*Excerpts from: van der Kolk MD, Bessel. The Body Keeps the Score: Brain, Mind, and Body in the Healing of Trauma*

## SHIFTING TO ONE SIDE OF THE BRAIN

The scans also revealed that during flashbacks, our subjects' brains lit up only on the right side. Today there's a huge body of scientific and popular literature about the difference between the right and left brains. Back in the early nineties I had heard that some people had begun to divide the world between left-brainers (rational, logical people) and right-brainers (the intuitive, artistic ones), but I hadn't paid much attention to this idea. However, our scans clearly showed that images of past trauma activate the right hemisphere of the brain and deactivate the left.

We now know that the two halves of the brain do speak different languages. The right is intuitive, emotional, visual, spatial, and tactual, and the left is linguistic, sequential, and analytical. While the left half of the brain does all the talking, the right half of the brain carries the music of experience. It communicates through facial expressions and body language and by making the sounds of love and sorrow: by singing, swearing, crying, dancing, or mimicking. The right brain is the first to develop in the womb, and it carries the nonverbal communication between mothers and infants. We know the left hemisphere has come online when children start to understand language and learn how to speak. This enables them to name things, compare them, understand their interrelations, and begin to communicate their own unique, subjective experiences to others.

The left and right sides of the brain also process the imprints of the past in dramatically different ways. The left brain remembers facts, statistics, and the vocabulary of events. We call on it to explain our experiences and put them in order. The right brain stores memories of sound, touch, smell, and the emotions they evoke. It reacts automatically to voices, facial features, and gestures and places experienced in the past. What it recalls feels like intuitive truth—the way things are. Even as we enumerate a loved one's virtues to a friend, our feelings may be more deeply stirred by how her face recalls the aunt we loved at age four.

Under ordinary circumstances the two sides of the brain work together more or less smoothly, even in people who might be said to favor one side over the other. However, having one side or the other shut down, even temporarily, or having one side cut off entirely (as sometimes happened in early brain surgery) is disabling.

Deactivation of the left hemisphere has a direct impact on the capacity to organize experience into logical sequences and to translate our shifting feelings and perceptions into words. (Broca's area, which blacks out during flashbacks, is on the left side.) Without sequencing we can't identify cause and effect, grasp the long-term effects of our actions, or create coherent plans for the future. People who are very upset sometimes say they are "losing their minds." In technical terms they are experiencing the loss of executive functioning.

When something reminds traumatized people of the past, their right brain reacts as if the traumatic event were happening in the present. But because their left brain is not working very well, they may not be aware that they are reexperiencing and reenacting the past—they are just furious, terrified, enraged, ashamed, or frozen. After the emotional storm passes, they may look for something or somebody to blame for it. They behaved the way they did because you were ten minutes late, or because you burned the potatoes, or because you "never listen to me." Of course, most of us have done this from time to time, but when we cool down, we hopefully can admit our mistake. Trauma interferes with this kind of awareness, and, over time, our research demonstrated why.

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Adrenaline is one of the hormones that are critical to help us fight back or flee in the face of danger. Increased adrenaline was responsible for our participants' dramatic rise in heart rate and blood pressure while listening to

their trauma narrative. Under normal conditions people react to a threat with a temporary increase in their stress hormones. As soon as the threat is over, the hormones dissipate, and the body returns to normal. The stress hormones of traumatized people, in contrast, take much longer to return to baseline and spike quickly and disproportionately in response to mildly stressful stimuli. The insidious effects of constantly elevated stress hormones include memory and attention problems, irritability, and sleep disorders. They also contribute to many long-term health issues, depending on which body system is most vulnerable in a particular individual.

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Trauma affects the entire human organism—body, mind, and brain. In PTSD the body continues to defend against a threat that belongs to the past. Healing from PTSD means being able to terminate this continued stress mobilization and restore the entire organism to safety.

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After trauma, the world is experienced with a different nervous system. The survivor's energy now becomes focused on suppressing inner chaos, at the expense of spontaneous involvement in their life. These attempts to maintain control over unbearable physiological reactions can result in a whole range of physical symptoms, including fibromyalgia, chronic fatigue, and other autoimmune diseases. This explains why it is critical for trauma treatment to engage the entire organism, body, mind, and brain.

If for some reason the normal response is blocked—for example, when people are held down, trapped, or otherwise prevented from taking effective action, be it in a war zone, a car accident, domestic violence, or a rape—the brain keeps secreting stress chemicals, and the brain's electrical circuits continue to fire in vain.2 Long after the actual event has passed, the brain may keep sending signals to the body to escape a threat that no longer exists. Since at least 1889, when the French psychologist Pierre Janet published the first scientific account of traumatic stress,3 it has been recognized that trauma survivors are prone to "continue the action, or rather the (futile) attempt at action, which began when the thing happened." Being able to move and do something to protect oneself is a critical factor in determining whether or not a horrible experience will leave long-lasting scars.

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The limbic system is shaped in response to experience, in partnership with the infant's own genetic makeup and inborn temperament. (As all parents of more than one child quickly notice, babies differ from birth in the intensity and nature of their reactions to similar events.) Whatever happens to a baby contributes to the emotional and perceptual map of the world that its developing brain creates. As my colleague Bruce Perry explains it, the brain is formed in a "use-dependent manner." This is another way of describing neuroplasticity, the relatively recent discovery that neurons that "fire together, wire together." When a circuit fires repeatedly, it can become a default setting—the response most likely to occur. If you feel safe and loved, your brain becomes specialized in exploration, play, and cooperation; if you are frightened and unwanted, it specializes in managing feelings of fear and abandonment. As infants and toddlers, we learn about the world by moving, grabbing, and crawling and by discovering what happens when we cry, smile, or protest. We are constantly experimenting with our surroundings—how do our interactions change the way our bodies feel? Attend any two-year-old's birthday party and notice how little Kimberly will engage you, play with you, flirt with you, without any need for language. These early explorations shape the limbic structures devoted to emotions and memory, but these structures can also be significantly modified by later experiences: for the better by a close friendship or a beautiful first love, for example, or for the worse by a violent assault, relentless bullying, or neglect.

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In other words: If an organism is stuck in survival mode, its energies are focused on fighting off unseen enemies, which leaves no room for nurture, care, and love. For us humans, it means that as long as the mind is defending itself against invisible assaults, our closest bonds are threatened, along with our ability to imagine, plan, play, learn, and pay attention to other people's needs.

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A WINDOW INTO THE NERVOUS SYSTEM

All of the little signs we instinctively register during a conversation—the muscle shifts and tensions in the other person's face, eye movements and pupil dilation, pitch and speed of the voice—as well as the fluctuations in our own inner landscape—salivation, swallowing, breathing, and heart rate—are linked by a single regulatory system.5 All are a product of the synchrony between the two branches of the autonomic nervous system (ANS): the sympathetic, which acts as the body's accelerator, and the parasympathetic, which serves as its brake.6 These are the "reciprocals" Darwin spoke of, and working together they play an important role in managing the body's energy flow, one preparing for its expenditure, the other for its conservation.

The sympathetic nervous system (SNS) is responsible for arousal, including the fight-or-flight response (Darwin's "escape or avoidance behavior"). Almost two thousand years ago the Roman physician Galen gave it the name "sympathetic" because he observed that it functioned with the emotions (sym pathos). The SNS moves blood to the muscles for quick action, partly by triggering the adrenal glands to squirt out adrenaline, which speeds up the heart rate and increases blood pressure.

The second branch of the ANS is the parasympathetic ("against emotions") nervous system (PNS), which promotes self-preservative functions like digestion and wound healing. It triggers the release of acetylcholine to put a brake on arousal, slowing the heart down, relaxing muscles, and returning breathing breathing to normal. As Darwin pointed out, "feeding, shelter, and mating activities" depend on the PNS.

There is a simple way to experience these two systems for yourself. Whenever you take a deep breath, you activate the SNS. The resulting burst of adrenaline speeds up your heart, which explains why many athletes take a few short, deep breaths before starting competition. Exhaling, in turn, activates the PNS, which slows down the heart. If you take a yoga or a meditation class, your instructor will probably urge you to pay particular attention to the exhalation, since deep, long breaths out help calm you down. As we breathe, we continually speed up and slow down the heart, and because of that the interval between two successive heartbeats is never precisely the same. A measurement called heart rate variability (HRV) can be used to test the flexibility of this system, and good HRV—the more fluctuation, the better—is a sign that the brake and accelerator in your arousal system are both functioning properly and in balance.