How Does Psychological Trauma Affect the Body and the Brain

It would take many volumes to thoroughly discuss the brain in total. In this book I will stick to an overview discussion of the parts of the brain that are most relevant to the essential understanding of trauma: the cortex (the thinking center of the brain) and the limbic system (the emotional and survival center of the brain).

The Cortex

Among other functions, the cortex is the site of conscious thought and awareness. Maintaining attention to our external environment (what we see, hear, smell, etc.) as well as our internal environment (thoughts, body sensations, and emotions) requires activity in the cortex. Thinking, including the recall of facts, description of procedures, recognition of time, understanding, and so on, also takes place in the cortex. Though it varies from individual to individual, low levels of increased stress with the accompanying increase in adrenaline levels will actually improve awareness, clear thinking, and memory.[1] That is why coffee is such a popular beverage at work and among university students: a jolt of caffeine makes our memory, observations, and thinking processes sharper. However, past a certain (individually determined) level, increased adrenaline will degrade, that is, have the opposite effect on, those same processes. A most recognizable example is seen on television quiz programs. More often than not, contestants eliminated by a wrong answer will assert that when watching the program at home, they never missed an answer. Why then were they stumped when on TV? Most likely, their stress levels rose beyond the helpful low-adrenaline kick and succumbed to overload that dampened their ability to access information that was easily available under calmer circumstances. The same thing can happen with trauma. Though many survivors report a sharpening of perception and thought, those with PTSD usually have a different experience. In such cases, their brains became overloaded with adrenaline and they were no longer able to think clearly as they ran, fought, or—most likely—froze in response to the traumatic threat. Understanding the interaction of the cortex with the limbic system during low and high stress will help to make this loss of cortex ability clearer.

The Limbic System

Located in the middle part of the brain between the brain stem and cortex, the limbic system is responsible for our survival. It protects us from danger in major part by recognizing and utilizing sensory information and then setting in motion the protective responses of flight, fight, and freeze. The limbic system assesses the states of both internal and external environments via sensory input and transfers the data to other brain structures. The amygdala is the limbic structure that assigns the sensory information an emotional interpretation and instructs the body in how to respond accordingly. For

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[1] Adrenaline and noradrenaline are the familiar names for the hormones epinephrine and norepinephrine. In the United States, the latter terms are more usual in scientific texts. However; in Europe and elsewhere, it is the more familiar usage that predominates. Because this book is written for both therapists and clients, and will be read on both sides of the Atlantic Ocean, adrenaline and noradrenaline are used throughout.

instance, while waiting at the train station for your friend to arrive, you might already be smiling as your amygdala identifies her familiar posture and gait from a distance. In nervous system time, your smiling response appears long before you have consciously recognized her face as she approaches. On the other end of the spectrum, it is also the amygdala that evaluates sensory information (what is seen, heard, smelled, etc.) as comprising danger. In such an instance it will raise an alarm and instruct the body to respond quite differently, to run away or dive for cover (flight), fend off (light), or go numb or faint (freeze).

Another structure in the limbic system, the hippocampus, is very important for managing, remembering, and recovering from trauma. Among other things, it is the hippocampus that registers and then informs the cortex about the time context of an event. It marks the memory of each event with a beginning, middle, and end. For example, remember a simple episode from yesterday: a meal, a phone call, taking a shower whatever. As you bring to mind the details, notice whether you recall how the incident began, what happened during it, and then the end of it.

As I am writing this page right now, I am remembering teaching my elderly neighbor how to use his new cellular teIephone—the first one he had ever owned. It started with my knocking on his front door. He welcomed me in. Then, we went through the various steps of using the phone. I programmed some speed dial numbers for him and he wrote down how to find them. Then after about an hour, we were finished. He said, "Thanks!” I said,” you're welcome. Just don't forget to turn it on" He let me out the door.

My memory of the details in sequence are due to the hippocampus doing its job. It will usually do that for any event, recording and then telling the cortex when it started, how long it proceeded, and that it finished.

Take special note of that last step of hippocampal sequencing, recording that an event has ended. With regard to remembering trauma, this is vitally important. In fact, typically PTSD is the result of a hippocampus that was not able to mark the end of the trauma. It was never able to tell the cortex that the trauma ended. Such a failure of the hippocampus is really the crux of PTSD, perhaps even the major cause. When the hippocampus is able to recognize and tell the cortex that a traumatic event has concluded, the cortex can then instruct the amygdala that the trauma is over. Once informed, the amygdala can then halt its alarm response, telling the body there is no further need for hypervigilance or flight, fight, or freeze. That is what happens when a trauma is resolved—whether at the time or in the near or distant future. The hippocampus recognizes the end of it and informs the cortex, which in turn alerts the amygdala to stop all the defensive action. In fact, it is this feature of hippocampal function that makes trauma recovery possible. Without it, the amygdala will go on responding as if the trauma continues again and again and again, which is exactly what is happening when the system fails and PTSD develops. In that case, the hippocampus fails to mark the end of the event, it is not able to inform the cortex, and the amygdala's alarm persists.

While the amygdala is immune to the rise in stress hormones that accompanies traumatic stress, the hippocampus is not so lucky. It is very vulnerable to high levels of stress hormones and will stop working correctly when adrenaline and other hormones reach a high level. Stress arousal needs to be lowered before the hippocampus will have a chance to function properly again.

The Twins of information Processing

Joseph LeDoux (1996) distinguished two pathways for the processing of sensory information. Both are very speedy in real time. Nonetheless, in the context of nervous system time, one is very fast and the other is rather slow. The first, the quick route, is via the amygdala and bypasses the cortex altogether. The amygdala takes in sensory information from both internal and external environments (see the next section) and tells the body what to do, how to respond. For example, hearing the voice of a loved one on the phone may cause you to sigh deeply before you've even realized who it is and said hello. The amygdala hears the voice, recognizes it as familiar and associates it with pleasant experience. It does the same with noxious sensory information as well. For example, the smell of smoke may have your heart accelerating long before you have discovered the source. The amygdala registers the smell of smoke, associates it with potential danger; and then prepares the body for defensive action by raising the heart rate. In this quick route of information processing, these reactions are set in motion instantly, long before the possibility for any cortical involvement.

The second, slower route utilizes the hippocampus to send information to the frontal cortex where it can be evaluated with conscious thought. In the two examples in the previous paragraph, this is how it would work. Hearing the voice of the loved one, the hippocampus sends information to the prefrontal cortex that makes possible the identification of who the person is, when you last heard from or saw that person, and any other vital information. On the other hand, when smelling smoke, the hippocampus would relay that information to the cortex where action could be set in motion to discover the source of the smoke or to determine that there is no danger either because the smoke has ceased or because the source was benign.

Survival in life, particularly when dealing with trauma, requires that both of these systems be working properly. However the high levels of stress hormones, primarily adrenaline, associated with PTSD tend to disable the hippocampus along the slower processing route. When arousal goes up past a certain threshold, the hippocampus stops functioning. When that happens during a traumatic incident, the time sequencing will not be accurately recorded, if it is recorded at all. That means that memory of the event will be devoid of structure: no beginning, no middle, and—critically—no end. In such an instance, the amygdala continues to call an alarm as if the trauma is continuing on and on or again and again. The cortex never received the message that it was over, so it cannot tell the amygdala to calm down. The result is that the person with PTSD is plagued by the persistent reactions of the amygdala to the past danger.

There are some who believe that this hippocampal failure is pathological, a sign of something wrong. However; shutting down the hippocampus is actually part of the survival response. When one's life is in danger, it may be critical to be able to react without thinking. That's the amygdaIa's job. If the hippocampus remains active at such a threatening time, it could hamper the autopilot and speed necessary for survival. So the amygdala raises the level of stress hormones and the hippocampus goes off-line, so to speak. Still, the shutdown is supposed to be temporary and problems arise when it persists. The hippocampus is meant to come fully back online once the trauma is past, informing the cortex that it is all over. When that doesn't happen, PTSD results.

Trauma recovery involves, in part, turning the hippocampus and the slower information processing route on once again. Once that is accomplished, the cortex, with the aid of the hippocampus, will be able to recognize that the trauma is no longer occurring and in turn will tell the amygdala to halt its constant alarm. A successful outcome will usually see the physical symptoms that have been caused by the amygdala's constant alarm (e.g., palpitations, concentration difficulties, nervousness) subside.

Central Nervous System

The central nervous system is the control center for all body and mind systems. The term is used interchangeably to refer to both the body's entire nervous system and also to the central part of the nervous system, the brain and spinal cord. The nerves that emanate from the spinal cord are divided into two major classifications, those that direct the motor nervous system and the ones connected to the sensory nervous system.

Sensory Nervous System

The motor nervous system (see the next section) usually gets the most attention in books and training on trauma and PTSD, particularly the autonomic nervous system. However; the sensory nervous system holds many keys for understanding how the limbic system, particularly the amygdala, responds to trauma. As well, working directly with the sensory nervous system can help many trauma survivors to get their footing firmly back into the safety of the here and now.

There are two categories of sensory nerves: exteroceptive and interoceptive. The exteroceptors are nerves of the five senses: sight, hearing, taste, touch, and smell. These are the senses that gather information from the environment external to our bodies. The other category the interoceptors, get input from our internal environment: balance, internal sensations, and the ability to locate all parts of our body without looking (proprioception).

Paying attention to the sensory nervous system can be extremely important when endeavoring to resolve trauma. It is the information from the senses that the amygdala uses to determine whether an environment is safe or dangerous and how to respond (smile, run, and so on).

A common habit of those who suffer from PTSD, as well as panic and anxiety disorders, is their tendency to place a disproportionate amount of emphasis on their interoceptive sensations. This is understandable from the standpoint that all of those conditions bear with them highly uncomfortable physical sensations (e.g., rapid heart rate, dizziness). However, problems arise when the individual uses those discomforting internal sensations to judge the safety or danger of the external environment. In these instances, individuals forget to use their exteroceptors, their senses of sight, hearing, smell, and so on, to actually evaluate a current situation. They may be so overwhelmed by heart palpitations, for example, that they assume what is going on is dangerous without actually knowing if that is the case. This can develop into a kind of trap, survivors assuming that this or that situation is dangerous because of what they are feeling on the inside. It is a deceptive process. In reality, one is safest when able to use exteroceptors to evaluate a situation or environment, but for some trauma survivors, this is a difficult concept to grasp and a challenging process to teach. The way out of this dilemma is to develop a dual awareness (Rothschild, 2000) that will make possible paying attention to both internal and external senses simultaneously.

Motor Nervous System

All muscles are part of the motor nervous system. There are two divisions, the somatic and the autonomic. Muscles of the somatic nervous system are the skeletal muscles, each of which reaches across a joint. Movement is made possible through the contraction and relaxation of the muscles that move the bones on either side of the joint either nearer to or more distant from each other. For example, to chew a piece of gum, the jaw muscles must alternate contraction and relaxation. This makes movement possible between the upper and lower jawbones by in turn bringing them closer together and then farther apart again. Any muscle that facilitates an action (walking, writing) or prevents an action (holds back an impulse) is part of the somatic nervous system.

The autonomic nervous system comprises the viscera and visceral muscles, such as the heart, lungs, and intestines. While most action in the somatic nervous system can be conscious or voluntary, the autonomic nervous system functions automatically. In fact, it is sometimes called the automatic nervous system as most of the time it is functioning outside of our awareness.

Both the autonomic and somatic nervous systems are involved in response to trauma. When confronted with a threat, the amygdala will direct the autonomic nervous system to arouse the body to defensive action. It does this through the hormones of adrenaline and noradrenaline, which increase heart rate and respiration to send lots of oxygen to the muscles (somatic nervous system). This makes possible either strong and quick movement for flight or fight, or paralysis of the muscles (either stiff or slack) for the protective freeze response. When not in a state of stress, the amygdala will direct the autonomic nervous system to wind down body responses, slowing heart and breath and directing blood flow to the viscera to aid digestion and elimination. In that state, muscles are more relaxed (as opposed to slack) and rest and restoration are possible.

The Role of Cortisol

In the past few years, the role of cortisol in response to and recovery from trauma has become confused. Because it is part of the entire scenario of response to trauma, indeed a stress hormone, cortisol has become erroneously regarded by many as something that increases stress. This is actually not the case and a simple surveying of cortisol research, particularly that by Rachel Yehuda and colleagues (1990, 1995), who first discovered the role of cortisol in trauma, clarifies the matter. With regard to the trauma response, cortisol is a vital friend. The discussion of the amygdala and hippocampus focused on what happens to lay the groundwork for the development of PTSD. The picture is quite different in the scenario that leads in the other direction, to resolution.

When a traumatic situation has ended and the individual has survived through flight or fight, the amygdala directs the adrenal glands to release cortisol to dampen the trauma response. Cortisol halts the arousal and helps the autonomic nervous system to swing from a state of stress to a state of calm. In fact, one of the difficulties for people with PTSD is that their cortisol levels are lower than usual. Cortisol has not been able to do its job for them. In years past, attempts were made to inject those with PTSD with cortisol in the hope that it would be able to do the same after the fact. However, none of these studies showed much promise for a delayed introduction of cortisol.

For those interested in the role of cortisol in other conditions, look particularly to studies on depression. It appears that those suffering from depression typically have raised levels of cortisol. If diagnosis is in doubt, simply assessing cortisol levels will point to an individual’s greater tendency toward depression or PTSD (Yehuda et al., 1996).

Babette Rothschilde. (2011), Trauma Essentials: The Go To Guide pg 33-40