized as being involved in executive functions. See the excellent summary and discussion of findings in Fuster 1997, 150–84. See also Pribram 1973 and 1994. Although executive function is frequently equated with frontal cortex function, Paul Eslinger reminds us that the neural substrate of executive functions is better conceptualized as a neural network that includes the synchronized activity of multiple regions, cortical and subcortical. Eslinger also notes the usual neglect of critically

important affectively based empathy and social and interpersonal behaviors in neuropsychological, information-processing, and behavioral approaches (1996, 390–92).

15. Levine (1986) also considers MacLean's triune modular concept a useful tool in network modeling.

16. The dynamic of the model, the tug and pull of ego and empathy, self- and other-interest, allows the expression of the mix of motive and behavior as a range or spectrum. The usual dichotomizing of self-interest and altruism is seen only at the extremes of ranges. All or most behavior is a mix of varying proportions. Jencks (1990, 53–54) also notes that every motive or act falls somewhere on a spectrum or range between the extremes of selfishness and unselfishness. Teske (1997) sees a blend of self- and other-interest in his identity construction concept.

17. See Eckel and Grossman 1997. Without making any connection with brain science or the reciprocal algorithms of behavior, the authors use a typology of fairness (for me, for you, for us) that expresses the conflict systems model and the reciprocal algorithms of behavior.

18. That is, in physics it is not known exactly why and how wave function collapses or reduction occurs and how eigenstates are determined (see Hameroff and Penrose 1996, 311). The standard Copenhagen Interpretation saw collapse as occurring at randomly measured values when the quantum system interacted with its environment, was otherwise measured, or was consciously observed (see Stapp's well-known article on the Copenhagen interpretation [1972]). Penrose (1994) and Hameroff and Penrose (1996) introduce a new physical ingredient they call objective reduction (OR), which becomes guided and tuned into orchestrated OR, in which quantum systems can self-collapse by reaching a threshold related to quantum gravity. Ellis has compared consciousness to a wave pattern or function (1986, 67). Harth notes, in summarizing his sketch-pad model, that "the transformation from the extended activities in the association areas and working memory to specific mental images may be likened to the collapse of a wave function in quantum mechanics." He does not, however, imply any quantum effect (1997, 1250).

19. The algorithms of reciprocal behavior may also be thought of as high-level Darwinian algorithms (see Cosmides and Tooby 1989; Tooby and Cosmides 1989), which function as the cognitively generalized sum of perhaps many contributing and perhaps more highly specific innate algorithms (see also Cory 1996; Vandervert 1997). It may be further noted that the CSN model, which rests on evolved algorithms of the brain, may be consistent with the sensory motor approach to cognition (see Newton 1996) as long as the very extensive and complex evolved algorithmic processing and structuring of sensory and motor inputs and outputs is not treated too simplistically. The CSN model moves to identify and explicate some fundamental brain algorithms that provide framework, structure, and dynamic to our sensory motor experiential performance. At this point it should perhaps be acknowledged that the neural mechanisms underlying social behavior may vary widely among unrelated species to the extent of being entirely different when we move, for instance, from the relatively simple neurological structures of social insects, which apparently function like automatons, to the enormous complexity of the human brain, which functions on the basis of choice among conflicting alternatives. That different mechanisms may produce similar results is illustrated dramatically by the evolutionary case of the eye. The evolution of the eye was not a process of unfolding developmentally; rather it developed independently perhaps forty different times in evolutionary history, based on at least three functional principles (see Corning 1995, 92–93; Land and Fernald 1992).

20. A standard translation of Buber's *I and Thou* is R. Smith's (Buber 1958).

21. Although justice as a formal concept is a very complex philosophical, legal, and ethical issue, a full discussion of which is beyond the scope of this paper, I feel that the sense of fair play motivating it emerges from a respect for self and others (ego and empathy), which I try to indicate in the dynamic balance range.

22. The term *theory of mind* was originally coined by primatologist David Premack (Premack and Woodruff 1978), who was researching the question of whether chimpanzees had a concept of other minds existing in their fellow primates. It has since been used in an attempt to account for the deficit of relatedness to others presumed to be central to the condition of autism (Frith [1993] 1997; 1989; Baron-Cohen 1995; Brothers 1995). It has been applied to child development, where the standard account is concerned with the child's grasp of others' attention, beliefs, and false beliefs (Astington, Harris, and Olson 1988) and to persons with frontal

lobe damage such as the much discussed case of Phineas Gage (see Damasio 1994). Attention has also been directed toward how the child constructs the meaningful intention and evaluative attitudes of others (Fridlund 1991; for a critique of some current issues, see Grossman, Carter, and Volkmar 1997). Any adequate theory of mind would have to have to allow, either explicitly or implicitly, for a generalized concept of self or ego, as well as a similarly generalized concept of empathy or other interest, or else it would be utterly meaningless. That is, to have a theory of the mind of others, you must first have an idea of a mind of self.

23. Organs often evolve to express functionality existing even in the single-celled microbe; for example, eyes evolve from light-sensitive proteins, lungs and digestive organs from the transport of cellular oxygen and materials. Similarly, the capacity to amplify or diminish internal signals as well as signals from the environment has been shown to exist in protein molecules within single-cell organisms lacking a nervous system or even a single neuron (Bray 1995). The thalamocingulate gateway, perhaps especially the anterior cingulate cortex, apparently has in part specialized this cellular function (see Tonomi and Edelman 1998; Devinsky and Luciano 1993).

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