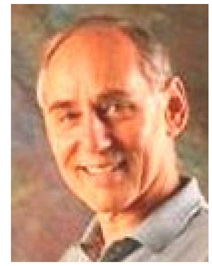
Bringing Oxytocin Into The Room:
Notes On The Neurophysiology Of Conflict



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"We do not see things as they are. We see things as we are."
Anais Nin

While people in conflict commonly refer to facts, behaviors, feelings, personalities, or events, for the most part we ignore the deeper reality that these are processed and regulated by the nervous system, and are therefore initiated, resolved, transformed, and transcended largely within our brains.

All conflicts are perceived by the senses, manifested through body language and kinesthetic sensations, embodied and given meaning by thoughts and ideas, steeped in intense emotions, made conscious through awareness, and may then be resolved by conversations and experiences, and develop into character, nurture a capacity for openness and trust, and contribute to learning and an ability to change.

To explain the etiology of conflict therefore requires us to gain a deeper understanding of how the brain responds to conflict. This should clearly include the ways distrusting personalities are formed, even among primates; the sources of aggressive character traits and the “fight or flight” reflex; the wellsprings of spiritual malaise and hostile gut reactions; and the neurological foundations of forgiveness, open-heartedness, empathy, insight, intuition, learning, wisdom, and willingness to change.

While conflict and resolution have yet to be reduced to a simple set of deterministic biochemical events taking place exclusively within the brain, research clearly demonstrates that basic neurological processes provide all of us with alternative sets of instructions that lead either toward impasse or resolution, stasis or transformation, isolation or collaboration. For these reasons, it will serve us well as mediators to understand more about the neurophysiology of conflict. We have yet to examine communication and conflict resolution very deeply from the perspective of neurophysiology, though we know that the presence of an empathetic listener, particularly one who is skilled in mediation, can by itself create a significant shift in conflict dynamics, and alter, at a subtle level of awareness, the *attitudes* of parties in conflict. But why is this so, and what does it imply for conflict resolution?

For millennia, our greatest sages – particularly those from the East, including Lao Tse, Confucius, and Buddha - have sought to convince us that the universe consists of opposites that, at the deepest level, merge into a single, unified whole. Yet it has taken until the 20th century and the discovery of quantum mechanics – initially by Planck and Einstein, then by Bohr and Heisenberg – to establish *scientifically* that observers and the things they observe are part of a single interconnected system, and reveal how and why the act of observation, at a subtle level, directly influences the object or process being observed. For all our immense progress in recent years in understanding conflict and discovering techniques that encourage resolution, until recently we have paid little attention to the physiology and internal operations of the brain, and the ways it perceives and responds to the complex, ever-changing experience of conflict.

I am not a trained neurophysiologist, but an avid lay reader, and have learned an immense amount of useful information regarding conflict resolution from reading scientific studies of the brain and how it functions. What follows is a brief synopsis of some of the more interesting and important ideas and news items I have read describing recent research and experiments in neurophysiology as they pertain to conflict and the mediation process.

What is the Brain?

Most conflicts are triggered by external experiences and information regarding them is conveyed to us by sensory inputs that have been gathered from our environment. Our conflicts therefore seem to us to take place externally, yet everything we understand about the meaning of what happened, and all of our responses to the actions of others are initiated and coordinated internally by our brains.

What, then, is the brain, how is it structured, and how does it typically respond to conflict? First, the brain has been analogized to a massively powerful parallel processing computer, more powerful than anything we have been able to design or create. One hundred billion nerve cells make up the brain, each of which may create up to ten thousand synaptic connections, and together can form more than a million neuronal connections every second.

An average desktop computer is capable of sending 25 billion instructions per second, while a human brain can send 100 over trillion. An adult human brain, by some accounts, can make as many as 500 trillion synaptic connections per second. This, by itself, can explain what we commonly refer to as intuition, which is merely what we know that we don't know that we know.

Second, the brain is divided into two halves or hemispheres that are largely separate, but connected at the base by a corpus collossum. Each hemisphere processes information regarding conflict somewhat differently: one side functions linearly and considers problems individually and in detail, while the other side works more holistically and considers problems collectively and as a whole. One side favors logical reasoning while the other side favors pattern perception; one works by linear thinking while the other practices emotional responsiveness. The right hemisphere, for example, has been shown to be more adept at discriminating between emotional expressions and processing negative emotions, while the left is demonstrably less so, and more involved in processing positive emotions.

Third, the brain is organized into regions, each of which processes different aspects of the information it receives related to conflict in specialized ways. For example, the ventral tegmental area reinforces the reward circuit; the prefrontal cortex allows for objectivity and logic; the nucleus accumbens, which is directly beneath the frontal cortex, releases oxytocin, which is described in greater detail below; the hypothalamus produces testosterone; and, most importantly, the amygdala, an almond-shaped region near the brain stem, regulates immediate responses to conflict and change, especially anger and fear.

Neurotransmitters and Conflict

The brain is awash in chemicals, including hormones and neurotransmitters that accentuate or dampen its responses and influence its organization and operations. Neurotransmitters are chemicals that relay, amplify, or modulate signals that are sent between neurons and other cells. There are many different hormones and neurotransmitters, of which the most important are glutamate and GABA, which excite and modify synapses. With regard to conflict, the following compounds seem to be most active:

- Adrenalin, which triggers the fight or flight response
- Testosterone, which stimulates aggression
- Oxytocin which instills trust, increases loyalty, and promotes the “tend and befriend” response
- Estrogen, which triggers the release of oxytocin
- Endorphins, which reinforce collaborative experiences with pleasure
- Dopamine, which generates a reward response and fortifies addiction
- Serotonin, which regulates moods
- Phenylethylaline, which induces excitement and anticipation
- Vasopressin, which encourages bonding in males in a variety of species

Many vertebrate brain structures involved in the control of aggression are richly supplied with receptors that bind with hormones produced in the endocrine system, in particular with steroidal hormones produced in the gonads. In a wide range of vertebrate species, there is a strong relationship between male aggressiveness and circulating levels of androgens such as testosterone, a hormone produced in the testes.

These aggressive behavioral patterns and the modulation of an animal's tendency to fight or flee are controlled by a hierarchical system of neural structures. Many of these are found in the limbic system; a part of the forebrain that is involved in emotionally based behavior and motivation. These neural structures interact with biochemicals that are produced inside and outside the nervous system.

For example, it has been shown that serotonin injections cause lobsters and other animals to take a dominant or aggressive posture, while octopamine injections induce submissive postures, which favor cooperation. When serotonin levels are increased in subordinate animals, their willingness to fight also increases, and declines as they are reduced.

From fish to mammals, aggression levels have been shown to rise and fall with natural fluctuations in testosterone levels. Castration has been found to reduce aggression dramatically, while the experimental reinstatement of testosterone by injection restores aggression. Circulating testosterone also influences the responses and signals that are used during mating and fighting in many species. In stags, the neck muscles needed for roaring enlarge under the influence of testosterone, while in male mice, the scent of another male's urine, which contains the breakdown products of testosterone, elicits intense aggressive responses.

In pregnant female mice, the scent of urine from a male that is ill can even induce the formation of antibodies in their embryos, and the presence of stress chemicals that are increased by fighting and are detected by females who are able to detect the smell of male urine can produce personality and behavioral changes in unborn offspring.

The experience of fighting has been shown to have a significant impact on brain biochemistry and therefore on brain structure, especially in the limbic system which is strongly associated with conflict. For example, among rainbow trout and lizards, dominant animals show significant transient activation of their brains’ serotonin systems, whereas subordinate animals display a longer-term elevation of these systems.

Researchers have shown in several vertebrate species that electrical stimulation of the midbrain and hindbrain elicits stereotyped, yet undirected aggressive behaviors, while stimulation of the hypothalamus and a nearby pre-optic region in the forebrain elicits well-coordinated attacks on other members of the same species. Lesions in these areas have also been shown to reduce aggression.

The hypothalamus and pre-optic area of the forebrain are also involved in the generation of coordinated aggressive behaviors that are produced in lower brain regions. This activity is modulated by the brain’s higher centers, including areas of the limbic system – in particular the septum, which lies above the hypothalamus and has an inhibitory effect on aggression, while the amygdala located deep in the temporal lobes has the opposite effect.

In a series of experiments, dogs and monkeys have been shown to respond negatively to favoritism and unfairness in experiments where certain animals have been given rewards without having performed, causing others to punish them or refuse to cooperate with researchers. The lateral habenula has been shown to react strongly when expected rewards are denied or replaced by mild punishments. Dopamine neurons are inhibited by the habenula, and since dopamine contributes to learning by producing positive sensations in response to success, researchers now think the habenula may also contribute to learning by shutting off dopamine in response to disappointment, representing an internal form of the carrot and the stick. Some research suggests that the habenula is implicated in depression. It has also been shown that the orbitofrontal cortex (OFC), located at the front of the brain behind the eyes, reacts to mistakes and helps us alter our behaviors in response. Researchers have established that the negative emotions we routinely encounter in conflict are triggered in more or less the following sequence:

- Sensory information from primary receptors in the eye, nose, ear, and other organs travels along neural pathways to the limbic forebrain.
- These stimuli are evaluated for emotional significance. Research by Joseph E. LeDoux has demonstrated that auditory fear conditioning involves the transmission of sound signals through an auditory pathway to the thalamus, which relays this information to the dorsal amygdala.
- The amygdala coordinates a “relevance detection” process that is rapid, minimal, automatic, and evaluative.
- Emotions are then activated in the subcortical thalamo-amygdala pathway and relayed from the thalamus to the neocortex for cognitive appraisal and evaluation.
- In some cases, the same information is simultaneously sent to the neocortex for slower processing, creating a dual, two-circuit pathway that permits reason to override an emotional response.

Perception, Mirror Neurons and Suggestibility

The brain notices changes in its immediate environment predominantly by contrast or comparison against a relatively static backdrop of familiarity, expectation, desire, fear, and habit. Observing the contrast between what is moving and what is not is the way our minds attempt to simplify and predict what is likely to happen next. At a primitive level, for example, there is an immense evolutionary advantage in being able to notice a potential threat by contrasting the mirror symmetry of a predator’s face and eyes, or sudden movement against an asymmetrical, slower moving background. In a similar way, we are biased by evolution to credit threatening behaviors more than non-threatening ones. A number of recent brain studies have revealed how perceptions and memories are profoundly distorted by emotions and by focused concentration, and how they can be reshaped by suggestion and subsequent events. Thus, areas of the brain that are linked with negative emotions and judging others are switched off, for example, when mothers look at photographs of their babies. Instead, the right prefrontal cortex lights up, not only in parents watching their children, but in lovers and Buddhist monks who have been asked to meditate on loving-kindness and compassion. In other research, memory and awareness have been shown to decline dramatically in the presence of stress chemicals that are released during periods of intense emotion. It has also been revealed, in reverse, that the free expression through outward signs of an emotion can intensify it, while repressing or not expressing it, as far as is possible, can soften it. Thus, experiments have shown that if people are able to control their facial expressions during moments of pain, there is less arousal of the autonomic nervous system and an actual diminution of the pain experience.

In one delightful experiment, a significant percentage of people who were assigned to focus their attention on a single task, such as counting the number of individuals in a colored tee-shirt to whom a basketball was passed. When they did so, the participants completely ignored and even vigorously denied afterwards that an unusual or bizarre occurrence had occurred, in this case, the entry onto the basketball court of someone dressed in a gorilla outfit, who walked and pranced across their line of vision.

Scientists have begun to trace the development of empathy in primates, including human beings, leading to the discovery of “mirror neurons,” which fire in the brains of observers watching a given action, and replicate to some extent the experience of the one being observed. Similar neurons fire when we observe someone else suffering or frightened, reproducing those experiences in the form of empathy.

In one surprising recent experiment, “phantom limb syndrome,” in which a lost limb may experience itching or pain, has been shown to dramatically disappear when the subject is allowed to observe a false image of the lost limb by means of a mirror, thereby tricking the brain’s mirror neurons into thinking that the lost arm or leg had reappeared.

Several studies have shown that the brain is highly responsive to suggestion. In a series of remarkable experiments it has been shown that the performance of simple, seemingly unrelated tasks can be increased or decreased merely by placing a briefcase or sports equipment nearby, triggering unconscious associations with work or play.

In an interesting study, subjects were made happy or angry, then shown happy and angry faces and friendly and hostile interpersonal scenes in a stereoscope. Happy subjects perceived more happy faces and friendly interpersonal scenes while angry subjects perceived more angry faces and hostile interpersonal scenes. In addition, it has been shown that relatively small favors or bits of good luck (like finding money in a coin telephone or getting an unexpected gift) induced positive emotion in people, and that these emotions increased the subjects' inclination to sympathize or provide help.

At the same subtle level, a number of experiments have shown that behaviors can be modified simply by the introduction of background scents such as lavender, or the lemony odor of detergent, and that consumers of different products purchase different products more or less readily in the presence of certain scents. Equally dramatically, test results can be predictably raised or lowered merely by asking people of color to identify their race beforehand, or by giving indirect racial or emotional cues, or by priming teachers falsely in advance of a test regarding the innate intelligence or stupidity of their students, producing conformance with expectations and a well-established “Pygmalion effect.”

In one remarkable study, when 12- and 13-year-old African American students were asked to spend 15 minutes indicating which values, such as friendship or family, they upheld, the achievement gap between them and white students decreased by 40%. Similarly, when female college students read passages before a test arguing against gender differences in mathematical ability, their scores increased by 50%.

At a very subtle level, Yale University psychologist John Bargh found that when volunteers were “primed” with words associated with the elderly, like “wrinkle,” they took significantly longer to walk down a hall than those who hadn’t. And interestingly, for conflict resolvers, Alex Pentland of the MIT Media Lab found that watching body language and tone of voice for only a few minutes allowed researchers to predict with 87% accuracy the outcome of subsequent negotiations between strangers. This suggests that the brain can be re-programmed by consciously selected practices. It has been shown, for example, that the ventromedial prefrontal cortex (which is responsible for empathy, compassion, shame, and intuitive emotional responses to moral dilemmas) can be significantly strengthened by the practice of meditation, or merely thinking compassionately for a few moments about the well being of others.

Other experiments have demonstrated that men become more loving toward their female partners as their ovulation approaches, that women prefer different forms of male attractiveness at different stages in their menstrual cycle, and that women make decisions about male attractiveness based on chemical indicators in their sweat indicating that they have immunities the women do not, as measured by genes for the major histocompatibility complex or MHC. Other studies have found that men also prefer women with dissimilar MHC genes, specifically human leukocyte antigen or HLA genes.

An important recent study from Stockholm suggests that lesbian women have more asymmetric brains, like heterosexual men, and that gay men have more symmetric brains, like heterosexual women. Moreover, in heterosexual women and gay men the amygdala connects mainly to areas of the brain that manifest fear as anxiety, whereas in heterosexual men and lesbian women it connects more strongly to areas that trigger the fight or flight reflex. It has also been shown that sweat from women who watched violent movies was accurately rated by others as stronger, less pleasant, and smelling more “like aggression” than sweat from women who had watched a neutral movie. In a recent study, researchers from Stony Brook University in New York taped absorbent pads to the underarms of 40 volunteers who went on their first skydive. In a double blind experiment, a second group smelled sample pads from them and from non-skydivers in an fMRI scanner, and showed increased activity in their amygdala and hypothalamus while breathing sweat produced under frightening conditions, indicating that humans may in fact be able to smell fear.

Oxytocin and Dual Pathways in Conflict

The physical basis for collaboration, altruism, trust, forgiveness, and interest-based conflict resolution techniques, has been clearly identified with the "tend and befriend" hormone oxytocin. Oxytocin was first synthesized by Vincent du Vigneaud in 1953, for which he received the Nobel Prize for Chemistry in 1955. It is secreted by the posterior lobe of the pituitary gland and can be made synthetically. Physiologically, it promotes the secretion of breast milk and stimulates the contraction of the uterus during labor. It cannot be ingested orally, but can be administered intravenously, sublingually, or by nasal spray, although its strongest effects last only for a few minutes.

Oxytocin is widely believed responsible for prompting empathy, compassion, trust, generosity, altruism, parent-child bonding, and monogamy in many species, including human beings. Oxytocin has been dubbed the "bonding" hormone, primarily as a result of research involving voles. Prairie voles in the U.S. are largely monogamous and the males provide care for the young. Montane voles, on the other hand, are polygamous and the males are less caring of their young. Experiments have deprived prairie voles of oxytocin and provided it to montane voles, causing a dramatic reversal of these behaviors.

In one extraordinary study, participants were given a small amount of pretend money and encouraged to invest it with a stranger. On average, they initially invested only a quarter to a third of the money they possessed. But after four sniffs of the neurotransmitter oxytocin, their trust levels skyrocketed, and without hesitation they became willing to invest 80% more. Here is a summary from the original study:

"Human beings routinely help strangers at costs to themselves. Sometimes the help offered is generous—offering more than the other expects. The proximate mechanisms supporting generosity are not well understood, but several lines of research suggest a role for empathy. In this study, participants were infused with 40 IU oxytocin (OT) or placebo and engaged in a blinded, one-shot decision on how to split a sum of money with a stranger that could be rejected. Those on OT were 80% more generous than those given a placebo. OT had no effect on a unilateral monetary transfer task dissociating generosity from altruism. OT and altruism together predicted almost half the interpersonal variation in generosity. Notably, OT had twofold larger impact on generosity compared to altruism. This indicates that generosity is associated with both altruism as well as an emotional identification with another person."

[Zak PJ, Stanton AA, Ahmadi S (2007) Oxytocin Increases Generosity in Humans. PLoS ONE 2(11): e1128. doi:10.1371/journal.pone.0001128]

Several experiments have shown that positive emotion facilitates creative problem solving. One study, for example, showed that positive emotion enabled subjects to name more uses for common objects. Another showed that positive emotion enhanced creative problem solving by enabling subjects to see relations among objects that would otherwise have gone unnoticed. A number of studies have demonstrated the beneficial effects of positive emotion on thinking, memory, and action in preschool and older children.

A recent study by a group in Zurich, Switzerland showed that oxytocin improves recognition and memory of previously presented faces, which were more correctly assessed as being "known," but the ability to recollect faces that had not been seen before was unchanged, and there was no difference when recalling images of houses, landscapes or sculptures. The researchers argue that "this pattern speaks for an immediate and selective effect of the peptide [oxytocin in] strengthening neuronal systems of social memory."

There is a considerable body of research that has linked oxytocin with collaboration and creative problem solving, and these with the release of endorphins, the brain's version of morphine. Creative problem solving has also been shown to increase with diversity, and a mathematical proof has been offered purporting to demonstrate that more diverse groups predictably experience greater creativity, success in problem solving, and satisfaction as a result.

Thus, the brain possesses not one, but *two* systems for responding to conflict, and is capable both of adrenalin-based "fight or flight" responses, and of oxytocin-based "tend and befriend" ones. Just as, in biology, there are evolutionary advantages to aggression and "selfish genes," there are also advantages to collaboration and altruistic efforts that aid others. There are two bundles of nerves, for example, that connect the eye and other sensory organs with the brain. One travels directly to the amygdala where fight or flight responses are initiated, while the other proceeds to the neocortex where logical explanations can be discovered, allowing us to override costly adrenalin-based responses.

As we learn, develop language, mature, and accumulate long-term memories and experiences, these dual pathways to the amygdala and the neocortex become more developed and integrated, and we become able to process events in either or both pathways at the same time.

This duality allows the amygdala pathway to specialize in processing information that may require a rapid response, while the neocortex pathway specializes in evaluating information that may be important in forming cognitive judgments or developing complex coping strategies. Duality also allows us to by-pass the amygdala's initiation of the fight or flight response and consciously choose the less aggressive option of tend and befriend.

Moreover, the brain not only dictates how we respond to changes in our environment, it is actually *shaped* and molded by those changes. The brain requires sensory stimulation in order to develop, and repeated stimulation creates physical connections between neurons that strengthen the pathways and networks responsible for thoughts, feelings, and behaviors.

These stimulations have been shown to produce profound attitudinal changes. Indeed, several experiments have demonstrated that countless previous experiments on laboratory mice and rats over the course of decades have been profoundly influenced by whether the animals were raised in rich or impoverished environments.

The environment in which a young animal is raised also has a profound effect on whether and how it fights as an adult. These environmental factors are not always directly related to social experience. For example, mice that are deprived of food during their early development become particularly aggressive as adults. On the other hand, environmental effects on the development of aggression may depend on social interactions in contexts other than fighting; for instance, mouse pups that have been roughly handled by their mothers are more aggressive as adults. Similar results have been found in a range of species that have been reared in social isolation.

More surprisingly, physical tests have revealed that babies are able to rewire their mothers' brains *in utero,* and that some of the genetic material and cells of each remain in the other and may influence a variety of behaviors, including a tendency to aggression or collaboration.

Is Aggression Inevitable?

Clearly, aggression and war are "hard-wired" into the brain, but so are empathy and collaboration. Recent research has emphasized the cooperative aspects of warlike behavior, which forms a core element not only in gangs, but sports teams, organizations and nation states, which use internal cooperation as an aid to external competition. Indeed, modern warfare can be seen as requiring a high level of internal collaborative activity.

Yet it has also been shown, for example by researchers at the University of Edinburgh, that men in war simulations tend to overestimate their chances of winning, making them more likely to attack and behave aggressively, and leading to unnecessary losses that a more sober calculation might predict.

It has recently been argued by evolutionary biologists at the University of New Mexico, based on data from 125 civil wars, that cultures become more insular and xenophobic when diseases and parasites are common, perhaps in an effort to drive away strangers who may carry new diseases. By contrast, cultures with a low risk of disease are more open to outsiders. They argue that when the risk of infectious diseases fell in Western nations following World War II due to antibiotics and sanitation, these societies became less hostile and xenophobic.

In one interesting experiment, cricket players on the Caribbean island of Dominica experienced a surge in testosterone and aggressive behavior after winning against another village, but did not experience the same surge when winning against a team from their own village. Similarly, it has been shown that an increase in testosterone typically experienced by men in the presence of a potential mate is muted if she is in a relationship with a relative or friend.

This suggests again that building empathy and "identification with the enemy" will prove useful as techniques for countering aggressive behavior. There is also research suggesting that whereas women may be better at brokering harmony within groups, men may be better at making peace between groups. These techniques suggest that it may be possible to identify more precisely which approach will work best in a given setting to reduce warfare and aggression.

Implications for Conflict Resolution

These are just a few of the more dramatic conclusions that have emerged from countless studies and experiments, from which I have culled those that seemed most interesting and significant based on my experience as a mediator. What, then, does all this research suggest for conflict resolution?

In the first place, it reinforces the idea of brain "plasticity," indicating that the brain is not fixed but evolving, learning, and producing new synapses all the time, even among those who were previously considered elderly and incapable of doing so. Among other things, this gives us hope, and explains why it is possible for people to switch suddenly from aggression to collaboration.

Second, it suggests that a variety of techniques might be useful in reducing adrenalin, increasing oxytocin, and stimulating collaboration and trust. One clear example is research that involves what we call "mirroring," but in scientific literature is called mimicry, and sometimes included under the heading of persuasion. It has been demonstrated, for example, in human subjects, that mirroring body language after a two second delay (so it is not recognized as mimicry by the subject) improves the outcomes of negotiations and encourages collaborative behavior.

In reading each of these studies and experiments, we can imagine a number of subtle ways we might go about encouraging a shift in the attitudes of disputants toward problem solving and collaboration. For example, it is clear by hindsight that a number of very common simple techniques, such as welcoming, introductions, reaching agreement on ground rules, caucusing, summarizing, and securing small agreements, will predictably reduce the release of adrenalin and stimulate the release of oxytocin. This may cause us to wonder: what deeper results might we achieve by better understanding how the brain processes and overcomes the fight or flight response?

Even basic information about neurophysiology can lead us to technique, for example, by allowing mediators to work directly with different hemispheres of the brains of conflicted parties, not only presenting information in ways that are more accessible to one hemisphere or the other, but by focusing attention, for example, on the eye that feeds information to a particular hemisphere that may be more receptive to it.

Other quite subtle techniques might also have an impact on the brain chemistry of conflict, including the introduction of scents that remind people less of fear than of social connection, serving chocolate to stimulate the production of dopamine, placing objects that stimulate positive emotions inside the mediation room, asking questions about values to orient people to their highest standards, using body language to trigger mirror neurons, or offering positive acknowledgments regarding something each party did or said.

None of this is meant to suggest that oxytocin should be administered in large and continuous doses to parties in mediation, or that we should slip into clever, yet inevitably crass forms of physical manipulation. Rather, it is to say that we have been working with brain chemicals unconsciously for years, and it is now possible for us to begin thinking about conflict resolution more scientifically and using the information we gather to encourage more positive responses, being careful to build transparency, empowerment, and authenticity into the process.

Conclusion

Perhaps the most extraordinary thing about the human brain is its capacity to understand and alter the world, starting with itself. We have begun a period of rapid, perhaps exponential increase in understanding how the brain operates, and a growing ability to translate that knowledge into practical techniques. But without an equally rapid, equally exponential increase in our ability to use that knowledge openly, ethically, and constructively, and turn it into successful conflict resolution experiences, our species may not be able to collaborate in solving its most urgent problems, or indeed, survive them.

All of the most significant problems we face, from war and nuclear proliferation to terrorism, greed, and environmental devastation, can arguably be traced to our brain’s automatic responses to conflict. Out of the last few years of neurophysiological research has emerged a new hope that solutions may indeed be found to the chemical and biological sources of aggression. These solutions require not only a profound understanding of how the brain works, but a global shift in our attitude toward conflict, an expanding set of scientifically and artistically informed techniques, a humanistic and democratic prioritization of ethics and values, and a willingness to start with ourselves.