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ARTICLE

Wounds That Time Won't Heal: The Neurobiology of Child Abuse

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Neuropsychologist Teicher reveals the alarming connections scientists are discovering between child abuse—even when it is psychological, not physical—and permanent debilitating changes in the brain that may lead to psychiatric problems. The discoveries are a wake-up call for our society, but they may also hold hope for new treatments for abused children and the adults that they become.

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by Martin H. Teicher, M.D., Ph.D.

Wounds That Time Won't Heal: The Neurobiology of Child Abuse

We easily understand how beating a child may damage the developing brain, but what about the all-too-common psychological abuse of children? Because the abuse was not physical, these children may be told, as adults, that they should just "get over it."

But as developmental neuropsychiatrist Martin H. Teicher reveals, scientists are discovering some startling connections between abuse of all kinds and both permanent debilitating changes in the brain and psychiatric problems ranging from panic attacks to post-traumatic stress disorder. In these surprising physical consequences of psychological trauma, Teicher sees not only a wake-up call for our society but hope for new treatments.

We know that the abuse or neglect of children is tragically common in America today. Nor are most of us surprised when studies point to a strong link between the physical, sexual, or psychological maltreatment of children and the development of psychiatric problems. To explain how such problems come about, many mental health professionals resort to personality theories or metaphors. Perhaps the child's adaptive or protective mechanisms have become counterproductive or self-defeating in the adult. Perhaps childhood abuse has arrested psychosocial development, leaving a "wounded child" within the adult. Although such explanations may offer genuine insight and may support patients in therapy, too often they instead minimize the impact of early abuse. They make it easy to reproach the victims, to say, in so many words, "Get over it."

Research on the effects of early maltreatment, including the work of my colleagues and myself at McLean Hospital in Belmont, Massachusetts, appears to tell a different story: that early maltreatment, even exclusively psychological abuse, has enduring negative effects on brain development. We see specific kinds of brain abnormalities in psychiatric patients who were abused as children. We are also beginning to understand how these abnormalities may account directly for the personality traits and other symptoms that patients manifest.

With *The Etiology of Hysteria* (1896), Sigmund Freud first introduced the topic of childhood sexual abuse in a scientific context. He was convinced that, as children, many of his patients had been sexually abused by their parents, older siblings, or

other relatives. Furthermore, he claimed, based on his new analytical method, that their hysterical and neurotic symptoms could be traced directly to repressed memories of that early abuse. This hypothesis marked the birth of psychoanalysis. Freud later retreated from this theory, though, refusing to believe that childhood abuse could be as prevalent as he had initially claimed. He evolved the more complex theory that "memories" of early sexual abuse were merely repressed childhood fantasies. This theory has so swayed psychiatry for almost a century that it has largely blinded us to the frequency of real abuse in psychiatric patients' childhoods and to the role of abuse in psychopathology.

Episodes of serious neglect and physical abuse are featured regularly in the news, constantly reminding us of the horrifying cruelty adults inflict on children.

Physical abuse of children by their parents remained a hidden problem until 1962, when C. Henry Kempe published *The Battered Child Syndrome,* and an avalanche of publicity led to the enactment of child abuse reporting laws. During the 1970s, case reports of sexual abuse and incest appeared with increasing frequency in medical literature. By the 1980s, scientifically valid studies of the incidence and consequences of childhood sexual abuse were being published.

Today, episodes of serious neglect and physical abuse are featured regularly in the news, constantly reminding us of the horrifying cruelty adults inflict on children. In separate surveys in San Francisco, Los Angeles, and Canada, and of college students in New England and Texas, the percentage of women reporting sexual abuse during childhood ranged from 19 to 45. The medical literature is replete with research on this problem; clinicians, supersensitized to it, increasingly suggest that childhood abuse lies behind a patient's problem, even in the absence of direct evidence. Despite occasional hysteria and misuse of the diagnosis, however, the problem is all too real.

It is our hope that as we identify the specific physiological pathways by which abusive experiences alter brain development, our society will take more seriously the challenge of uprooting the violence against the children in our midst.

A HARVEST OF PSYCHIATRIC DISORDERS

Physical, sexual, and psychological trauma in childhood may lead to psychiatric difficulties that show up in childhood, adolescence, or adulthood. The victim's anger, shame, and despair can be directed inward to spawn symptoms such as depression, anxiety, suicidal ideation, and post-traumatic stress, or directed outward as aggression, impulsiveness, delinquency, hyperactivity, and substance abuse.[1]

Childhood trauma may fuel a range of persistent psychiatric disorders. One is somatoform disorder (also known as psychosomatic disorder), in which patients experience physical complaints with no discernible medical cause. Another is panic

disorder with agoraphobia, in which patients experience the sudden, acute onset of terror and may narrow their range of activities to avoid being outside, especially in public, in case they have an attack.

More complex, difficult-to-treat disorders strongly associated with childhood abuse are borderline personality disorder[2] and dissociative identity disorder[3] Someone with borderline personality disorder characteristically sees others in black-and-white terms, first putting them on a pedestal, then vilifying them after some perceived slight or betrayal. Such people have a history of intense but unstable relationships, feel empty or unsure of their identity, often try to escape through substance abuse, and experience self-destructive impulses and suicidal thoughts. They are plagued by anger, most often directed at themselves.

Initially identified in combat veterans, PTSD seems to result as well from natural disasters, child abuse, and other devastating experiences. People with PTSD keep re-experiencing the traumatic event in waking life or in dreams, and they actively avoid situations that might bring back memories of the trauma.

In dissociative identity disorder, formerly called multiple personality disorder (the phenomenon behind Robert Louis Stevenson's "Dr. Jekyll and Mr. Hyde"), at least two seemingly separate people occupy the same body at different times, each with no knowledge of the other. This can be seen as a more severe form of borderline personality disorder. In borderline personality disorder, there is one dramatically changeable personality with an intact memory, as opposed to several distinct personalities, each with an incomplete memory. People with dissociative identity disorder have two or more (on average, eight to fifteen) personalities or personality fragments that control their behavior at different times. Often there is a passive, depressed primary identity who cannot remember personal history as fully as can the other more hostile, protective, or controlling identities.

Post-traumatic stress disorder (PTSD) afflicts some people who have undergone a traumatic event involving serious injury or a threat to life or limb. Initially identified in combat veterans, PTSD seems to result as well from natural disasters, child abuse, and other devastating experiences. People with PTSD keep re-experiencing the traumatic event in waking life or in dreams, and they actively avoid situations that might bring back memories of the trauma. They may also suffer a general numbing of their responsiveness, show diminished interest in significant activities, restrict the range of their emotions, or have feelings of detachment or estrangement from others. Finally, they may also experience increased arousal (such as difficulty falling or staying asleep), irritability or outbursts of anger, difficulty concentrating, hyper vigilance, and an exaggerated startle response.

ABUSE AND THE DEVELOPING HUMAN BRAIN

For a century or more, scientists have hotly contested the relative importance of experience versus genetic endowment in the development of the brain and behavior. We know now that our genes provide the foundation and overall structure of our brain, but that its myriad connections are sculpted and molded by experience. Based on animal studies, scientists have long believed that early deprivation or abuse may result in neurobiological abnormalities, but until recently there has been little evidence for this in humans.

Observing parallel outcomes in animals and people has bolstered our belief that trauma causes brain damage, not the other way around.

Then, in 1983, A. H. Green and his colleagues suggested that many abused children evidenced neurological damage, even without an apparent or reported head injury. Interestingly, although minor neurological disturbances and mild brain-wave abnormalities were more common in children who had been abused than in those who had not, Green and his colleagues did not believe that the abuse had caused them. Instead, they saw these neurological disturbances as a possible additional source of trauma, amplifying the damaging impact of an abusive environment. In 1979, R. K. Davies reported that in a sample of 22 patients involved as a child or as the younger member in an incestuous relationship, 77 percent had abnormal brain waves and 36 percent had seizures. In Davies's interpretation, however, these children were more vulnerable to being sexually abused by family members because of their neurological handicap.

My hypothesis is that the trauma of abuse induces a cascade of effects, including changes in hormones and neurotransmitters that mediate development of vulnerable brain regions. Testing this hypothesis in humans is difficult because abuse is not always a random act. If we observe an association between a history of abuse and the presence of a physical abnormality, the abuse may have caused that abnormality. But it is also possible that the abnormality occurred first and elevated the likelihood of abuse, or that the abnormality ran in the family and led to more frequent abusive behavior by family members or other relatives. To try to sort out these competing hypotheses, we conducted studies of analogous early stress in animals, where the potentially confusing elements can be carefully controlled. Observing parallel outcomes in animals and people has bolstered our belief that trauma causes brain damage, not the other way around.

A CONSTELLATION OF ABNORMALITIES

Our research (and that of other scientists) delineates a constellation of brain abnormalities associated with childhood abuse. There are four major components:

Limbic irritability, manifested by markedly increased prevalence of symptoms

suggestive of temporal lobe epilepsy (TLE) and by an increased incidence of clinically significant EEG (brain wave) abnormalities.

Deficient development and differentiation of the left hemisphere, manifested throughout the cerebral cortex and the hippocampus, which is involved in memory retrieval.

Deficient left-right hemisphere integration, indicated by marked shifts in hemispheric activity during memory recall and by underdevelopment of the middle portions of the corpus callosum, the primary pathway connecting the two hemispheres.

Abnormal activity in the cerebellar vermis (the middle strip between the two hemispheres of the brain), which appears to play an important role in emotional and attentional balance and regulates electrical activity within the limbic system.

Let us look briefly at the main evidence for each of these abnormalities.

Epilepsy-Like Symptoms

People with temporal lobe epilepsy (TLE)—.25 percent to .5 percent of the U.S. population—have seizures in the temporal or limbic areas of the brain. Because these areas constitute a sizable, varied part of the brain, TLE has a veritable catalog of possible symptoms, including sensory changes such as headache, tingling, numbness, dizziness, or vertigo; motor symptoms such as staring or twitching; or autonomic symptoms such as flushing, shortness of breath, nausea, or the stomach sensation of being in an elevator. TLE can cause hallucinations or illusions in any sense modality. Common visual illusions are of patterns, geometric shapes, flashing lights, or "Alice-in-Wonderlandlike" distortions of the sizes or shapes of objects. Other common hallucinations are of a ringing or buzzing sound or repetitive voice, a metallic or foul taste, an unpleasant odor, or the sensation of something crawling on or under the skin. Feelings of déjà vu (the unfamiliar feels familiar) or jamais vu (the familiar feels unfamiliar) are common, as is the sense of being watched or of mind-body dissociation—the feeling that one is watching one's own actions as a detached observer. Emotional manifestations of temporal lobe seizures usually occur suddenly, without apparent cause, and cease as abruptly as they began; they include sadness, embarrassment, anger, explosive laughter (usually without feeling happy), serenity, and, quite often, fear.[4]

Emotional manifestations of temporal lobe seizures usually occur suddenly, without apparent cause, and cease as abruptly as they began; they include sadness, embarrassment, anger, explosive laughter (usually without feeling happy), serenity, and, quite often, fear.

TLE is difficult to diagnose because its symptoms can mimic those of other psychiatric and nonpsychiatric illnesses. The characteristic electrical discharge of TLE can be observed only in an electroencephalogram (EEG) during a seizure that is close enough to the brain's surface to be picked up by scalp electrodes. Without this

objective EEG data, a diagnosis must be based on the frequency and severity of symptoms and the ruling out of other likely causes of those symptoms.

To explore the relationship between early abuse and dysfunction of the temporolimbic system, we devised the Limbic System Checklist-33 (LSCL-33), which calibrates the frequency with which patients experience symptoms of temporolimbic seizures.[5] We studied 253 adults who came to an outpatient mental health clinic for psychiatric assessment; slightly more than half reported having been abused physically, sexually, or both. Compared to patients who reported no abuse, average LSCL-33 scores were 38 percent greater in the patients with physical (but not sexual) abuse, and were 49 percent greater in the patients with sexual (but not other physical) abuse. Patients who acknowledged both physical *and* sexual abuse had average scores 113 percent greater than patients reporting no abuse. Males and females were similarly affected by abuse.

As we expected, abuse before age 18, when the brain is still rapidly developing, had a greater impact on limbic irritability than later abuse. Patients physically or sexually abused after age 18 had scores not significantly different from nonabused patients. Patients with both physical and sexual abuse, however, were strongly affected regardless of when the abuse occurred, and those first abused after age 18 were almost as affected as those first abused earlier.

Brain Wave Abnormalities

Our second study tried to ascertain whether childhood physical, sexual, or psychological abuse was associated with specific evidence of neurobiological abnormalities. We reviewed the records of 115 consecutive admissions to a child and adolescent psychiatric hospital to search for a link between different categories of abuse and evidence of abnormalities in brain-wave studies. We found clinically significant brain-wave abnormalities in 54 percent of patients with a history of early trauma but in only 27 percent of nonabused patients. Among patients who had been abused, abnormal EEG findings were observed in 43 percent of those with psychological abuse; 60 percent of the sample with a reported history of physical abuse, sexual abuse, or both; and 72 percent of the sample in which serious physical or sexual abuse had been documented. The overall prevalence of abnormal EEG studies in patients with a significant history of abuse or neglect was the same for boys and girls and for children and adolescents.

The salient specific difference between abused and nonabused patients was in left-sided EEG abnormalities. In the nonabused group, left-sided EEG abnormalities were rare, whereas in the abused group they were much more common, and more than twice as common as right-sided abnormalities. In the psychologically abused group, all the EEG abnormalities were left-sided.

To dig deeper into the possibility that abuse may affect development of the left hemisphere, we looked for evidence of right-left hemispheric asymmetries in the results of neuropsychological testing. We compared patients' visual-spatial ability (predominantly controlled by the right hemisphere) to their verbal performance

(predominantly controlled by the left hemisphere). In the nonabused group, left-hemisphere deficits were about twice as prevalent as right-hemisphere deficits, but in patients with physical, sexual, or psychogical abuse, left-sided deficits were more than six times as prevalent as right. In patients with a history of psychological abuse, left-hemisphere deficits were eight times as prevalent as right-sided deficits. This corroborated our hypothesis that abuse is associated with an increased prevalence of left-sided EEG abnormalities and of left-hemisphere defects in neuropsychological testing.

Problems on the Left

In order to investigate the effects of childhood trauma on development of the left hemisphere, we then used a sophisticated quantitative method of analyzing EEG that provides evidence about the brain's structure.[7] In contrast to conventional EEG, which reveals brain function, EEG coherence provided information about the nature of the brain's wiring and circuitry. In general, abnormally high levels of EEG coherence are evidence of diminished development of the elaborate neuronal interconnections in the cortex that would process and modify the brain's electric signals.

We used this technique to study 15 child and adolescent psychiatric inpatients who had a confirmed history of intense physical or sexual abuse compared with 15 healthy volunteers. Patients and volunteers were between 6 and 15 years of age, right-handed, and with no history of neurological disorders or abnormal intelligence. Measuring EEG coherence indicated that the left cortex of the healthy controls was more developed than the right cortex, which is consistent with what is known about the anatomy of the dominant hemisphere. The abused patients, however, were notably more developed in the right than the left cortex, even though all were right-handed. The right hemisphere of abused patients had developed as much as the right hemisphere of the controls, but their left hemispheres lagged substantially, as though arrested in their development.

This abnormality in the cortex showed up regardless of the patient's primary diagnosis, which could be depression, PTSD, or conduct disorder. It extended throughout the entire left hemisphere, but the temporal regions were most affected. This finding of left cortex underdevelopment is consistent with our earlier finding that abused patients had increased left-hemisphere EEG abnormalities and left-hemisphere (verbal) deficits as shown by neuropsychological testing.

Affects on the Hippocampus

The hippocampus, located in the temporal lobe, is involved in memory and emotion. Developing very gradually, the hippocampus is one of the few parts of the brain that continues to produce new cells after birth. Cells in the hippocampus have an unusually large number of receptors that respond to the stress hormone cortisol. Since animal studies show that exposure to high levels of stress hormones like cortisol has toxic effects on the developing hippocampus, this brain region may be adversely affected by severe stress in childhood.

J. Douglas Bremner and his colleagues at Yale Medical School compared magnetic resonance imaging (MRI) scans of 17 adult survivors of childhood physical or sexual abuse, all of whom had PTSD, with 17 healthy subjects matched for age, sex, race, handedness, years of education, body size, and years of alcohol abuse.[8] The left hippocampus of abused patients with PTSD was 12 percent smaller than the hippocampus of the healthy controls, but the right hippocampus was of normal size, as were other brain regions, including the amygdala, caudate nucleus, and temporal lobe. Not surprisingly, given the role of the hippocampus in memory, these patients also had lower verbal memory scores than the nonabused group.

Murray Stein and his colleagues also found left hippocampal abnormalities in women who had been sexually abused as children. Their left hippocampal volume was significantly reduced, but the right hippocampus was relatively unaffected. Fifteen of the 21 sexually abused women had PTSD; 15 had a dissociative disorder. They suffered a reduction in the size of the left hippocampus proportionate to the severity of their symptoms.

These studies suggest that child abuse may alter development of the left hippocampus permanently and, in so doing, cause deficits in verbal memory and dissociative symptoms that persist into adulthood.

Shifting from Left to Right

The left hemisphere is specialized for perceiving and expressing language, the right hemisphere for processing spatial information and also for processing and expressing negative emotions. We wondered, then, whether abused children might store their disturbing childhood memories in the right hemisphere, and whether recollecting these memories would activate the right hemisphere more than it is activated in those without such a history.

To test this hypothesis, we measured hemispheric activity in adults during recall of a neutral memory, then during recall of an upsetting early memory.[10] Those with a history of abuse appeared to use predominantly their left hemispheres when thinking about neutral memories and their right when recalling an early disturbing memory. Those in the control group had a more integrated bilateral response.

A Deficient Pathway

Since childhood abuse (as we found) is associated with diminished right-left hemisphere integration, we wanted to know whether there was some deficiency in the primary pathway connecting the two hemispheres, the corpus collosum. We found in boys who had been abused or neglected that the middle portions of the corpus collosum were significantly smaller than in the control groups. Furthermore, in boys, neglect exerted a far greater effect than any other type of maltreatment; physical and sexual abuse exerted relatively minimal effects. In girls, however, sexual abuse was a more powerful factor, associated with a major reduction in size of the middle portions of the corpus collosum. These results were independently replicated by Michael De Bellis at the University of Pittsburgh, and the effects of early experience on the

development of the corpus collosum have been confirmed by research in primates.

Calming Irritability in the Brain

Decades ago, Harry Harlow compared monkeys raised with their mothers to monkeys raised with wire or terrycloth "surrogate mothers." Monkeys raised with the surrogates became socially deviant and highly aggressive adults. Building on this work, other scientists discovered that these consequences were less severe if the surrogate mother swung from side to side, a type of movement that may be conveyed to the cerebellum, particularly the part called the cerebellar vermis, located at the back of the brain, just above the brain stem. Like the hippocampus, this part of the brain develops gradually and continues to create new neurons after birth. It also has an extraordinarily high density of receptors for stress hormone, so exposure to such hormones can markedly affect its development.

New research suggests that abnormalities in the cerebellar vermis may be involved in psychiatric disorders including depression, manic-depressive illness, schizophrenia, autism, and attention-deficit/ hyperactivity disorder. We have gone from thinking of the entire cerebellum as involved only in motor coordination to believing that it plays an important role in regulating attention and emotion. The cerebellar vermis, in particular, seems to be involved in the control of epilepsy or limbic activation. Couldn't maltreating children produce abnormalities in the cerebellar vermis that contribute to later psychiatric symptoms?

Testing this hypothesis, we found that the vermis seems to become activated to control— and quell—electrical irritability in the limbic system. It appears less able to do this in people who have been abused. If, indeed, the vermis is important not only for postural, attentional, and emotional balance, but in compensating for and regulating emotional instability, this latter capacity may be impaired by early trauma. By contrast, stimulation of the vermis through exercise, rocking, and movement may exert additional calming effects, helping to develop the vermis.

Something as seemingly inconsequential as five minutes of human handling during a rat's infancy produced lifelong beneficial changes.

ATTENTION, HORMONES, AND THE BRAIN

We know that through their effects on hormone levels, early experiences influence brain development. Fifty years ago, Seymour Levine and Victor Denenberg showed that small alterations in their environment led to lasting changes in rats' development, behavior, and response to stress. Something as seemingly inconsequential as five minutes of human handling during a rat's infancy produced lifelong beneficial changes. We now understand through the reserach efforts of Michael Meany and Paul Plotsky that the effects of brief handling were highly beneficial and were due to increased maternal attention. Those pups whose mothers spontaneously

lick and groom them the most (about one-third in a laboratory setting) display the same benefits as the rats with the human handling. By contrast, long isolation produces stress that has a deleterious effect on brain and behavior development.

If we assume that lots of attention, licking, and grooming are the natural state of affairs and that lower levels of attention are a form of neglect, we can use this model to explore some of the biological consequences of neglect or abuse in children. Low rates of maternal attention decrease the production of thyroid hormone by the rat pups. This, in turn, decreases serotonin in the hippocampus and affects the development of receptors for the stress hormone glucocorticoid. Since corticosterone, one of our primary stress hormones, is kept in check by a complicated feedback mechanism that depends on these same stress hormone receptors, their inadequate development increases the risk of an excessive stress hormone response to adversity. For this and certain other reasons, lack of maternal attention predisposes the animals to have a heightened level of fear and a heightened adrenaline response. Some of the consequences of this are altered metabolism and suppressed immune and inflammatory responses, neuronal irritability, and enhanced susceptibility to seizures. Still other consequences of an abnormally intense corticosterone response are reduced brain weight and DNA content, suppressed cell growth in the cerebellum and hippocampus, and interference with myelinization—the process of sheathing nerve fibers to enhance conduction of electrical impulses.

These consequences seem consistent with inadequate development of the corpus collosum, which is a highly myelinated structure, and abnormal development of the hippocampus and cerebellum. High levels of cortisol can also hinder development of the cerebral cortex, the extent of vulnerability dependent on how rapidly the brain was growing at the time of the insult. During the years of rapid language acquisition (approximately 2-10 years of age), the left brain develops more rapidly than the right, making it more vulnerable to the effects of early maltreatment.

Finally, diminished maternal attention also appears to be associated with a lifelong decrease in production of the hormone oxytocin in the brain, and enhanced production of the stress hormone vasopressin. Recent research by Thomas Insel suggests that oxytocin is a critical factor in affiliative love and maintaining monogamous relationships. Both hormones may also help control sexual response, with vasopressin enhancing sexual arousal and oxytocin triggering climax and release. By affecting these hormones, early neglect or abuse theoretically could predispose mammals to experience enhanced sexual arousal, diminished capacity for sexual fulfillment, and deficient commitment to a single partner.

FROM NEUROBIOLOGY TO SYMPTOMATOLOGY

In summary, we now know that childhood abuse is linked with excess neuronal irritability, EEG abnormalities, and symptoms suggestive of temporal lobe epilepsy. It is also associated with diminished development

of the left cortex and left hippocampus, reduced size of the corpus callosum, and attenuated activity in the cerebellar vermis. We see a close fit between the effects of early stress on the brain's transmitters—our discoveries about the negative effects of early maltreatment on brain development—and the array of psychiatric symptoms that we actually observe in abused patients.

Many disorders are associated with childhood abuse. One is depression or heightened risk for developing it. Many scientists believe that depression may be a consequence of reduced activity of the left frontal lobes. If so, the stunted development of the left hemisphere related to abuse could easily enhance the risk of developing depression. Similarly, excess electrical irritability in the limbic system, and alterations in development of receptors that modulate anxiety, set the stage for the emergence of panic disorder and increase the risk of post-traumatic stress disorder. Alterations in the neurochemistry of these areas of the brain also heighten the hormonal response to stress, producing a state of hyper vigilance and right-hemisphere activation that colors our view with negativity and suspicion. Alterations in the size of the hippocampus, along with limbic abnormalities shown on an EEG, further enhance the risk for developing dissociative symptoms and memory impairments.

We have also found that 30 percent of children with a history of severe abuse meet the diagnostic criteria for attention-deficit/hyperactivity disorder (ADHD), although they are less hyperactive than children with classic ADHD. Very early childhood abuse appears particularly likely to be associated with emergence of ADHD-like behavior problems. Interestingly, one of the most reliable neuroanatomical findings in ADHD is reduced size of the cerebellar vermis. Some studies have also found an association between reduced size of the mid portions of the corpus callosum and emergence of ADHD-like symptoms of impulsivity. Hence, early abuse may produce brain changes that mimic key aspects of ADHD.

Our discoveries that abused patients have diminished right-left hemisphere integration and a smaller corpus callosum suggest an intriguing model for the emergence of one of psychiatry's least understood afflictions: borderline personality disorder. With less well integrated hemispheres, borderline patients may shift rapidly from a logical and possibly overvaluing left-hemisphere state to a highly negative, critical, and emotional right hemisphere state. This seems consistent with the theory that early problems of mother-child interaction undercut the integration of right and left hemispheric function. Very inconsistent behavior of a parent (for example, sometimes loving, sometimes abusing) might generate an irreconcilable mental image in a young child. Instead of reaching an integrated view, the child would form two diametrically opposite views—storing the positive view in the left hemisphere, the negative view in the right. These mental images, and their associated positive and negative world views, may remain unintegrated, and the hemispheres remain autonomous, as the child grows up. This polarized hemispheric dominance could cause a person to see significant others as overly positive in one

state and as resoundingly negative in another. Couple this with possible alterations in oxytocin- and vasopressin-mediated sexual arousal, and you see why patients with borderline personality disorder have tumultuous relationships.

DEALING WITH THE DAMAGE

I hope that new understanding of childhood abuse's impact on the brain will lead to new ideas for treatment. The most immediate conclusion from our work, however, is the crucial need for prevention. If childhood maltreatment exerts enduring negative effects on the developing brain, fundamentally altering one's mental capacity and personality, it may be possible to compensate for these abnormalities—to succeed in spite of them—but it is doubtful that they can actually be reversed in adulthood.

The costs to society are enormous. Psychiatric patients who have suffered from childhood abuse or neglect are far more difficult and costly to treat than patients with a healthy childhood. Furthermore, childhood maltreatment can be an essential ingredient in the makeup of violent individuals, predisposing them to bouts of irritable aggression.

One day we will find ways to chart the progress of brain development so that we can spot early signs of stress-mediated abnormalities and monitor each patient's progress and response to treatment. In the meantime, early intervention should be our priority. The brain is more plastic and malleable before puberty, increasing our chances of minimizing or reversing consequences of abuse. If we are right that many abuse-related changes result from a cascade of stress-mediated neuronal and hormonal responses, then we could minimize the impact of abuse by finding ways to reduce ongoing stress or suppressing an excessive stress response.

One consequence of childhood maltreatment is limbic irritability, which tends to produce dysphoria (chronic low-level unhappiness), aggression, and violence toward oneself or others. Even into adulthood, drugs can be useful in alleviating this set of symptoms. Anticonvulsant agents can help, as can drugs that affect the serotonin system.

Abuse also causes alterations in left-right hemisphere integration. Some research suggests that anticonvulsant drugs may facilitate the bilateral transmission of information. Left-right hemisphere integration may also improve through activities that require considerable left-right hemisphere cooperation, such as playing a musical instrument. Certain existing psychotherapies may be helpful. Cognitive-behavioral psychotherapy, which emphasizes correcting illogical, self-defeating perceptions, may work by strengthening left-hemisphere control over right-hemisphere emotions and impulses. Traditional, dynamic psychotherapy may work by enabling patients to integrate right-hemisphere emotions while maintaining left-hemisphere awareness, strengthening the connection between the two hemispheres.

A powerful new tool for treating PTSD is eye-movement desensitization and reprocessing (EMDR), which seems to quell flashbacks and intrusive memories. A moving visual stimulus is used to produce side-to-side eye movements while a clinician guides the patient through recalling highly disturbing

memories. For reasons we do not yet fully understand, patients seem able to tolerate recall during these eye movements and can more effectively integrate and process their disturbing memories. We suspect that this technique works by fostering hemispheric integration and activating the cerebellar vermis (which also coordinates eye movements), which in turn soothes the patient's intense limbic response to the memories.

Whether abuse of a child is physical, psychological, or sexual, it sets off a ripple of hormonal changes that wire the child's brain to cope with a malevolent world.

THEIR CHOICE—OR OURS?

Society reaps what it sows in nurturing its children. Whether abuse of a child is physical, psychological, or sexual, it sets off a ripple of hormonal changes that wire the child's brain to cope with a malevolent world. It predisposes the child to have a biological basis for fear, though he may act and pretend otherwise. Early abuse molds the brain to be more irritable, impulsive, suspicious, and prone to be swamped by fight-or-flight reactions that the rational mind may be unable to control. The brain is programmed to a state of defensive adaptation, enhancing survival in a world of constant danger, but at a terrible price. To a brain so tuned, Eden itself would seem to hold its share of dangers; building a secure, stable relationship may later require virtually superhuman personal growth and transformation.

At the extreme, the coupling of severe childhood abuse with other neuropsychiatric handicaps (for example, low intelligence, head trauma, or psychosis) is repeatedly found in cases of explosive violence. Dorothy Otnow Lewis and Jonathan Pincus have analyzed the neurological and psychiatric history of violent adolescents and adults. In one study they evaluated all 14 juveniles condemned to death in four states and found that all had suffered head injuries, most had major neurological impairment, 12 had subnormal IQ's, 12 had been severely physically abused as children, and 5 had been sodomized by relatives. In another study, they reviewed the childhood neuropsychiatric records and family histories of incarcerated delinquents. What might have been a tip-off to those who later were arrested for murder? The future murderers were distinguished from other delinquents by psychotic symptoms, major neurological impairment, a psychotic first-degree relative, violent acts during childhood, and severe physical abuse.

In a follow-up study of 95 formerly incarcerated juvenile delinquents, they found that the combination of intrinsic neuropsychiatric vulnerabilities and a history of childhood abuse or family violence effectively predicted which adolescents would go on to commit violent crimes. Lewis concludes that child abuse can engender all pivotal factors associated with violent behavior, namely, impulsivity, irritability, hyper vigilance, paranoia (which she interprets as an extreme version of hypervigilance), decreased judgment and verbal ability, and diminished recognition of pain in oneself

(dissociation) and others. As our review shows, these factors fit closely with the enduring neurobiological consequences of abuse.

To be convicted of a crime in the United States, one supposedly must have the capacity both to know right from wrong and to control one's behavior. Those with a history of childhood abuse may know right from wrong, but their brains may be so irritable and the connections from the logical, rational hemisphere so weak that intense negative (right-hemisphere) emotions may incapacitate their use of logic and reason to control their aggressive impulses. Is it just to hold people criminally responsible for actions that they lack the neurological capacity to control?

If we know that the roots of violence are fertilized by childhood abuse, can we make a long-term commitment to reduce violence by focusing on our children rather than our criminals?

Prosecutors and pundits are quick to coin catchphrases like the "abuse excuse" to dismiss childhood trauma's pervasive and enduring consequences for behavior. This is as unthinking as the exhortation to "get over it." Childhood trauma is not a passing psychological slight that one can choose to ignore. Even if the abused person comes to terms with the traumatic memories and chooses (for the sake of sanity) to forgive the perpetrator, this will not reverse the neurobiological abnormalities. The only sound legal approach to a person with a history of abuse who commits a violent crime is to take into account the person's neurobiological capacity to control his behavior. If it is irrational and hypocritical to hold a minor to the same standard of behavioral control as a mature adult, it is equally unjust to hold a traumatized and neurologically impaired adult to the same standard as one not so afflicted. Childhood abuse, age, and neurological impairments can be critical mitigating factors that a just society should not ignore.

If we know that the roots of violence are fertilized by childhood abuse, can we make a long-term commitment to reduce violence by focusing on our children rather than our criminals? What if we set a goal of reducing the cases of childhood abuse and neglect by 50 percent a year? What if we monitored statistics on childhood abuse as avidly as we track housing starts, inflation, or baseball scores? We would have to commit ourselves, seriously, to improving access to quality day care and after-school programs. We might need to educate and support parents so they could know how to nurture their children more effectively. We certainly would need to foster better relationships among peers and siblings.

Think of what we could save if we needed fewer prisons and fewer mental health professionals. Think of the benefits of moving one step closer to a society that everyone could experience and enjoy.

Our brains are sculpted by our early experiences. Maltreatment is a chisel that shapes a brain to contend with

strife, but at the cost of deep, enduring wounds. Childhood abuse isn't something you "get over." It is an evil that we must acknowledge and confront if we aim to do anything about the unchecked cycle of violence in this country. ■

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