Post Traumatic Stress Disorder
What Happens in the Brain?

Sethanne Howard and Mark W. Crandall, MD
US Naval Observatory, retired, Wash. DC
Reisterstown, Maryland

Abstract

This is a brief look at the processes that lead to post traumatic stress disorder (PTSD) and what happens in the brain. We take a light handed approach to the insides of the brain, not to demean but to promote understanding. PTSD is a disabling misery that is best understood through information.

Introduction

EVERYONE SUFFERS TRAUMA AT SOME TIME. The first documented case of psychological distress was reported in 1900 BCE, by an Egyptian physician who described a hysterical reaction to trauma. One in two people will be exposed to a life-threatening, traumatic event in their lifetime. It can be the death of a loved one; it can be war; an attack, robbery, rape; it can be the loss of a job. Usually the person recovers after some time, and the trauma fades to a memory – painful but not destructive. Trauma, however, is not the same as the mental disorder PTSD – Post Traumatic Stress Disorder. Now and then, the body cannot quite heal the trauma, and there are long-term changes in the brain. If the trauma is severe, prolonged, or life threatening, the aftereffects can last for years, physical damage can occur, and one suffers the debilitating effects of PTSD.

While many people experience traumatic events, not everyone develops PTSD. The best epidemiologic or population studies indicate that about 7% of Americans have had or will have PTSD at some point in their lives, and that about 5% have PTSD at any given time. Women are twice as likely as men to develop PTSD. At a cost of over 44 billion dollars a year in medical and related costs, PTSD is a disorder well worth the time to understand.

Many people in the Western world take a "blame-the-victim" approach to avoid dealing with mental illness. One might call it the "just" disease. "*It's your fault you are miserable, you know. You just can't cope,*

you just feel sorry for yourself, you just don't want to get well, you just want everyone else to solve your problems for you, you just" ... you just ... you just … this list goes on and on. A litany of 'you just.' That word 'just' causes a lot of problems. The 'just' speaker is not going to understand. The speakers will not *try* to understand. They have already closed their minds and will make sure that you know how bad *their* situation is compared to yours. Shame, denial, and misinterpretation are used to bad advantage (*quit asking for sympathy, quit over-reacting, etc.*).

The medical profession tries to help. The World Health Organization publishes a diagnosis book: the *International Classification of Diseases* (ICD). ICD-6 contained, for the first time, a section for mental disorders. The history of mental disorder in the United States is interesting. In 1840 medicine used only one category for mental illness: idiocy/insanity. By 1860 there were seven categories: melancholia, mania, epilepsy, monomania[i], paresis[ii], dementia, and dipsomania[iii]. It was not until after World War II that a more useful set of definitions appeared. In 1952 the first edition of the *American Psychiatric Association's Diagnostic and Statistical Manual*, DSM-I, appeared. The DSM-IV, the current edition, is essentially the diagnoses 'dictionary' for mental illnesses. It is a thick book available at bookstores. We now have the 9th edition of the ICD-9. So the current set of diagnoses is barely fifty years old.

There are some very interesting things in the DSM-IV. Is there a firm separation between a 'physical' disorder and a 'mental' disorder? The answer is no. Every physical disorder has a mental component; every mental disorder has a physical component. Together they form two interlocking pieces of the whole person. We can't have one without the other. It can even happen that the person with schizophrenia has the flu! Unfortunately we (and medicine) do not have a good word for this, so we keep the two words 'physical' and 'mental'. A good physician understands this.

Society and even many physicians assume that the DSM-IV classifies people not disorders. Actually the book does exactly the opposite: it classifies disorders not people. Society persists in this cruel fiction of classifying people instead of disorders. They use mental illness to define the whole person (*You are a manic-depressive.*). Try to picture a person pointing a finger and saying *"You are a broken bone."* Hopefully they sound equally silly.

Sometimes, however, they don't. Add to this misuse of words the additional injury that Americans still assign shame to mental illness and associate it with a character or moral flaw, and we have the terrible situation where countless mentally ill people suffer the doubly cruel injury of the ravages of the disease and the scorn of an uncomprehending society.

Insurance companies use the DSM-IV and ICD-9 to assign payments. All insurance claims insist on a diagnosis code (*It may be buried deep in the paperwork, but it is there*). So physicians and other mental health professionals use it. This is both good and bad. It is good, because it enables a payable insurance claim. It is bad because it forces a diagnosis that may not be fully appropriate. The DSM is a laudable attempt to organize mental illnesses into definable categories. If mental illness had well separated and defined categories this would work well. Unfortunately mental illness does not separate out into nice, neat labels. So the codes in the DSM-IV are far from perfect, just as the treatment and diagnosis of mental illness are not perfect. A good mental health professional knows this and will provide appropriate diagnoses for the insurance claim; one that will minimize any social damage. Then they will throw it away and treat you as a whole person, using whatever method is best for you.

The diagnoses of mental disorders are now multi-level. (Actually they concocted five diagnoses axes. If you are mathematically inclined, this is a 5D space. If you are not mathematically inclined, they have five ways to classify the disorders, and it can often take all five to identify the disorders properly.) That is good for the doctors, but it makes it more complicated for the non-professional to have a clear definition to use. A broken bone is an easy one. All the sub-types, severity levels, even decision trees in the DSM-IV make it hard to find a single word to use for mental illnesses. "I suffer from ...." When those dots really are paragraphs of words – well you see the problem.

People shy away from saying these things anyway because society has this unhealthy association of shame with a mental disorder. That leads to a lot of misconceptions. There are sixteen types of mental disorders. One is the anxiety disorder class. PTSD is an anxiety disorder. The DSM-IV diagnosis code for PTSD is 309.81. Panic attacks belong in the anxiety disorder class. Clinical depression, a common mental disorder, is a mood disorder.

Trauma and PTSD

I shall concentrate on PTSD. Most people are familiar with the definition concerning soldiers in a war; however, PTSD has expanded from its original wartime definition to include all people, not just soldiers. It can result from a single or prolonged life-threatening event. The memory can bury itself deep in the mind and, for years afterward, torment the person with all kinds of strange unexplained feelings. Some people come through these events and recover. Some do not. Why the difference? As yet, probably no one knows.

PTSD is difficult to treat, even difficult to diagnose. The disorder carries an especially strong stigma of dishonor and moral weakness. During the first and second world wars, people called some soldiers suffering from PTSD and stress breakdown “cowards” or “deserters.” The military has come a long way since then in recognizing the seriousness of this disorder. Since PTSD is actually the body’s natural response to an injury, it is not really an illness in the same sense as depression. It is, however, often accompanied by depression and other mental illnesses.

There are six criteria for a diagnosis of PTSD. (1) The person goes through or sees something that involves actual or threatened death or serious injury. The person responds to this with intense fear, helplessness or horror. (2) The person then relives this traumatic event through dreams, or recollections. He or she can behave as if the trauma is actually happening right then, and can react strongly to events that even resemble the original trauma. (3) The person tries desperately to avoid this, and to avoid anything associated with the trauma, in fact, may not even remember the trauma yet still react strongly to certain stimuli. (4) The person often has difficulty sleeping and concentrating. He or she may be hyper-vigilant. All this lasts longer than (5) a month and causes (6) significant distress in daily life.

Perfectly straightforward, isn’t it? Someone is “scared to death,” leaving behind an injured brain that relives the event and stays scared all the time. The next edition of the DSM will contain an updated definition for PTSD that will widen the criteria to include emotional as well as physical trauma.

Typically one thinks of trauma as a single life-threatening event; however, trauma can also arise from an accumulation of small incidents rather than one major incident. Examples include: repeated exposure to horrific scenes at accidents or fires, repeated involvement with serious

crime, breaking news of bereavement caused by accident or violence, especially if children are involved, repeated abuse (verbal, physical, or sexual), regular intrusion and violation of one's physical or psychological space (bullying, stalking, harassment, domestic violence), *etc*. People who are especially vulnerable to these events are emergency workers (*e.g*. police, firemen, and hospital workers), crime scene investigators, children, and soldiers. Some mental health professionals now use the term Prolonged Duress Stress Disorder (PDSD) when the symptoms are the result of a series of events.

Although it is fair to think of PTSD as an injury rather than an illness, it is important to remember that a disabling injury is as difficult to handle as a disabling illness. Unfortunately, the sufferer may not know he or she suffers from PTSD, and may think the suffering is "madness." The sufferer is afraid to tell anyone because of the social stigma associated with emotional distress. To make things worse, even professionals often misinterpret many of the PTSD symptoms as psychotic ones. They misdiagnose the person and therefore provide possibly harmful treatment and drugs.

PTSD is not madness. It is a normal reaction to undue and deadly stress. The body says "*Hey! I am not designed to work this way. If I let this go on there will be irreparable damage. I will do something dramatic now to reduce or eliminate the stress. We're talking survival here, dummy!*" And so the body takes action.

What is going on here? A lot of things. The human body is a marvelous system. It is also a complex system, full of feedback loops. Mess too badly with some of those loops, and one result can be long-term disabling PTSD.

The Two –Part Body

Let's look at the whole system before we leap into the brain. Not the 'whole' body – there is too much detail inside a *simple* human body – so we start with a two-part body: the automatic part versus the thinking part. One thing the human body does is keep the basics going so you do not have to *think* the basics. The basics are too, well, too basic to be left to our thinking skills. This is the automatic part. What does this automatic system do for us? The autonomic (*the word is linked to autonomous*) nervous system is an entire little brain unto itself. It keeps on going whether we think about it or not. It runs bodily functions without our

awareness or control. (*Thank goodness, too. I would hate to think my way into every single breath.*) It has two pieces: the sympathetic system and parasympathetic system.

The sympathetic system handles automatic responses to the "fight-or-flight" condition. (*Yo, I'm in danger here body, get with the program and do something.*) These responses are actions like dilating the pupils and blood vessels (*got to have room for that increased blood flow*), increasing the heart rate, and putting digestion on hold. (*You don't have time to eat right now, worry about that hunger later. I am busy fighting off that tiger on your behalf.*)

The parasympathetic system does other things, including slowing down the heart, constricting the pupils, and stimulating the digestion. It takes care of what the body needs when it is off-duty from fighting for survival. (*I can stop running from that tiger now, so it's time to eat.*)

The two pieces seem to drive the body in opposite directions. We hope the body can keep the system in balance and not let one or the other run amuck.

The autonomic nervous system sends a constant stream of information to the hypothalamus (*another piece in the brain*). The hypothalamus has an important job – regulation (*There is always a limit switch somewhere*) – to maintain the status quo. It controls an amazing variety of things. It gathers data from all over the body and then sends back signals to compensate for anything out of whack. It soaks up information from that autonomic nervous system, reads body temperature, checks your balance, blood pressure, visual cues, blood sugar levels, chemical levels, and memories. It gathers signals from the outside through the five senses (*Ouch, that's hot! Yuk! Bad smell*); each sense having its special area in the brain; for example, visual data to the occipital cortex, tactile to the sensory cortex, auditory to the middle temporal gyrus, and olfactory to the orbitofrontal cortex.

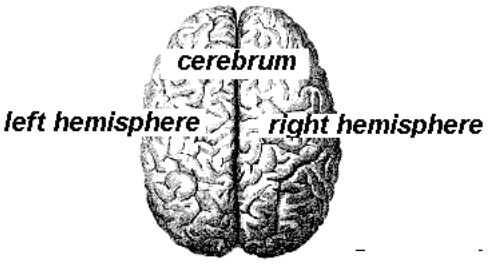
The hypothalamus also integrates all this information and sends back messages to the body (*squint to reduce excess light hitting the eyeball, etc.*). Messages also go back to the autonomic nervous system. A lot of information goes through the endocrine system as well (including the pituitary gland – a major piece of the endocrine system). This gland is no larger than a pea and controls all the other parts of the endocrine system. It produces all kinds of hormones. More about the stress hormone later.

A Light-Hearted Look at the Brain

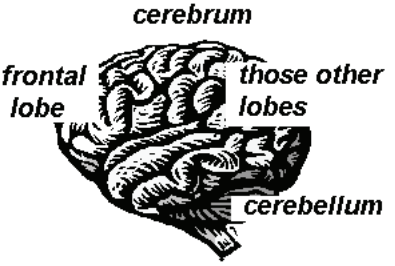
So where are we? Let the autonomic part continue to do its thing, and let's leap into the entire brain. The brain has a basic structure to it.

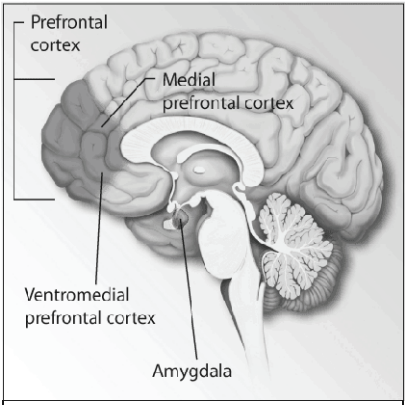
Actually we have three brains in one. Brain 1 is in the center called the "R complex" (R stands for reptilian because it is very similar to the brains of reptiles). Brain 2 is wrapped around Brain 1, called the "limbic system" or "old mammalian brain." *Limbus* is the Latin word for arc or girdle. Brain 2 is shell-like or girdle shaped. Brain 3 is the outside surface, the *neocortex,* and this is the evolutionary modern part of our brain.

Let's look top down on the brain. All we see from this view is Brain 3 – the neocortex. On the top is the *cerebrum* divided down the middle from the front to the back into the left and right *cerebral hemispheres.* When you hear about that left brain/right brain thinking, they are talking about these hemispheres. The brain also has a side-to-side division towards its back end, although this one is not as distinct as the other one. In front of this side-to-side division are the *frontal lobes* (one left and one right naturally because of those hemispheres).



At the back end of this side-to-side division are the *parietal, temporal*, and *occipital lobes*. If we peer sideways at the brain, under that cerebrum, there are more parts. Tucked under there is the *cerebellum.* Inside the middle of all this are the *pons* and the *medulla*. The brain stem comes from the spinal cord into this region. The *thalamus, hypothalamus, hippocampus,* and many other things are in there. The autonomic nervous system connects in here. In terms of evolution, this area of the brain is quite ancient. This makes sense too because the autonomic system has to take care of things like breathing without our having to think about them. All living things share this type of automatic functioning in some manner. That blade of grass does not have to "think" itself into green (*or brown if it gets no water*). Basically your conscious control tends to happen in the cerebrum area (that is the thinking part). The automatic





Brain Structures Involved in Dealing with Fear and Stress

control tends to happen in the cerebellum. The hippocampus is the piece that handles memory creation and storage. Apparently it stores memories all over the brain.
(*It finds a good spot, dumps in a memory, sets up a database entry somewhere, and moves on.*)

The hippocampus is deep inside the brain. It is a long narrow strip shaped almost like two horseshoes. The knobs at the end are the amygdala. The hippocampus makes new memories. Without it you could not live in the present, you would be stuck in the past. The figure to the left is a cut away of the brain showing the pieces important to stress.

Neurons and Neurotransmitters

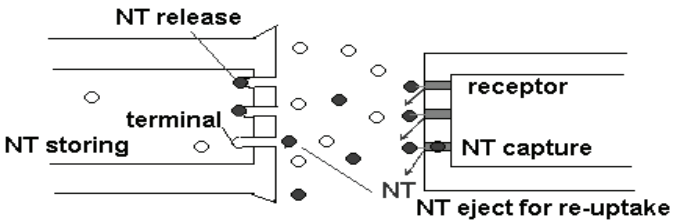
All the parts communicate through an amazing network of neural pathways: nerve cells strung out along *axons* (the neural highway). A nerve cell has two things to do. One: it has to propagate any impulse signal along the highway (*keep the traffic flow going*), and two: it has to transmit information to another nerve cell not on its axon (*across the gap*).

Impulses along an axon are electrical, mediated by sodium and potassium ions. An impulse is an all or nothing proposition. It goes, or it does not go. Electrical signals travel through the axons at quite respectable rates, sometimes as fast as 120 meters/second (*4,700 inches/second, about 268 miles per hour. In other words a signal makes its merry way around your body *very* fast. Light itself travels slightly less than 1,000 times faster than that.*). There are a lot of these neurons too, probably about 10^{11} of them[iv]. Even more interesting is that these things can reconnect in new ways, and probably do this all the time.

The other thing the nerve cell does is to transmit a signal from itself to another neuron. This involves actually a lot of chemical reactions. These involve the *neurotransmitters* (*NT's*). There are lots of them. Neurons emit NT's into that gap and other neurons with compatible receptors absorb them. (*How else can the information get around the body? If we were all one continuous nerve cell this would be easy, but we*

are not. Instead we are billions of these things. So the signals have to 'jump' the gap between neurons.) The signaling process, not to put too fine a point on it, is *sensitive*, you see. Those neurons have to be well tuned before they can talk properly. Drugs, disease, moods, genetics all can affect the proper signaling of neurons. When a neural bundle in the brain talks to another neural bundle, it uses NT's to help the communication (chemical reaction). It is a multi-step process.

1. Neuron makes and stores up NT's.
2. Neuron releases NT from a nerve terminal.
3. NT's wanders the gap and interacts with a receptor (*something receptive in the next neuron*)
4. Terminate that interaction with the receptor. (*I don't know why the brain has to turn this stuff off quickly but it does.*)
5. Destroy the NT or re-absorb it back into the original terminal.



NT= neurotransmitter

We can see, though, that this is a sensitive process. Lots of things can alter it. Mess with the creation and storage. Mess with the release. Mess with the receptor, mess with the shut off, and mess with the re-absorption. The figure above shows two neurons with a gap between them. One has terminals; the other has receptors. The neuron on the left has two terminals about to release an NT; one terminal is ready to catch (re-absorb) the NT just released by the receptor on the other neuron. There are several wandering NT's in the gap. The neuron on the right has receptors receiving them quickly, closing off the receptor once it caught one, and tossing the NT back into the fray to the terminals for re-absorption. One terminal is ready to re-absorb the NT.

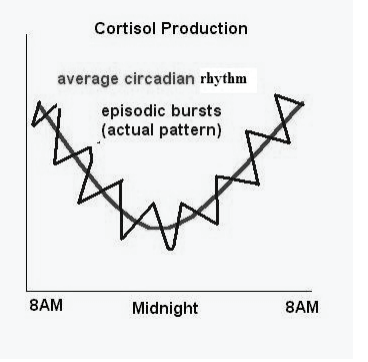
Two important NT's are serotonin and dopamine. Dopamine has many functions in the brain. Most importantly, dopamine is central to the reward system. Low levels of dopamine may lead to depression. Serotonin is sort of a midwife to the whole process. Serotonin wanders around in between the bundles, in the gap there. Actually the bundles are emitting and absorbing the serotonin all the time. They emit and reabsorb all kinds of things. However, serotonin facilitates the communications. If there is not enough serotonin around then the communication is faulty. A selective serotonin reuptake inhibitor (SSRI) is a psychiatric drug that stops the neural bundles from re-absorbing the serotonin [inhibits the re-absorption]. So the serotonin stays around the gap a bit longer and is there to aid communications. Drugs like Paxil, Prozac, and Zoloft are SSRI's.

Serotonin receptors – there are 3 main types and type 1 has 4 subtypes. One subtype seems to like the hippocampus area. Another type is found in the 4th layer of the cortex, *etc*. Anyway, if somehow there is not enough serotonin in that gap then the neural signaling can go awry.

Back to the autonomic nervous system that keeps the basics going so you don't have to think about them. We left the hypothalamus telling you what to do. It checks the status of your body and signals changes to keep things stable. So you shiver when you are cold, you sweat when you are hot, and you salivate when you are hungry. These signals play a role in your emotions. They activate that "fight-or-flight" reaction, for example. This also includes signals to adjust the hormone levels.

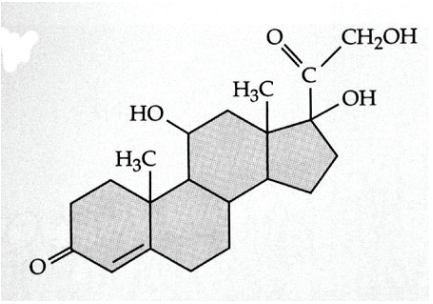
Cortisol

The endocrine glands (*pituitary* – in the brain, and *adrenal* – near the kidneys) secrete hormones. One is important to stress. It is, naturally, the "stress hormone," cortisol. Cortisol is a steroid hormone that regulates blood pressure and cardiovascular function as well as the body's use of proteins, carbohydrates, and fats for energy. A body under stress (illness, trauma, even temperature extremes) increases cortisol production. More cortisol means storing extra sugar for fuel, pumping up blood pressure, increasing heart rate, *etc*. All these are responses to stress. High levels of cortisol impair verbal memory performance.



Throughout a 24-hour day the level of cortisol in your blood stream varies; high in the morning, low at midnight. The graph at the right shows this variation over one day. Actually the cortisol levels are bumpy; the smooth line is an average of the bumps.

Well, the feedback loops are looping, hormones buzzing, basics going, and, as if it wasn't busy enough, the brain engages in puzzles! Is it harmful or safe? That's a puzzle to solve. Well, let's check the memory banks for any background information on this, and then decide to make a new memory, update an old one, ignore it, or take an action. The activity level is continuous, multi-leveled, and easily disrupted. There are lots of neurons firing, neuropeptides coming and going, chemicals reacting, and hormones, lots and lots of hormones. Cognition, memory, and mood all result from this constant activity of electrical impulses through the complex network of nerve cells throughout the brain.



Cortisol molecule

Hippocampus and Amygdala

OK, loops, hormones, signals, senses, basics, puzzling. What's left? The solution. Something needs to make a decision. That means the brain needs to check the databanks for past information that might help. Enter that hippocampus. When you build or retrieve a specific memory, the hippocampus brings together memory elements from all the sensory areas. It stores them initially right there in its storage areas as short term memories. When you tire of paying conscious attention to those memories, it reorganizes them and moves them into other parts of the brain. Under normal conditions, then, a short-term memory converts to a long-term memory, the database entry is built, and the memory stashed away accessible at some later time.

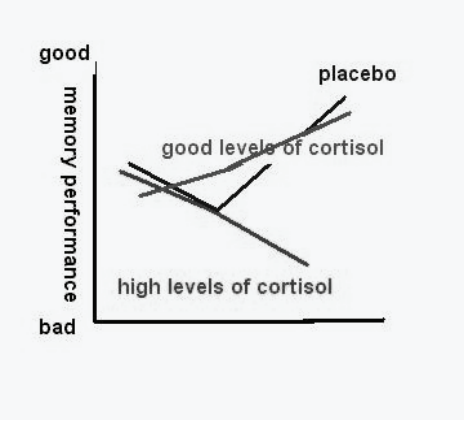
The amygdala gets involved in all this too. It mediates emotional content. It is continually asking questions about current events and sensory inputs: *"Is this a danger? Is this safe? Are we happy? Do I like this? Do I need to worry? Do I need to start up the stress responses, trigger those hormones?"* It queries the hippocampus to check the database for past instances of this event. It integrates information from internal chemistry,

external events, and memories, attaches the emotions, and decides an action.

Information arrives from the other parts of the brain; then an action flows out. Finally a decision! ("*Oh yes, this was a good thing. I like french fries*." Take french fry and munch. "*Nope, that's bad. I don't like bills.*" Pay bill and grimace. "*Ah-h, I remember that song.*" Gentle smile. "*Ouch! don't do that!*" Bonk nose of nurse giving the shot. Well, OK, control the bonk, but *desire* to bonk.)

Loops, basics, puzzling, signals, hormones, senses, database building, database retrieval, and *voila*, we are ready to integrate to the solution! The entire process goes on continuously. It is a very busy brain. No wonder we get headaches!

Another way to look at this is to picture two systems, one hot and one cool. The cool one is a cognitive, complex system (*the thinker*)*;* the hot one is an emotional-fear system (*the trigger finger*). The hippocampus is cool. It records, in an unemotional and neutral manner, well-elaborated autobiographical events, complete with their spatial-temporal context. It is subject to control. (*i.e.*, I can *think* my way in and out of it, or I can alter my interpretations and reactions.) The amygdala is hot. It reacts to un-integrated fragmentary fear – it hooks directly to low-level fear responses. It is direct, quick, highly emotional, and inflexible. It keys more to instinct and is less subject to easy control.



What's normal? Both. Everyone has hot and cool memories. Your memory database stores it all, both the cool and the hot: the cool system codes the context of the event; the hot system contributes the emotional highlights of the event (specifically the ones associated with fear). Later, a stimulus can evoke a hot memory and you relive the original low-level response. A cool memory is narrative, recollective, and episodic with a sense of time. You remember the event; you do not relive it or mistake it for a current event.

What happens if something interrupts or diverts all this signaling, traffic control, and memory storage to the wrong place? There are many

diseases that interfere with this process. When an interruption occurs, the signals (the NT's) falter, leading to a failed transmission of information from one point to another in the brain. In some cases this loss may be inconsequential. You never notice. In other cases it may cause a massive failure of the system: loss of memory, misperception of reality or inability to perceive reality, or inappropriate reaction. The graph above shows what happens to a person's memory performance over time when there are small and large levels of cortisol present. Clearly when the body releases a lot of cortisol in response to stress, a person's memory performance degrades. A little bit seems OK, and the body does have some cortisol present all the time.

Trauma

Trauma breaks the normal processing. Trauma is danger. The amygdala, busy with its continual questioning, determines that danger exists. The brain triggers the intricate fight-or-flight chemical dance to protect itself. "*Do I run away, do I fight, do I shut down? Whatever I do, I am going to do it right now*."

The "hot" drive for survival takes over. The brain is now in the middle of the dangerous event. It is not "outside" looking in at this event, and therefore, the entire system is not easily subject to rational control. (*I'm busy, damn it. Quit bothering me with logic.*) The danger response takes several actions. Some of them are instinctual. They come with the brain at birth, hard-wired as it were. Until the danger signal is resolved, the hot system is in charge. The cool system is disabled or put far in the background. (*I don't care how much you think about it, it ain't gonna change a thing. We are taking action pal, so give it up.*)

One typical hot action protects the brain through dissociation. (Everyone dissociates at some time or other. This is quite normal and usually benign. The stupor that comes from a long boring drive is dissociation.) The dissociated brain stops the horror of the event before it becomes a full real-time impossible reality. It "walls off" the event, and in extreme cases induces amnesia. It is a very healthy survival technique.

A danger response also sets off a cycle of stress hormones that zoom around the body doing lots of things like raising blood sugar, blood pressure and heart rate, and interfering with digestion. The normal process that builds short-term memory is disrupted because the brain needs to focus its attention on the immediate danger. (*No time to store this away to*

think about later, need to save the body now!) The body enters a state of hyper vigilance with an increased acoustic startle response. That particular response is a primitive reflex to threat and is seen in animals as well as humans.

All this is necessary when the body responds to a threat. The threat is immediate. You need to fix it now, not next week but now. This is short-term survival. We don't make it to long-term survival if we don't fix the short-term danger. What is beneficial for short-term survival, however, is not necessarily good for long-term health. So one hopes the trauma or stress is short-lived and quickly resolved. Then the brain will, after a time, recover from the danger signal, relax the hot system and let the cool process become more active.

Trauma Goes Over into PTSD

If the trauma is prolonged, extreme or repetitive, it can actually physically injure the brain. The best analogy is that the amygdala stays in the alert state so long that it gets "stuck" there. It keeps the body from operating a healthy combination of the hot and cool systems. The neuron pathways in the amygdala lose their "elasticity" or ability to recover. "*Hey! I am still in danger here; I need to keep the body ready to fight! OK, hippocampus, just stay cool and wait over there until I get back to you. Yo, hormones, keep 'em coming. Nobody's messing with MY survival. Liver, give me more sugar for energy, adrenals stay with me now.*" Whoa. You can see what happens. The body depletes its resources.

Remember the cool system is the one that puts things in time order in the database. (*So you don't confuse today with five years ago.*) Since the cool system stays mostly "offline" or very weakly enabled during trauma, it fails to put the right time stamp on all this activity, and so the real time trauma events stay as fragmented disconnected memory bits. With fragmented memory bits, the memory database is corrupt and has gaps. But the body keeps sensing danger and sending out stress response signals. The person keeps living "in the moment." If this goes on long enough or is severe enough, the person develops PTSD. Long after the original trauma ends, the person suffers from the symptoms. He or she lives and responds to "now" even though "now" may be a memory fragment from long ago. He or she cannot separate "now and safe" from "now and danger."

The longer the vigilant state lasts the higher the chances of permanent damage. The cool hippocampus cannot get to the long-term

memories. The amygdala keeps shutting them down. Without the ability to access the cool, cognitive solutions, the PTSD sufferer is unable to check the safety of a current event, cannot distinguish danger from safety. Current, safe events trigger flashbacks and other strange memory or emotional signals. So the brain keeps retriggering itself all over again into the hyper-alert state. Each new challenge and event is as dangerous as the last. This phenomenon is sometimes known as *sensitization*.

The injury is real. The injury is physical. It is not mere confusion or misdirected thinking, or sign of a weak character. It most certainly is not a case of "just get over it."

There is a special and sad vulnerability for children. During early development, the brain enters a hyper-alert phase as part of the learning and growing process. Children absorb an amazing of information in a short time. They learn walking, talking, communication, and how to control information. Children learn the difference between their actions and themselves. They learn to separate themselves from their environment. They build their identites. One pictures that alert little amygdala busy processing all that new information from the world, storing up experiences, defining rules, figuring out language and the power of words (*that's the terrible twos.)*, figuring out society, and "*look! See what happens when I drop the ball – it falls to the floor and makes a noise and rolls away. Will it do that again? Let's see.*" Children are wonderful scientists and natural experimenters. It must be an exciting time for the brain.

What if there is trauma? Trauma can push this alert state to such extremes that there is damage to the brain cells (PTSD). If the child stays this way for an extended time, then memories that might have become long term (and therefore retrievable later to the adult brain) are never connected. She loses her memory of childhood. And she never fully builds an integrated personality. This is not necessarily a multiple personality, although in the most extreme cases, the child can develop the Dissociative Identity Disorder (DID) that results in multiple personalities. Some people have improperly characterized all such injuries as DID. Far more common than DID, however, is the injured, traumatized personality that develops PTSD.

In the case of a young child this is especially serious. It seems as if children are born with a brain filled with templates, some complete, most needing some input from the environment to complete their structure. The child fills in these templates as she grows and learns human behavior. At

some critical point the child integrates all the templates into an executive control, an identity, a self. The safer the environment the healthier the final product. Probably by the age of six the templates are complete enough to define a whole person.

If the child completes the integration, then she/he can endure a lot of physical and mental attacks and not lose their identity. She/he will develop their own strategies for survival. If however the trauma is severe enough, then depending upon the trauma and when it occurred, one or more particular templates may remain incomplete; she/he does not integrate. Sadly, they do not know this has occurred. The painful future, the misunderstandings to come, the failures and confusions, these will all make little sense to them. They think that their brain is operating the same way that everyone else's brain does. They think they have the same genetic templates and the same completed personality. They do not understand why they have problems.

If there is enough fear, then the brain recognizes almost all real-time input as a threat, and if the links are weak to begin with, the child never learns to "touch" reality.

Acknowledge, Accept, and Accommodate

Certain problems are likely to occur with PTSD. They include panic disorder, agoraphobia, obsessive-compulsive disorder, social anxiety disorder, phobias, depression, sleep disorders, and substance abuse. These disorders sometimes precede PTSD, but may also develop after the onset of PTSD. Other medical problems like skin problems, pain, and gastrointestinal distress, also seem to be more likely to occur in those suffering from PTSD. Fortunately, successful treatment of PTSD often results in the cessation of these problems.

PTSD is real, painful, and disabling. The cost is over 44 billion dollars a year, 23 billion in direct medical costs. Fortunately, there are now effective treatments for PTSD. Acting early may prevent PTSD from becoming worse and causing problems in one's career and relationships. PTSD is treated by a variety of forms of psychotherapy (talk therapy) and pharmacotherapy (medication). There is no single best treatment, but some treatments appear to be quite promising, especially cognitive-behavioral therapy (CBT). CBT includes a number of diverse but related techniques such as cognitive restructuring, exposure therapy, and eye movement

desensitization and reprocessing (EMDR). Treatment can last from months to years.

If you know someone who suffers from PTSD, what do you do? Remember that your meta-language (body language) conveys 90% of your message. Your words convey only 10% of your message. Convey positive messages, not degrading ones. For example, in the workplace the following are not good for anyone but disastrous for someone suffering from PTSD: unstable physical environment, hostile environment, long work hours, and stress. In handling PTSD as in handling any disability, acknowledge, accept, and accommodate.

There are a large number of useful web sites on PTSD. Two of them are:

http://www.ncptsd.va.gov/ncmain/index.jsp is the Department of Veteran's Affairs National Center for PTSD and

http://www.nimh.nih.gov/HealthInformation/ptsdmenu.cfm is the National Institutes of Health site for PTSD. Both have lots of useful information.

Endnotes

[i] Monomania is a type of paranoia in which the patient has only one idea or type of ideas

[ii] In the past, the term was most commonly used to refer to "General paresis," which was a symptom of untreated syphilis.

[iii] A dipsomaniac is a person with an uncontrollable craving for alcohol. It differs from alcoholism in that it is an uncontrollable periodic lust for alcohol, with, in the interim, no desire for alcoholic beverages. Dipsomania is a dated term.

[iv] As a comparison, there are about 10^{11} stars in our Galaxy.

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