CHAPTER 3

FITTING IT ALL TOGETHER: IMPULSE/CHECK/BALANCE

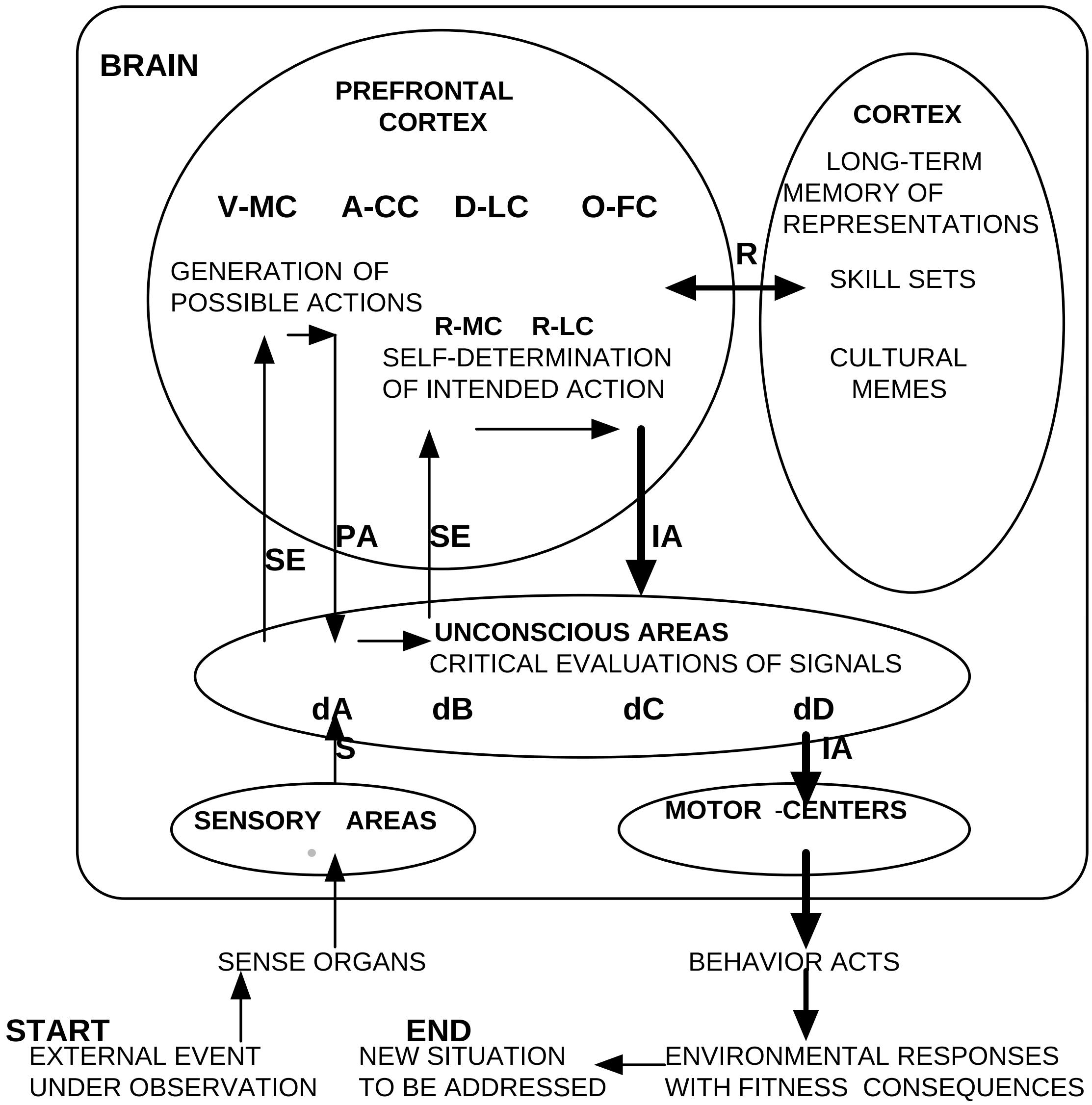
Cognition, per se, cannot check the impulse of a drive.

That can only be done by an impulse the other way. William James

It is easier to describe the various parts of the brain than to describe how they fit together into a working whole. After all, it is estimated that there are 10 trillion synaptic connections in the brain, as well as billions of neurons with several hundred miles of axon cables carrying a phenomenal number of combinations of electric signals firing at the rate of up to ten times per millisecond. And these neurons are bathed in blood carrying some 130 specialized chemical neurotransmitters. It is indeed a great deal to explain. Based on findings from all the related disciplines, I plan to lay out a rough circuit sketch, showing the interconnection of the parts and an algorithm for the dynamics of their interplay. Figure 3.1 lays out the schematic sketch of the interconnections that will be explained as we go along.

FIGURE 3.1

SCHEMATIC OF HOW THE BRAIN WORKS AS A DECISION-MAKING APPARATUS



S =SENSORY SIGNALS **SE** = SIGNALS WITH EMOTIONAL MARKER
R= REPRESENTATIONS **PA=** POSSIBLE ACTION **IA=** INTENDED ACTION

V-MC= VENTROL-MEDIAL CORTEX **O-FC** =ORBITAL-FRONTAL CORTEX
D-LC =DORSAL-LATERAL CORTEX **A-CC** =ANTERIOR-CINGULATE CORTEX
R-MC =ROSTRO-MEDIAL COREX **R-LC** ROSTRO-LATERAL CORTEX

The decision process starts with a signal from a sense organ to each unconscious area drive where it is critically evaluated and then moves on as a marked signal or *impulse* into the prefrontal cortex where it can be *checked* by impulses from other drives when they are in conflict. In a conflicted situation the prefrontal cortex then calls on our multiple cognitive capacities to generate possible actions to integrate and *balance* the impulses. After feeding these ideas back to the drives for testing, the most satisficing choice for the four drives (and possibly for the R-MC and the R-LC, see below) is sent on to the motor cortex for execution. The discussion below will provide a more detailed explanation of this complex process, with supporting evidence and examples. I will start by reporting on three experiments that reveal much about how the conscious and the unconscious brain interact in this decision-making process.

Three Key Experiments

The first set of experiments, conducted at Ohio State by a team under the leadership of Sarah Boysen,[i] tested the response of chimpanzees to a choice between two tempting dishes of candy. The chimps had learned to indicate their choices by pointing at one of the dishes. The catch was that the chimps were actually given the dish that they had not pointed at while another chimpanzee was given the dish that they had chosen. The experiments revealed that chimpanzees, even over repeated trials, consistently pointed at the larger pile of candy and showed great displeasure at seeing it given to another chimp. These chimpanzees were highly accustomed to taking part in various experiments and had demonstrated significant cognitive abilities in other kinds of tests, yet in this test they were simply unable to resist the impulse to go for the larger pile of candy. Children given this test were quickly able to learn that pointing to the lesser pile was the rewarding thing to do (although children under two years of age did have some problems). There appeared to be nothing in the brain of the chimpanzees that could enable them to check their impulse to go for the most.

These results have been replicated in many ways and contrast sharply with human behavior. Like chimpanzees, humans have impulses that are generated by each drive in the unconscious brain, but the human brain can check and moderate raw impulses, usually bringing them into some balance with the other drives. I believe that understanding this complex process is the key to understanding how the parts of the human brain are tied together. The process takes place in the prefrontal cortex, the mental integrative center, as it intensively and iteratively interacts with the drives. A human has no trouble dealing with such a candy choice because he or she possesses not only a drive to acquire the most candy (dA) but also an independent drive to comprehend (dC) what is going on in this game, a drive the chimpanzee does not have. This drive to figure-out-what's-going-on checks the unreflective impulse to grab for the bigger dish of candy and, instead, pushes the prefrontal cortex to come up with a better theory of the situation. Each new theory generated by the prefrontal cortex can be run back to the dC area to test if it feels right. Does it intuitively make sense? If so, it will be tried. If it does not work, the process will proceed and, sooner or later, will probably hit on a winning theory. Although chimpanzees display curiosity, they seem to have nothing that comes close to the human drive to comprehend, to come up with a plan that works.

In order to build further on the significance of Boysen's research, I will draw heavily on the insight of William James cited earlier: "Cognition, per se, cannot check the impulse of a drive. That can only be done by an impulse the other way. Cognition at most can only anticipate a consequence of exercising an impulse that can then excite another drive to set loose an impulse the other way." This impulse+check+balance process provides the algorithm for what humans can readily do but which the chimpanzees in Boysen's experiment could not do. This sharp contrast in mental abilities is what makes it painful for humans even to watch the impulsive frustration of the chimps.

The second experiment I will consider in some detail also involves chimpanzees and their drive to acquire, but this time it engages with their drive to bond, or, more accurately, their lack of an independent drive to bond such as humans have. This experiment was conducted by a team of anthropologists from Harvard and the Max Planck Institute and reported in *Science.* To quote from their report:

> Recent research has shown that primates possess a number of sophisticated social-cognitive skills, with some theories of cognitive evolution predicting that highly social primates are special in this regard. For example, many species of nonhuman primates follow the gaze direction of [fellow primates] and humans to outside

> objects—an adaptive social-cognitive skill for vicariously detecting food, predators, and important social interactions among group mates… Curiously, however, there is one task involving gaze-following at which chimpanzees and other primates perform poorly. In the so-called object choice task, an experimenter hides a piece of food in one of two opaque containers, and the subject, who did not see where the food was hidden, is allowed to choose only one. Before presenting the subject with the choice, the experimenter gives a communicative cue indicating the food's location, for example, by looking at, pointing to, tapping on or placing a marker on the correct container. The majority of primates… do not spontaneously perform above chance levels on this task no matter what the cue, and those who eventually perform well typically take dozens of trials or more to learn.

The one specific example of these tests they provide reports that only two out of eleven chimpanzees made the "right" choice.

These results made the researchers "curious" as to why their chimpanzees did so "poorly." Why should chimpanzees, which seem so smart in other social-cognitive tests, seem so dumb on this one test? But it all makes a great deal of sense from the perspective of the renewed Darwinian theory, according to which chimps do not have the *independent* drive to bond that humans have. On the contrary, the new theory suggests that their only *independent* drives are the drives to acquire and to defend; the social or cognitive abilities that they clearly have are used as a means to pursue their dA and dD ends. This point requires some further explanation.

Social interactions between adult chimpanzees seem entirely tied to the rational self-interest of each party. The most conspicuous social interactions of adult chimpanzees are their long periods grooming of one another. Older peer adult males can be observed spending significant time grooming with their preferred partners. They use hand signals to indicate where they want to be scratched and these signals are usually followed. But this helping behavior is promptly reciprocated so as to reward the dA of each party. So the observed social bonds between adults seem to be temporary and opportunistic. (The very important exception to this consistent behavior is the close long-term caring bond between females and their infants.) The new theory would predict, therefore, that in the context of one-on-one competition for dA items such as food, chimpanzees can be expected to be consistently distrustful of the other and to expect consistent deception by the other.

It seems, therefore, that, in the mind of the chimpanzee, the offer of food in the experiment described above sets up a competitive two-person game. If I don't guess the right container the other guy, the experimenter, will get the food." The new theory would anticipate that chimpanzees would use their social and cognitive powers to outwit the experimenter, whom they assume has a similar brain, and so will, in turn, be trying to outwit them. (Only their loving mother would do otherwise.) In these circumstances, the smart (cognitive) thing to do is the opposite of what the experimenter is signaling. And of the eleven chimps in the sample, nine were smart enough to figure this out. Their only thinking mistake was to assume that the human experimenter would act like any ordinary chimp.

Meanwhile, the experimenters seem to have been assuming that any smart chimp would understand that the experimenter was sincerely trying to send helpful clues, just like any ordinary human would do, given their independent drive to bond. Hence the miscommunication. Notice that it took dozens of trials for the chimps to finally catch on that they were dealing with some kind of weirdo who was actually trying to help them get the food. But some of the chimps eventually did catch on. I would rate most of the chimps in these experiments as amazingly good, not "poor," at using their cognitive capacity to read social clues—but I would flunk them on bonding.

As regards the experimenters' confusion, I would note that their human birthright, the independent drive to bond, tends to blind them to the chimpanzees' consistently super self-oriented motives, just as the chimps' lack of that kind of an independent drive blinds them to the humans' helpful motives. While adult humans have, at one time or another, experienced deceit at the hands of other people, the experimenters' behavior demonstrates that humans have a hard time understanding another being who is *consistently* distrustful and deceitful. We will return to this point later in regard to the behavior of free-riders.

The third critical experiment—one that reveals the impulse/check/balance process in humans—was performed by Damasio (mentioned earlier in this book) and his colleagues. They conducted experiments with a panel of humans with normal brains and a panel of humans who had suffered brain damage in the ventromedial portion of the prefrontal cortex. One should note that Damasio's experimental game does not involve a social interaction involving winners and losers, but only a contract with an "impersonal house." I will quote Damasio's clear description of the experiment:

> In the basic experiment, the subject, known as the "Player," sits in front of four decks of cards labeled A, B, C, and D. The Player is given a loan of $2,000 (play money but looking like the real thing) and told that the goal of the game he is about to play is to lose as little as possible of the loan and try to make as much extra money as possible. Play consists of turning cards, one at a time, from any of the four decks, until the experimenter says to stop. The Player thus does not know the total number of turns [available before the game ends.]. The Player is told also that turning any and every card will result in earning a sum of money, and that every now and then turning some cards will result in both earning money and having to pay a sum of money to the experimenter…
>
> The turning of any card in decks A and B pays a handsome $100, while the turning of any card in decks C and D only pays $50. As cards keep being turned on any deck, quite unpredictably certain cards in decks A and B (the $100-paying decks) require the Player to make a sudden high payment, sometimes as much as $1,250. Likewise, certain cards in decks C and D (the $50-paying decks) also require a payment, but the sums are much smaller, less than $100 on the average. These undisclosed rules are never changed. Unbeknownst to the Player, the game will be terminated after 100 plays. There is no way for the Player to predict, at the outset, what will happen, and no way to keep in mind a precise tally of gains and losses as the game proceeds. Just as in life, where much of the knowledge by which we live and by which we construct our adaptive future is doled out bit by bit, as experience accrues, uncertainty reigns. Our knowledge—and the Player's—is shaped by both the world with which we interact and by the biases inherent in our organism, for example, our preferences for

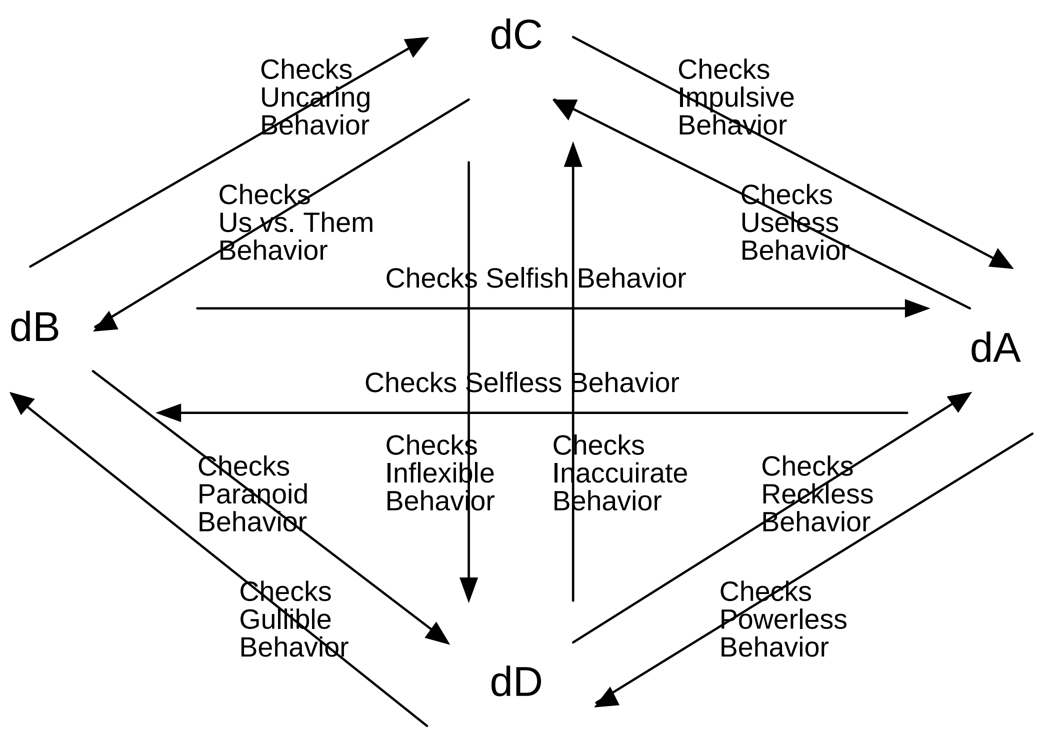
> gain over loss, for reward over punishment, for low risk over high risk.
> What regular folks do in the experiment is interesting. They begin by sampling from all four decks, in search of patterns and clues. Then more often than not, perhaps lured by the experience of high reward from turning cards in the A and B decks, they show an early preference for those decks. Gradually, however, within the first thirty moves, they switch the preference to decks C and D. In general, they stick to this strategy until the end.
> The behavior of ventromedial frontal patients in this experiment was most informative. What they did in the card game resembled what they often have done in real life since they sustained their brain lesion… Their behavior was diametrically opposed to that of normal individuals. After an early general sampling, the frontally damaged patients systematically turned more cards in the A and B decks, and fewer and fewer cards in the C and D decks. Despite the higher amount of money they received from turning the A and B cards, the penalties they kept having to pay were so high that halfway through the game they were bankrupt and needed to take extra loans from the experimenter.[ii]

Damasio discusses a number of possible explanations for his findings, but favors the explanation that the brain injury has blocked the *downward* connection between the prefrontal cortex and the unconscious area where the drives are located. In terms of the updated Darwinian theory, this would mean that, in the handicapped brains, when the dA impulse to go for the immediate reward of the $100 card reaches the prefrontal cortex from the limbic area, it cannot be looped back to the limbic area for evaluation by the drive to comprehend. Hence dC cannot signal the prefrontal cortex of its negative intuition about the Player’s current theory of the best way to play the overall game. (We can imagine the dC in this case as a spectator watching a marathon on television, helpless to warn a runner who has taken a wrong turn and is running at a winning clip away from the finish line.) The unchecked impulse to go for the immediate reward governs the resulting behavior just as it did with the chimpanzees in Boysen’s candy experiment. Of course, with the normal Players, this feedback loop could be executed and dC could signal the prefrontal cortex to search for a better theory of the overall game.

These experiments have given us our strongest leads yet on how the conscious and the unconscious brain interact in the decision-making process. Figure 3.2 presents examples in diagrammatic form of our hypotheses about the kind of check each drive gives the other three.

FIGURE 3.2

IMPULSES AND CHECKS



The experiments described above have tested for the manner in which dA is checked by dC and the manner in which dA is checked by dB. As of now, I know of no tests for the other possibilities. It would obviously be wonderful if some ingenious experimenters were to devise and run such tests.

The entire set of three experiments described above offers evidence to support the hypothesis that chimpanzee brains are not equipped with an independent drive to bond nor with an independent drive to comprehend and that these two drives are both found in healthy, undamaged human brains. This, I argue, is the most significant difference between humans and our closest primate relatives.

The Role of Emotions

The observant reader may have noticed that, following Damasio, I have used the term “emotional” to describe the “markers” that I believe are attached to the signals from the sense organs as they move through the limbic drive modules on their way to the prefrontal cortex. What is that all about? I think that human emotions, including ‘intuitions,’ can best be conceived as the language the unconscious brain uses in communicating with the conscious brain.

The analysis of the role of emotions in human behavior has an extensive history. It starts, appropriately, with Darwin and his 1872 book, *Emotions in Man and Animals*.[iii] Darwin believed that many, though not all; emotional expressions in humans are innate. In making his case, Darwin drew on four kinds of evidence. He pointed out that some human emotional expressions appear in similar form in many nonhuman animals. Some emotions also appear in very young children before there has been much opportunity for the children to learn them culturally. Moreover, some are expressed identically by humans with sight and by humans who were born blind and thus unable to mimic the appearance of a hand gesture or a facial expression. Finally, many emotional expressions appear in similar form across all human groups. Smiling is an example of an emotional expression that offers all four of these kinds of evidence.

Freud went further than Darwin by specifying and classifying the very limited number of drives he believed were expressed as emotions. For him, the two basic drives were the ego drive and the sex drive. The ego drive was the source for several secondary drives, including hunger, thirst, and aggression, as well as the impulses to control others, wield power, attack, and flee from danger. Most psychoanalytic treatment since Freud has focused on negative emotions such as guilt, fear, and anxiety, obscuring the fact that Freud saw emotions, more broadly, as essential for survival, performing the function of arousing, sustaining, and directing human action.

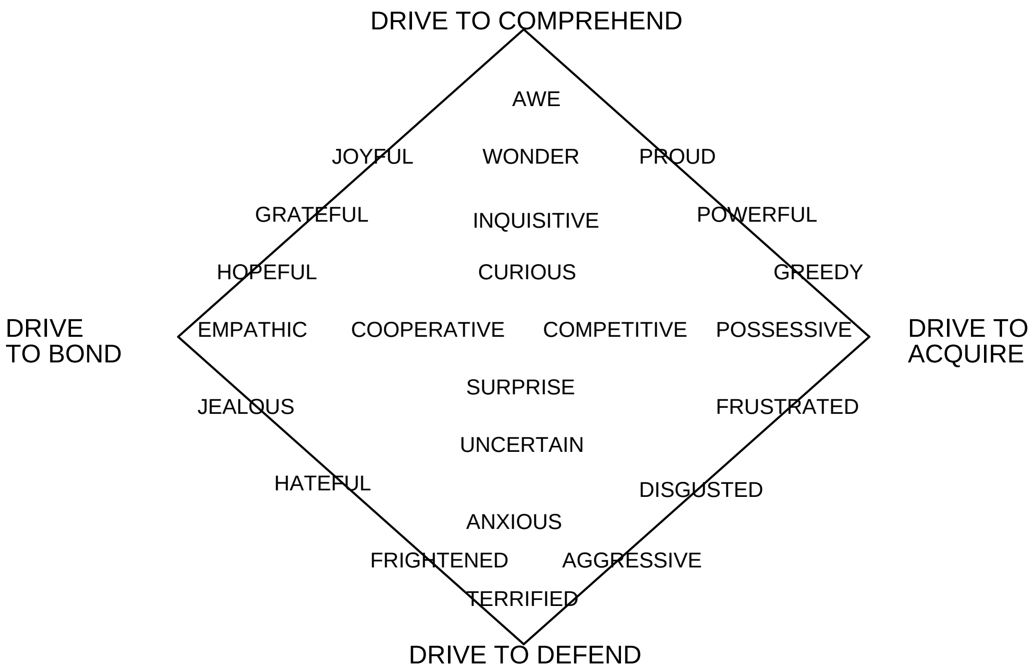
The point that emotions are essential for survival is important, because it contradicts the conventional wisdom that emotions lead to impulsive and irrational behavior that usually gets us into trouble. Emotions, according to this view, are carryovers from early evolutionary history; although they may have aided survival in the primitive world of the hunter-gatherer, they are largely dysfunctional in modern civilized life. I strongly disagree. In everyday life, emotions are usually an accurate guide on the path to fulfilling ultimate drives. Wise people have learned to sense and use their emotional clues—their inner voices—as well as their cognitive analysis when they face important choices. That emotional promptings are at times not logical is beside the point. For better or for worse, humans have only one innate drive to be logical for its own sake, the drive to comprehend.

Plutchik, in *Emotion: A Psychoevolutionary Synthesis,*[iv] has developed a more general theory of the role of emotions in human behavior. He agrees with Darwin on the evolutionary source of many emotions and with Freud that only a small number of primary subconscious drives are expressed in consciousness as emotions. He argues that all emotions are derived from primary drives and conceptualizes emotions as a bridge between the primary drives and cognition. Cognition, he believes, evolved to predict the future, an ability which helps us follow our emotional clues in order to fulfill our underlying biological drives. I agree with this formulation of the connection between drives, emotions, and cognition.

The best way to explicate Plutchik's categories of emotions is to array a sample of them on a quadrangle formed by the four drives and the spaces around and between them, as I have done in Figure 3.3.

FIGURE 3.3

EMOTIONS ARRAYED ON A FOUR-DRIVE QUADRANGLE



It should be apparent from this array that the placement of derived emotions is to some extent both crude and arbitrary. This is probably inevitable; words are somewhat clumsy symbols for the underlying emotions. But the point should be clear that emotions do come in different intensities and different mixes (think of the analogy of the combinations of the three primary colors) and the figure does convey a sample of the variety of emotions which can be derived from the four drives.

Deci, in *The Psychology of Self-Determination,*[v] pushes Plutchik's treatment of the role of emotion in human behavior a significant step further by bringing up the age-old question of free will, from a psychologist's rather than a philosopher's perspective. He credits William James with being the first psychologist to treat the subject in some detail. For James, *will* was the desire for an outcome that the individual thought was attainable; in other words, a state of mind that preceded voluntary behavior. Deci credits the well-known social psychologist Lewin with further clarifying these points. For Lewin, "there are three phases to an intentional action: a struggle between motives, a decision or intention that ends the struggle, and the…action itself."[vi] The strength of the resulting action does not depend on the intensity of the *intention* but rather on the intensity of the *drives* upon which the intention rests. Lewin then stated, "An intention that is not based on a natural need (such as a drive) will surely fail." These observations are central to our argument as to how the four drives are combined with the conscious decision-making process in humans. In our terms, the independence of the four drives—that is, their non-interchangeable nature—necessitates an internal mental struggle among them that forces itself into consciousness for resolution. The struggle is resolved by the intentional act of will that leads to an action. The action is, in turn, energized by the relevant drives as the action signal passes back through the limbic area on its way to the motor centers of the brain.

Deci describes this internal struggle in some detail, pointing out that people are frequently aware of having more than one motive at a time:

> While it may be possible to select a goal that will satisfy all of these motives simultaneously, typically that will not be the case. People must therefore decide which one or ones to attempt to satisfy at that time: the others must be held in abeyance. When there is only one motive, there is less need to recognize people's capacity for willing. However, with several motives, one must sift among the motives and select the one or ones that will be operative, and hold in abeyance the motives that were not chosen for satisfaction. It is particularly the function of holding motives in abeyance that necessitates the concept of will.[vii]

Deci also strengthens our perspective by criticizing the rational choice theory favored by economists. (Psychologists call it the "cognitive theories of choice.") Such theories, he argues, largely ignore the role of emotions in the choice process. On the contrary, Deci maintains, "emotions play a vital role in the motivation of behavior."[viii]

Deci moves on to offer definitions of will and self-determination which fit precisely with the new Darwinian theory. "Will is the capacity of the human organism to choose how to satisfy its needs…Self-determination is the process of utilizing one's will…. Willing is a necessary aspect of healthy human functioning." Thus, self-determination is a direct product of independent; non-interchangeable drives such as the four we hypothesize. This emphasizes the point of our theory that people desire to fulfill all four of their innate drives—they always look for smart ways to have it all. In some situations, of course, they cannot have it all and are forced to choose the fulfillment of one drive over another, perhaps later choosing to fulfill the neglected drive in order to cope with this situation.

This description of the role of emotions, motives, intentions, will, and self-determination in human behavior has been put together primarily from the work of psychologists, often from many years ago. The next section will discuss many of the same topics, but coming from the biological side and based on very recent work by neuroscientists and neurologists. I find the amount of agreement quite remarkable.

The Role of the Modules in the Prefrontal Cortex

In describing the role of the prefrontal cortex, I will be drawing heavily on Carter's description in her *Mapping the Mind*[ix] and linking this with my description of the functions of the drives in the unconscious brain. Carter summarizes the overall role of the prefrontal cortex:

> **The prefrontal cortex** as given over to man's most impressive achievements—juggling with concepts, planning and predicting the future, selecting thoughts and perceptions for attention and ignoring others, binding perceptions into a unified whole, and, most important, endowing those perceptions with meaning…This is the only part of the brain that is free from the constant labor of sensory processing. It does not concern itself with the mundane tasks in life such as walking around, driving a car, making a cup of coffee or taking in the sensory perceptions from an unremarkable environment. When something untoward occurs... the prefrontal cortex springs into life and we are jettisoned into full consciousness as though from a tunnel into blazing sunshine.[x]

I argue that these "untoward" events are signals from the unconscious area that two or more of our drives have been activated by sense organ signals and are rapidly signaling, in conflicted ways, for the attention of the prefrontal cortex. This is what turns on our full, high-level consciousness. These emotionally loaded signals enter the module of the prefrontal cortex known as the ventromedial cortex, the one that was damaged in Damasio's patients. To quote Carter again, "This [the ventromedial module] is where emotions are experienced and meaning bestowed on our perceptions."[xi] She describes this module's significant two-way connections to the limbic area:

> This is the brain's emotional control center… The connections between this region and the limbic system beneath it are very dense, closely binding the conscious mind with the unconscious, and this configurement is probably what gives it its special status: it is, if you like, the part that best incorporates the whole of our being, making sense of our perceptions and binding them into a meaningful whole… It makes sense of our existence.[xii]

Carter does not call the ventromedial module the seat of the *soul*, but from this description it seems to be a candidate. Damasio was more explicit about this issue: "Feelings form the base for what humans have described for millennia as the human soul or spirit."[xiii]

The ventromedial module sits alongside the orbito-frontal module, the second of four special prefrontal cortex modules that work tightly together to perform the brain's executive function. This module, according to Carter, "inhibits inappropriate actions, freeing us from the tyranny of our urges and allowing us to defer immediate reward in favor of long-term advantage."[xiv] In this sense, the orbito-frontal module seems to evaluate these conflicting emotional markers and to initiate the downward process of checking out with the limbic area the tentative balanced action proposals which have been generated by the prefrontal cortex. As Carter suggests:

> The orbito-frontal cortex has rich neural connections to the unconscious brain where drives and emotions are generated. The down signals from the cortex inhibit reflex clutching and grabbing, and if you take away that control—as happens sometimes in frontal lobe injury—the unconscious retakes the body… Orbito-frontal cortex seems, then, to be the area of the brain that bestows a quality we may refer to as *free will*.[xv][Italics added]

This seems to be a capacity to discipline the emotional centers to defer an impulse on behalf of more essential impulses—a *will* to accept the pain of giving something up for a greater good or lesser evil. It seems to be the "check" of the check and balance system. It also seems to be the final chooser of the brain, not in the sense of actually making the choices, but in the sense that it counts the votes (the rate of firing coming back from each drive) from the limbic area and announces the decision.

Just above this module lies the dorsolateral module. Here is where "things are held 'in mind' and manipulated to form plans and concepts."[xvi] This is where tentative plans can be mentally juggled. It is the center of what has been called the "working memory." It is the focal point of *consciousness*. Various action scenarios are imagined that can be fed back through the lower modules to the unconscious area for multiple readings on their ability to fulfill the several drives. It works very closely with yet a fourth module, which has actually been in full operation since the drives signals were first sensed by the ventromedial module.

That fourth module is the anterior cingulate cortex, which "helps [one] focus attention and 'tune in' to one's own thoughts."[xvii] It is this module that is in constant close touch with other parts of the cortex where the various memories and skills are held. It is the module that registers the existence of (or the absence of) a conflict between drives and reacts accordingly If necessary it calls the entire cortex to attention to focus on the critical issue at hand. It can call up, as needed, the relevant representations and bring them into the juggling process going on in the dorsolateral module next door. This part of the prefrontal cortex acts as a gatekeeper.

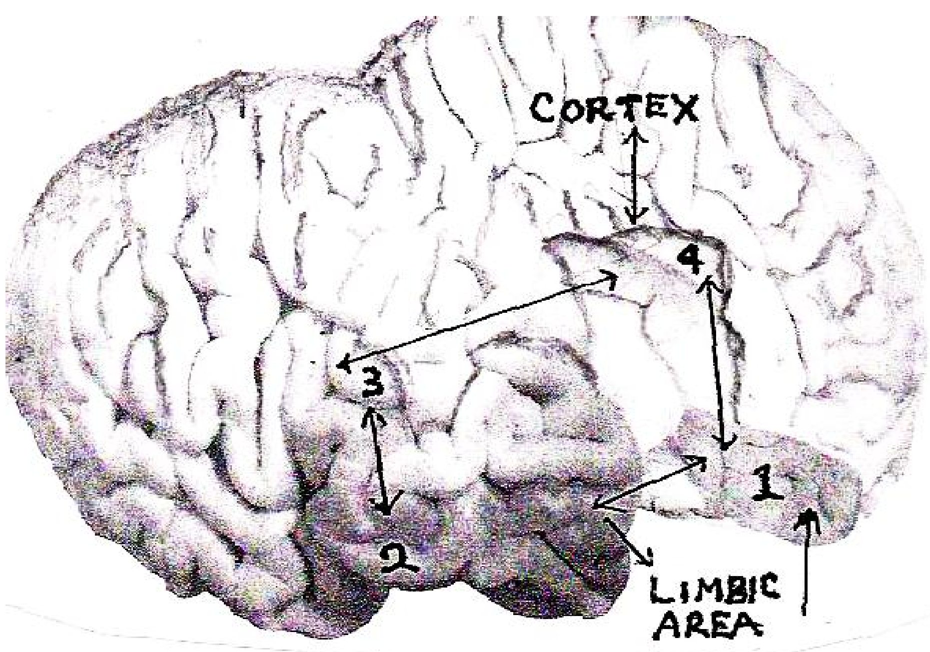
Carter's summary statements above about the functions of the prefrontal modules have been built up by a great number of detailed fMRI scans of the portions of the brain that are activated by various kinds of experimental conditions. One such sturdy, which was conducted by behavioral scientists at Emory University, is particularly interesting since it involved the drive to bond. Entitled *A Neural Basis for Social Cooperation,* this study reported on brain scans of 36 women as they played the well-known Prisoner's Dilemma Game. The researchers observed the greatest positive activation of the brain when the players engaged in repeated acts of mutual cooperation. The brain areas activated were primarily the nucleus accumbens and the caudate nucleus, both of which receive midbrain dopamine projections known to be involved with processing rewards. The ventromedial/orbitofrontal cortex, another brain area also involved in reward processing, was also activated for the interaction." [xviii] They also reported that the anterior cingulate cortex was involved and "this region may be generally involved with processing conflict related to emotions."[xix] Later they specify how the emotional conflict in the Prisoner's Dilemma Game would arise and how it might be resolved in the prefrontal cortex. "The decision to continue cooperating following a [mutual cooperation interaction] in the previous round also requires overcoming a bias that humans and other animals have to weight the attractiveness of a reward in inverse proportion to its delay, a bias that would encourage our subjects to value the immediate reward of defection and its payoff more than the delayed reward from sustained mutual cooperation … Accumulating evidence implicates the ventromedial frontal/orbitofrontal cortex in this role."[xx]

Figure 3.4, which has been adapted from Carter, summarizes the hypothesized functions and the interrelations of these four critical modules of the prefrontal cortex.

FIGURE 3.4

MAJOR PARTS OF PREFRONTAL CORTEX

AND THEIR INTERRELATED FUINCTIONS*



1. VENTROL-MEDIAL CORTEX

Tightly linked to receive signals from the limbic area. This is where emotions are experienced and meaning is bestowed on our perceptions.

2. ORBITAL-FRONTAL CORTEX

This area inhibits inappropriate actions, freeing us from the tyranny of our urges. It is where emotional impulses check each other and where willful choices are made. Tightly linked to the limbic area and possible location of the *will.*

3. DORSAL-LATERAL CORTEX

Working memory where all signals are held ”in mind” and manipulated to form tentative plans and concepts. Possible focus of *consciousness.*

4. ANTERIOR-CINGULATE CORTEX

Helps us to focus attention on conflicted impulses and to tap into cortex for relevant representations, cultural memes, and skills. * Adapted from Carter, *Mapping the Mind*, p. 182.

To trace the last stages of the work of the prefrontal cortex in decision-making, we must move beyond Carter’s description and turn to a more recent synthesis of this complex process. This is the 2007 book by Kathleen Stein entitled, The Genius Engine: Where Memory, Reason, Passion, Violence and Creativity Interact in the Human Brain” Stein’s ‘genius engine’ is, of course, the prefrontal cortex. She covers much of the same ground as Carter in describing the role of the PFC modules discussed above. But then she describes two additional modules, the rostrolateral cortex that functions as a memory of the cognitive self and the rostromedial cortex that functions as the emotional self. She draws heavily on the work of Kalina Christoff of the University of British Columbia who has focused her work on the abstract reasoning process, self-reflection and self-value judgments. These metacognitive issues engaged the rostra (for “prow” of “front”) part of the PFC. She found that the medial part of this area engaged with emotionally laden issues and the adjacent two lateral areas with cognitive issues. Both rostra areas lit up with decisions that are so complex that they require self-referential evaluation.

These could be the PFC modules that process the testing feedback from the drives that are evaluating PFC action options before they are acted on. These may be the PFC modules that “will” the final action on the most difficult problems. What Christoff calls the “tip of the consciousness pyramid. ” It may well be the place where we keep our memories of who we are, what we stand for, what we aspire to be, and where we judge the toughest decisions against these evolving self-memories. It may be the home of the one's self-concept the home of one's integrity and character.

Once an action plan has been decided on by this entire complex process, it is passed on to the back part of the frontal lobe, the part that allows us to take physical action. As Carter explains, "This part includes the language area which articulates speech, and the motor cortex, which controls movement."[xxi] Also, quite amazingly, she adds: "Just in front of the motor cortex is a strip called the premotor cortex.. This is where proposed actions are rehearsed before they are actually carried out."[xxii] So our brain even provides a rehearsal room before we open our mouths or strike a blow.

Obviously much, much more needs to be learned about the prefrontal cortex. Much more eventually needs to be learned about the role of the many neurotransmitters and the role of hormones in accelerating or inhibiting neuronal firings. It is now clear that the neurotransmitter dopamine plays a key role, not in the 'reward' system, per se, but in the 'wanting' system, expediting impulses from the drives to the PFC. Perhaps opiods are the neurotransmitters that follow-up to facilitate the reward system. It would not have been possible to have gained even these insights without the development of the fMRI and related brain-scanning machines. Nor would it have been possible without the study of patients who have suffered brain damage. Damasio has pioneered this approach to unifying our knowledge. More recently Stephen Hyman of Harvard came to similar conclusions to those of Damasio on the role of the PFC except he did it by studying a different form of pathology, that of seriously addicted drug users.

In a recent article on a talk of Hymen's he began, "by explaining what neuroscience has learned about the process by which humans choose among multiple goals and direct their behavior toward obtaining their choices. The part of the brain that manages this process is the prefrontal cortex." "With addiction there is a narrowing of life focus in that drug seeking crowds out all other motivations and goals." "Scientists have identified other structures [in the PFC] that perform functions such as holding goals in mind, monitoring behavior necessary to obtaining goals, and resolving conflicts that arise over conflicting goals." "Experiments with laboratory animals have shown that the release of dopamine signals the brain to expect a reward… These drugs are Trojan horses. Each of them contains a chemical that is enough like the neurotransmitter that they increase the mount of dopamine in the brain. When dopamine continues to be released beyond the normal period, the brain is thrown into a perpetual state of "wanting" which is the essence of addiction. Long-term use of addictive drugs created processes in the nerve cells that literally rewire the brain. The circuitry becomes deranged, which elicits automatic drug craving and drug seeking. These changes in the brain's circuitry and the resulting loss of control over the normal goal-getting and goal-seeking process are what makes it so difficult for addicts to recover and return to normal lives."[xxiii] Hyman's work offers strong reinforcement to Damasio's explanation of the interplay between the unconscious seat of our drives and emotions and PFC in the decision making process, that we, in turn, have built upon..

At the same time, it is encouraging to realize that gifted psychologists such as James, Freud, Plutchik, Deci, and Lewin came to very similar conclusions without the benefit of the research tools of the neuroscientists.

We began this chapter's story of "fitting it all together" with the unconscious area's inputs to the prefrontal cortex and their joint role in the decision process. Only now will we attend to the subconscious neocortex, with all its inputs into the PFC decision-making center. This is the wrinkled grey matter that covers all the top of our heads. We will consider in turn the roles of skill sets, cultural memes, and the long-term memories growing out of each individual's personal experience.

Skill Sets for Resolving Tensions between the Drives

The work of Pinker and others on innate skill sets (discussed in Chapter 1) has recently been built upon in a very original and useful fashion by two other social scientists, Jordan Peterson[xxiv] and Alan Fiske.[xxv] Their work is of special interest in that it adds to our understanding of how skill sets can help people resolve conflicts between the two pairs of drives that are most frequently in conflict. Peterson's work shows how a particular skill set helps us fulfill simultaneously the drives to comprehend and to defend, while Fiske's work shows how a group of four skill sets help us fulfill simultaneously the drives to acquire and to bond.

Reconciling dC and dD. Peterson focuses his attention on how the mind is built to detect and respond to novelty or surprises in the environment. He believes this skill serves to alert the entire body to attend to and concentrate on the unknown event and to explore it, but with caution. In four-drive terms, we approach and learn about the novel situation (dC) but remain ready to quickly retreat or attack (dD). In this process, the brain tries out different ways to form mental representations of the unknown object, searching for any pre-existing representation that approximates the unknown and noting possible matches and mismatches.

As Peterson expresses it, "Human beings are prepared, biologically, to respond to anomalous information—to novelty. This instinctive response includes redirection of attention, generation of emotion (fear first, generally speaking, then curiosity), and behavioral compulsion (cessation of ongoing activity first, generally speaking, then, active approach and exploration)."[xxvi] He adds: "The simplest cognitive/exploratory maneuver that renders an unpredictable occurrence conditionally predictable or familiar is likely to be adopted….If a solution 'works' it is 'right'." This fits in with Edelman's description of how neural sets employ the V/S/R process to develop more accurate representations,[xxvii] and with Loewenstein's discussion of how curiosity works.[xxviii] Such a mechanism for detecting and testing novelty would certainly qualify as an important skill, one which makes an important contribution to survival.

Reconciling dA and dB. Fiske's work has focused on developing an overview of the skill sets that humans use to relate to one another, which he calls the basic, universal forms of sociality. He finds that all varieties of human relationships can be grouped into four basic skill sets.

Fiske made his initial observations on the four forms of sociality while doing extensive fieldwork among the Moose people of Burkina Faso in West Africa, among the poorest people on earth. He has subsequently tested his findings not only in other African tribes but also in several advanced industrial countries.

The four forms Fiske identifies are communal sharing, hierarchy, reciprocity, and market pricing.[xxix] Communal sharing is found universally in the primary family group. In this setting, people largely follow the exchange rule, "From each according to their ability and to each according to their need." This form is employed beyond the family only in an uneven way, sometimes to the extended family and much less frequently beyond it. Communism was an ill-fated experiment in extending this from of sociality far beyond the primary family group.

Hierarchy, by contrast, is a relationship of inequality. Over time, humans negotiate a rank ordering among themselves as to who has more social importance, status, or dominance over others. This is the pecking order that is so clearly evident in many animal species. Rank can be established in many ways—age, intelligence, brute strength, wealth, social skills, and various combinations of these attributes. Ranking relationships do involve a form of exchange between the parties, even though it is unequal. The dominance of one party provides entitlement to resource advantages, but also carries with it an obligation to provide some amount of support for the lesser party. Well-established hierarchies of this type have mixed costs and benefits for the participants. One benefit is a relatively stable place for everyone, and everyone except those at the very bottom can dominate someone else. This basic form of human relations is, however, subject to destabilization whenever any party starts struggling for a better ranking, always at the expense of others. This mode is conspicuous in formal hierarchical organizations, as well as in heavily stratified societies such as medieval feudalism or the Indian caste system. A hierarchy is clearly built into the relationship between parents and their dependent children. Fiske argues that this mode of sociality is universal to humans and presumably innate in some initial form which is then fleshed out by one's particular cultural environment.

I would also note that the forms of hierarchy practiced by different species can vary a great deal, from the totally despotic control over subordinates in rank to mild influence over them. Wrangham has documented this sharp difference in his comparative reports on the "despotic" chimpanzee hierarchies and the mild form found in human hunter-gatherer groups.[xxx]

Fiske's third form of sociality, reciprocity, provides the ground rules that govern most peer relationships. This mode calls for an equality of exchange over an extended time. You scratch my back, and then I have an obligation, sooner or later, to scratch yours. These are the ground rules for establishing lasting friendships. There is very strong evidence that all humans, in all cultures, use this form of sociality regularly. Again reciprocity can vary by species. In chimpanzees' reciprocity is mosly short-termed opportunistic. In humans it is regularly long-term.

The fourth mode, market pricing, is exchange either by bartering or by a ratio to some medium of exchange. This can be the price negotiation that occurs in a standard, one-time commercial transaction with an American used car salesman, a Middle Eastern rug merchant, or an African street vendor. This kind of bargaining involves bidding and counter bidding, often with bluffing and calling bluffs, while keeping one's rock-bottom or reservation price a secret. It lends itself to exchanges between strangers who do not expect to trade repeatedly, and Fiske asserts that all humans seem to have a basic understanding of how to play this game.

Fiske presents evidence to support his hypothesis that these four skill modes are universal and presumably innate among all humans. In addition, he presents limited anecdotal evidence that these four modes are manifested in maturing children, in the order in which they have been presented, in a spontaneous, uncoached manner starting roughly with communal sharing in three-year-olds and proceeding to market pricing in eight-year-olds.

He develops the idea that each of these modes carries its own set of ground rules or moral codes and that people expect the rules to be observed and violations to be met with sanctions. For example, fairness and approximate equality of exchange over time are the key rules for the reciprocity mode, while the key rules for market pricing are "buyer beware" during the negotiations but abide by the resulting agreement or contract. The rules of communal sharing are to share generously with the most closely bonded of one's kind and to place their needs on a par with one's own. The morality of hierarchy consists of an attitude of respect, deference, loyalty, and compliance on the part of subordinates, complemented by the responsibility of the authority figure to provide protection for subordinates, a reasonable though lesser share of the resources available, and wise directive guidance. People seem to accept different payouts in this system based on competence and role complexity, but there also seems to be an intuitive limit to the size of the differential payouts that are judged to be fair.[xxxi]

In our renewed Darwinian terms, these four forms of social relations are four skill sets or start-up methods which people have innately available to them and on which they can elaborate, according to cultural norms, in order to simultaneously develop and maintain bonded ties and, at the same time, exercise the drive to acquire. The rules that are the essence of each of the four modes define them as a particular kind of social contract. When people are acting in market pricing or hierarchical mode, it is experienced as primarily a competitive relationship, oriented mostly to fulfilling dA. When people are acting in reciprocal or communal sharing mode, it is experienced primarily as a cooperative relationship, oriented mostly to fulfilling dB. Any given relationship between two people will generally have some competitive elements and some cooperative elements. The weighting of these two aspects will depend on the history of the relationship and the immediate context.

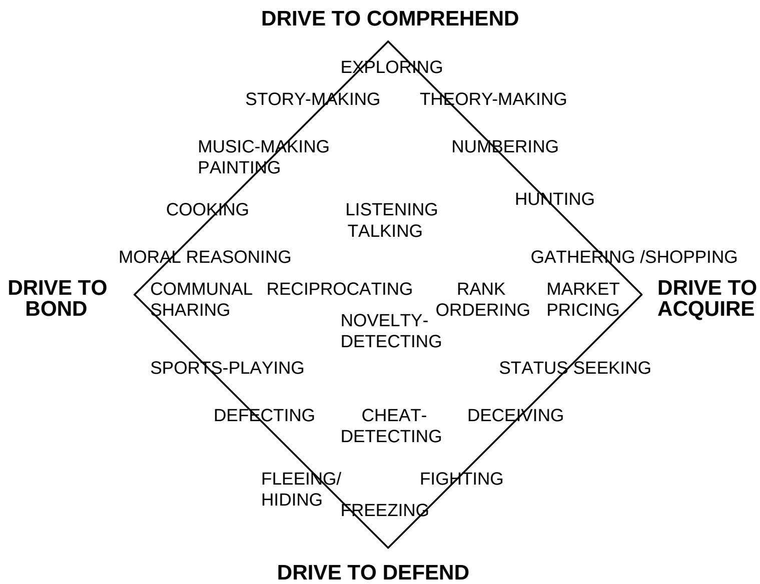
Fiske ends his book by supporting our hypothesized drive to bond as follows: “This relational-models theory construes human beings as inherently sociable. People seek to relate to others in each of the four basic modes…People understand their social life in terms of these four models, and they attempt to impose these relational structures on their social world. People want others to conform to the models.” People can employ all four modes at different times in the same relationship and can develop skill in shifting gracefully from one mode to another. For instance, it is not hard to find examples of college roommates interacting in all four modes in the course of a single day. Fiske concludes: “Consequently, conceptions of social relations, moral judgments, norms and relational motives often coincide. We are social by nature and by culture.”[xxxii]

Fiske’s findings about the four fundamental forms of human sociality have significant implications. For example, mainstream economists define all human relationships in market terms. The relationships between a business firm and its employees, for example, are analyzed as a labor market. Economists who study family relationships analyze them as market transactions. They simply do not recognize the other three patterns of sociality as having any role in their theoretical formulations. This is the inevitable logical consequence of their axiomatic assumption that rational self-interest is the only fundamental driver of human behavior.

In Figure 3.5, a variety of skill sets is arrayed to show how they could help fulfill the four drives.

FIGURE 3.5

SKILL SETS ARRAYED ON A FOUR-DRIVE QUADRANGLE



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The Role of Cultural Memes

Scholars of human behavior have adopted the practice of attaching the term *memes* to culture since it suggests that culture has a bearing on behavior somewhat analogous to that of genes. This term was first suggested by Dawkins and is, I believe, a useful analogy. After all, both genes and culture come in packets of information. They both are carried by individuals and move from generation to generation. To persist over time they both must pass the test of being of service to human survival and reproduction at some place or time**,** or at least of not impeding survival. In this regard, they both follow the Darwinian V/S/R algorithm. Of course, the analogy breaks down entirely when one looks at the substance of genes and of memes and at how they are created and propagated. We now know a fair bit about the substance of genes. But what is the substance of memes? They are in front of us all the time—social norms of behavior, rituals, specific items of belief, all forms of tools and crafts, all forms of art, all forms and styles of buildings, clothing, cooking, dancing, courtship, storytelling, warfare, sports, games and, more recently, science, and the list goes on and on—but we are not accustomed to thinking about them this way. Of course, we all recognize that memes have accumulated and built on one another over thousands of generations. Of course, we all recognize that cultural memes have an enormous influence on our everyday behavior. We cannot imagine human behavior without them. Every minute of every day we are learning new things from the cultural milieu around us. Any theory of human behavior must find a very big place for the influence of culture on our lives. Cultural memes are inside our heads as synaptic patterns that are representations of the external reality. They are a vast reservoir of possible, time-tested ways for all of us to fulfill our ultimate motives, our drives. What a wonderful inheritance! The modules of the prefrontal cortex are able to reach into this storehouse, pull out relevant items, and place them in the mix of our working memory as an essential part of our way of resolving the constant stream of conflicted impulses that require our conscious attention.

Science has now provided us with some dramatic examples of how cultural memes can directly activate and modify the pre-wiring of the brain, even parts of the unconscious brain. Recall Susan Mineka's experiments with monkeys, reported in Chapter 2. Baby monkeys raised in captivity showed none of the terror of snakes seen in all wild monkeys; that is, not until they saw the terror of their mothers at the sight of snakes. Here we saw clearly that a meme, a packet of cultural information (mommy goes nuts when she sees a snake) served to activate an innate phobia in the unconscious brains of the baby monkeys.

For another example, neuroscientists know that human brains attain their largest number of synaptic connections fairly soon after birth and that further development of our brains is primarily carried out by the pruning back of unused connections as well as by the continued refinement and reinforcement of other connections. Small children have an innate capacity to mimic any sound used in any of the vast number of languages of the world. But in any particular language, many of those sounds are not used and the capacity to mimic them gradually disappears, becoming very difficult to regain later in life. Again we see the influence of culture (the language the child hears being spoken) on the substance of the innate skill set for language. It is likely that culture has a similar major influence on the expression of all innate skill sets. After all, such skill sets are only starter kits, meant to provide a head start for the development of a fully mature skill. The cultural milieu will determine which latent skill sets will be activated and when and how they will be further developed. Mozart undoubtedly had an amazing innate musical talent but its mature expression was heavily dependent of his culture's supply of musical instruments and social encouragement.

Neuroscientists can now largely explain how cultural memes are built up and stored in specific places in our cortex and have identified the specific module in the prefrontal cortex, the anterior cingulate module, that pulls the relevant memes into the critical prefrontal dialogue by which all our conscious decisions are made.

In 1945, George Murdock, a leading anthropologist, produced a list of the cultural traits that were practiced in every single one of the several hundred human societies that were documented in the Human Relations Area Files at Yale University. Table 3.1 presents his whole list.

Table 3.1
Murdock's List of Universal Cultural Traits

Age-grading	Family feasting	Magic
Athletic sports	Fire making	Marriage
Bodily adornment	Folklore	Mealtimes
Calendar	Food taboos	Medicine
Cleanliness training	Funeral rites	Obstetrics
Community	Games	Penal sanctions
organization	Gestures	Personal propitiation of
Cooking	Gift-giving	supernatural beings
Cooperative labor	Government	Puberty customs
Cosmology	Greetings	Religious ritual
Courtship	Hair styles	Residence rules
Dancing	Hospitality	Sexual restrictions
Decorative arts	Housing	Soul concepts
Divination	Hygiene	Status differentiation
Division of labor	Incest taboos	Surgery
Dream interpretation	Inheritance rules	Tool-making
Education	Joking	Trade
Eschatology	Kin groups	Visiting
Ethics	Kinship nomenclature	Weather control
Ethnobotany	Language	Weaving
Etiquette	Law	
Faith healing	Luck superstitions	

Each of these sets of cultural memes has obviously passed the test of time, proving to be of significant importance to the entire species. They were each invented by individuals and then elaborated and passed on over the generations. While this evolutionary system of creation, propagation, and retention is different from the genetic system, the parallel development of the two systems makes the case for their intense co-evolution. We can, in some cases, discover how memes serve to activate pre-wired behaviors and we can also see, in other cases, how memes offer culturally evolved *hows* to the four-drive *whats* of behavior**.**

The most comprehensive and up-to-date account of the influence of culture on human behavior has been pulled together by Peter Richerson and Robert Boyd in their book, *Not by Genes Alone: How Culture Transformed Human Evolution.*[xxxiii] While making the points about culture spelled out above, these authors emphasize that it is the human ability to imitate others that makes it possible for humans to so faithfully adopt the cultural memes of their social environments. This capacity to mimic is a special human trait that is only weakly exhibited in the behavior of other primates and other mammals. Richerson has suggested to me in a private communication that imitation should be considered a "fifth" drive. I agree that it is an important human impulse but I believe it is a part of—an expression of—the drive to comprehend discussed in the previous chapter. After all, the pleasure of feeling "I got it" comes not only with an original insight but also with "catching on" to another's idea or skill. In the next chapter, I will discuss how the drive to comprehend could have evolved in parallel with the burst of complex cultural adaptations that are a trademark of our species.

The Role of Individual Personal Histories

The last major input to human behavior is the unique personal history of each human being. The paths we each take are a function of chance opportunities and chance hazards we have each encountered, but are also very much a function of our choices. In fact, I argue that the defining feature of being human is the requirement that we make important choices. The path we each have followed is recorded in memories which, over time, highlight some events and discard many others. Since each person's path through life is different, it is difficult to generalize on this influence, but it must not be forgotten. It is possible to look for patterns of occurrences that have had lasting consequences. Did some set of children experience similar traumatic events that had a similar effect on their later lives? Think of the children who experienced sexual violation by Catholic priests. Did some set of young people have a gifted teacher who awakened some latent skill set that had a defining effect on their subsequent careers? Think of the young dancers who were taught by Martha Graham.

Science is beginning to help look for such patterns by mapping out the brain's normal developmental sequence from the womb to full maturity. Some of this knowledge is providing very helpful insights for parents and others who care for the young. Using MRI scans, researchers have only recently found out some of the specific ways in which the brains of premature babies are less developed at birth than those of full-term infants. Based on these findings, hospital caregivers have developed better care techniques that are already bringing lasting improvements in the later development of these children.[xxxiv]

Similar brain-scanning research has now demonstrated that the last part of the brain to develop into full usage is the prefrontal cortex, which does not develop to full maturity until somewhere between ages 20 and 25.[xxxv] This finding is of great significance. It clarifies why teenagers are particularly prone to risky and impulsive behavior. The brain apparatus that is designed to check and balance impulsive behavior is only slowly coming into full function. The implication is clear: Young people need hands-on, loving guidance in order to avoid making bad mistakes that can plague their entire lives.

With this information in hand, a parent might find reinforcement for conducting a conversation with an eight-year-old son along these lines: "John, I just saw you grabbing your sister's very own toy away from her and now she is crying. (Pause) I want to sit down here with you and quietly ask you some questions about what just happened. I want you to take your time and thoughtfully give me true answers to my questions. Do you love your sister? (Pause) Do you want to hurt her? (Pause) How do you think your grabbing away her toy makes her feel? Do you think it hurt her? (Pause) Did the toy you grabbed belonhg to your sister? (Pause) I understand that you want to play with that toy,. There is nothing wrong about that. But can you think of any way to make that possible, at least part of the time, without hurting your sister whom you have just said you love?"

Such a parent is clearly playing the role of the prefrontal cortex, getting her son's dB drive (to love his sister) to check his impulsive dA drive (to play with his sister's toy). Put in these terms, this hypothetical parent's response seems like a sensible thing to do. But all parents know that this solution is not so obvious when one is caught in a rush of angry emotions upon seeing such blatant bullying behavior on the part of one's own child.

Summary

We are now ready to summarize how the various parts of the unconscious brain and the cognitive parts of the brain each interact with the prefrontal cortex and thereby contribute to conscious choice and behavior. These interactions are best understood by re-examining the schematic diagram in Figure 3.1.

The diagram can be read as follows, starting from the bottom left corner: Current environmental information passes through the sense organs to the sensory areas of the brain. This information may be in the form of cultural cues (such as the raised eyebrow of an elder), observations of something well known (such as a coveted sports car), or observations of a new situation (such as the behavior of an unfamiliar group of people—perhaps one's coworkers at a new job or one's future in-laws). Though our examples will deal with visual information processed through the eyes, the model applies equally to information processed through the ears, nose, skin, and so on. The signals from the sensory areas are passed through the limbic and basal ganglia areas, where the four drives reside. Here these signals are evaluated by the drive modules and pick up emotional markers, according to which of the four drives they activate. Any sensory signal may be loaded with more than one emotional marker, as when the sight of the coveted sports car triggers the dA module to load the signal with a positive evaluation while triggering the dB module to load it with a negative evaluation arising from a sense of bonded obligation to save money and stay safe for the sake of one's family.

These emotionally marked signals are next processed in the prefrontal cortex, starting with the ventromedial and anterior cingulate cortex. The prefrontal cortex has the cognitive capacities to generate potential courses of action that might satisfy the drives. This process is supported by long-term personal memories, skill-sets, and cultural memes summoned up from the rest of the cortex.

Once a tentative action (for example, to postpone buying the sports car) is chosen through the exercise of human will, this signal is fed back through the limbic center to test whether the proposal is at least tolerable to all the four drives. If it at least *satisfices* all four drives, it will pick up the emotional energy provided by the drives. These energized signals are then relayed to motor centers that control the muscles and other bodily parts. The resulting actions are what we recognize as deliberately intended human behavior (such as walking away from the showroom in which the tempting car is being displayed).

These actions in turn generate environmental responses with survival consequences (such as a spouse's loving appreciation along with a lingering regret from forgoing the sports car), a new situation with which the individual must now deal. The impulse/check/balance process has now played itself out. All this can happen very quickly and such cycles are repeated over and over in our everyday lives. We always have mixed emotions and real conflicts of interest facing off in our brains and this is what forces us to make often hard choices. This is what makes us human, highly adaptive hominids.

Some psychologists have, of course, developed competing models of how the parts of the brain work together to generate behavior. Probably the most prominent is the model carefully assembled by Daniel Wegner in his recent book, *The Illusion of Conscious Will.*[xxxvi] Wegner goes into detail on how the same parts of the brain discussed above work together to generate behavior. He, too, emphasizes the roles of the unconscious brain, the emotions, cognition, and so on. After fitting together all the pieces, he sums up his conclusion in the title of his book.

How did the two theories, which agree on almost all of his points, come to such different conclusions? It can be stated simply: Wegner does not hypothesize, as the renewed Darwinian theory does, that the unconscious brain of a normal human contains drives to bond and to comprehend which are frequently in conflict with the older drives to acquire and defend. Wegner implicitly assumes that the innate drives to acquire and to defend are the only drives in humans. If this were an accurate assumption, we would have to agree with Wegner that free will in humans is an illusion. The RD theory does agree with him that some choices made by humans—the unconflicted choices—are determined by automatic processes without any human conscious will or choice being involved (even if the individual feels he or she is exercising conscious deliberate choice after the fact of action). But given the existence, as proposed by the RD theory, of the drives to bond and to comprehend, one is led to the conclusion that we do indeed have significant degrees of freedom to guide our own behavior by deliberate choice. This choice process also means that the specific response one will make to a specific situation is unpredictable, except in terms of probabilities. I invite careful empirical tests of which model of man is the more accurate.

Although James stated the I/C/B formula in a clearer manner, Darwin had earlier signaled his awareness of conflict between instincts (our drives) and the necessity of the resulting choice. "A struggle may often be observed in animals between different instincts."[xxxvii] He also observed that, in humans, this conflict of drives (in our terms) often forced a choice between the pressures of dB and of dA. "[There] is no reason why he [man] should not have retained from an extremely remote period some degree of instinctive love and sympathy for his fellows… It is almost certain that he would inherit a tendency to be faithful to his comrades… be willing to defend, in concert with others, his fellow-men; and would be ready to aid them in any way [dB] which did not too greatly interfere with his own welfare or his own strong desires [dA]." [xxxviii]

This chapter represents an effort to pull together currently available knowledge of how the human brain works. The result is not yet a complete story but it is moving well along in that direction, We can all be amazed at what a truly remarkable organ we possess, capable of dealing with hugely complex problems. Think of the kinds of existential polarities that our brains are potentially able to resolve; the polarity between or concern with personal achievement and with our collective well being, our desire to investigate novel unknown situations and still be safe; our desires for immediate gratification and our concern with longer-term consequences; our need for specialized, differentiated knowledge and skill and our need to integrate these difdfere4nces. Any apparatus that can kelp us resolve these tensions deserves our highest respected. We can hope that as this knowledge builds, we can learn to use our brains closer to their full potential.

Davis Linden has recently written a book entitled, "The Accidental Brain".[xxxix] It is a useful book that does an especially good job of making the latest knowledge about the functioning of individual neurons available to a general audience. But frankly, I do no like its title. Of course, chance exists. Accidental events have certainly influenced the shaping of our brain during its evolution. This is what the variety in Darwin's formula is all about. But the selection part of his formula is by no means an accidental process. As Darwin said, selection rigorously favors the species that finds more adaptive solutions to the challenges its environment presents. There is a clear arrow of direction in this process, a development from less complex to more complex, from less competence to more competence in our mental ability in adapting to environmental complexity and change. This is especially true of our brain Progress in this regard is an historical fact. Our brains have evolved step-by-sep by solving problems the better to ensure our survival and reproduction. The fact that, as Linden points out, all of the newer parts of the brain had to be developed on top of the older brain should lead us all the more to marvel at how ingeniously this handicap has been overcome. In this regard I prefer the title of a great book I read many years ago as a doctoral student, The Wisdom of the Body, by Walter B. Cannon.

The next chapter will present the latest evidence of know our remarkable brain evolved. We will deal with the Wilson's puzzle of how our brain could have evolved the capacity to develop civilizations before civilizations existed. We will need to overcome the belief of many biologists that 'altruism' [their term] could not have evolved in the face of their 'normal' hominids associates whose 'Darwinian' self-centered traits would have lead them to exploit such people to extinction. Without dealing effectively with this roadblock we will fail in establishing a strong case for the existence of dB in humans.

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[xxxviii] Darwin, Descent, p. 112.
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