Traumatic Memory and Neurodevelopment

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Dr. Perry is an internationally recognized authority on the effects of maltreatment of children. His work has been instrumental in understanding the impact of traumatic experiences and neglect on the neurobiology of the developing brain. He is the Provincial Mental Health Director in Children's Mental Health for the Alberta Mental Health Board. In addition, he is a Senior Fellow of the Child Trauma Academy, a Houston-based organization, dedicated to education and research on the treatment of children. Both a clinician and a researcher, he has been consulted on many high-profile incidents involving traumatized children, including the Columbine, Colorado, school shooting, and the Branch Davidian siege. He is the author of more than 200 articles, chapters and proceedings, and the recipient of numerous awards. His presentation today includes Traumatic Memory and Neuro-development, as well as a proposed mechanism for the action of EMDR.

I am very honored to have this opportunity to speak to you today. EMDR has been a fascinating therapeutic approach that I have seen at work since its inception. I would like to share with you some of my musings about children, trauma, neurodevelopment and a possible mechanism for the action of EMDR.

I have worked in a number of clinical settings and when EMDR first began to emerge there were many people who were willing to stand up and say it was complete crap. However, I did not make that judgment because what I was hearing about it actually had significant biological plausibility based upon what I knew about trauma, and how the brain changes in response to trauma. Over the last ten years, we've had continuing evidence to support some of the neurodevelopmental concepts that potentially underlie the mechanisms for the action of EMDR. I have never given this presentation before, so please indulge me as I move from topic to topic before stating my conclusions about EMDR.

I am a neuroscientist by training and by temperament. The brain is an important organ. It's the organ that allows us to walk, talk, think, love and hate. All our ideas, hopes and dreams are mediated by the brain. One of the remarkable things about the brain is that it has the capacity to absorb experience. And it absorbs experiences in multiple ways and at multiple levels. One of the things I've been most interested in is how the human brain can absorb (within a single generation) the accumulated wisdom and experiences of thousands of previous generations.

In other words, I've been interested in how we invent ourselves - because, to a large degree, we are an invention. We live in a country that has invented a style of government; we live in buildings that have been invented; we use technology that has been invented; we speak a language that has been invented. English is an invention; there is no genetic approach for English. All these remarkable capabilities allow us to take experiences - patterned, repetitive experiences, and internalize them, and change our brains in ways that allow us to make internal representations of the external world. In many ways, these capabilities are the same neurobiological capabilities that make EMDR an effective intervention. It all boils down to simple principles about how the brain is organized, and simple principles about how the brain changes.

I don't expect you to become neuroscientists by the end of this presentation, but I will highlight a few important principles about neurons, neural systems, memory, and the brain that will hopefully arm you with a little more information about the clients you work with, and the experiences they have had. One of the most important things to recognize about the brain is that it Is not one big mass of billions of neurons in some disorganized array. The brain is not simply a big lump of fat. It is organized in a sensible, hierarchical fashion.

The Hierarchy of the Brain: I will be showing you a number of slides like this one. This diagram illustrates the hierarchical organization of the brain such that **the simplest functions are mediated by the lower parts of the brain**, and the more complex functions are mediated by the higher parts of the brain.

The Cortex, Limbic System, *Diencephalon (*The diencephalon is the second portion of the brain, or the part of the brain that lies between the telencephalon and mesencephalon. It includes the epithalamus, thalamus, metathalamus and hypothalamus)* **and Brain Stem:** Cognitive functioning is mediated in the cortex, and significant aspects of affect regulation are mediated in the limbic system. The diencephalon mediates lots of regulatory capabilities and functions such as sleeping, waking, and fine motor control, etc. The brain stem mediates very simple regulatory functions like heart rate, blood pressure, and the brain stem also contains neurons that are ultimately responsible for organizing and orchestrating the response to threat (which is very important for the work that we all do). The neural systems we use to respond to a threatening situation, and the neural systems that are activated during trauma originate in the brain stem, and then they send out neurons that connect with other neuronal connections all throughout the brain.

Response to Threat: When someone is threatened, a chain of neural networks is activated and goes across brain regions. I'll return to the importance of this concept in understanding EMDR later.

Neurons: This is a drawing of a neuron to illustrate that there is a linear organization to most neurons. Signals come in on the side labeled "dendrites" and they are processed and integrated. A signal coming from the whole collection of inputs to the dendrites goes down the axon to the cell body, and neurotransmitters are released and move out where they can influence other neurons. This causes the creation of neuronal networks. For example, when someone touches your finger, that physical pressure is translated into patterned neuronal activity that courses up through neurons into your spinal chord, and up into parts of your brain that allow you to realize that you're being touched, and to other parts of your brain that allow you to localize where you're being touched. This chain of neuronal connections allows us to do all of our complex functions.

Fortunately, neurons are designed to change; this is fortunate if there are abnormalities in the neural network that lead to dysfunctional output. Whether it's a physical sign or symptom, there is the theoretical possibility that neuronal systems can be changed in ways that would restore function or decrease symptoms. This is important. It's important because when you appreciate the fact that neurons change and that they are continuously exposed to various patterns of activity, it follows that some of your conceptual awareness can change with regard to your past experiences.

Therapeutic Interventions and Change: For a long time many people have believed, and some still believe that therapeutic interventions go into the brain and somehow reverse something that has already happened. You delve into a traumatic memory and release the "psychic pus," and patients get better. This is not a biologically accurate conceptualization. It's very important to recognize that therapeutic interventions. and all experiences create new memory and modify existing memory; they don't take things away. Once you've learned to ride a bicycle, you don't lose the "bicycle-riding" neuronal network for years, unless and until you begin to have degenerative disorders that are likely to deteriorate all your neuronal systems. Once you've learned to ride a bicycle there is no intervention to undo that learning, unless you activate the network of neuronal connections responsible for bicycle riding behavior. Neurons change response activation; that is, they change patterned, repetitive activation.

Patterned, repetitive neuronal activity: To recap, we know that neurons change, and that functions are mediated by changes in neurons. Neurons change in response to patterned, repetitive activity. The brain has connections to senses that allow us to translate sensory input (whether sight, sound or movement) into patterned neuronal activity, and neurons are more likely to change in response to these patterns. But chaotic sensory input leads to chaotic neuronal activity, which does not lead to a systematic change in any neuronal network. However, patterned, repetitive activity does lead to patterned repetitive neuronal activation and change.

This is essentially the basis for use-dependent development and change. And this is one of the most important principles of how the brain works. It is a crucially important element of how the brain develops, how the brain learns, and how the brain changes after acquiring a certain capability. For example, the more you practice the piano, the more you change the motor vestibular neuronal networks that allow you to internalize the ability to play the piano. The more you practice your spelling words, the more changes you make in the cognitive parts of your brain. The more you have a loving, caring, nurturing, interactive care giver when you are a child, the more you build into your brain the neurobiological capacity to form and maintain healthy relationships.

In many ways, the brain becomes an historical document. It stores experiences in an accumulative way. However, the brain is completely incapable of storing every single element of every single experience. For example, as you are sitting there - your rump is getting input from pressure transducers in the neurons of your skin and the muscles in your rump. And this is creating patterned, neuronal activity that goes to the parts of your brain that are matched with the same previously stored experiences.

Templates: The way the brain solves the problem that we are continuously bombarded with sensory input is that it creates templates against which all subsequent input is matched. Therefore, when your brain receives input from your rump today, it thinks, "Been there, done that, I don't have to waste any more molecular energy or effort, or change my neurons, I don't have to do anything because I've seen this sitting behavior before; this is familiar; this is something I've already internalized." Your brain can allow you to very efficiently go through life by adding to the brain only those things that are judged to be new. So you're not making any new affective (emotional) memories right now. None of you are making any new motor vestibular memories. None of you are making any new state memories, your physiology is not going wild right now.

As you sit there, you are only making small cognitive changes. You are using active working memory. As you listen to what I am saying, you are taking your own thoughts, experiences and ideas about this subject and mixing everything together. You're saying to yourself, "This makes sense, that doesn't make sense, what is he talking about, why doesn't he drink that water?" As your brain does all that - tiny little changes are occurring in your cortex. Some of this information will go to your short-term memory, and if you get some sleep tonight, it will go on to your long-term memory. So as you listen to this talk your brain is making tiny little changes in cortical memory, but it is not making any big changes in other parts of your brain.

Memory: The important point is that memory is within the capacity of the brain, and other biological systems. The brain is specifically designed to take some elements of one moment in time forward in time. Later we'll talk about why traumatic memory is different from typical daily experiences, but keep in mind that memory is actually a lot more than cognitive memory; a lot more than remembering names, faces and phone numbers.

When most people think about memory, they tend to focus on cognitive memory, but neural tissue stores experiences in many areas. Your brain stores experiences in your spinal cord, in your brain stem, in your motor vestibular system, and in all the limbic areas, so that you are able to create cognitive memories, affective memories, and motor vestibular memories - like typing. The fetal position is a motor vestibular memory. And then there are state memories.

State Memories: An example of a state memory might be something like the following. You are a Vietnam veteran and you're walking down the street. You hear a car back fire, and your heart rate goes up. This is an example of a state memory, a brain-stem mediated memory.

The brain is an historical organ. The brain stores our experiences in a sequential fashion based upon our development, and based upon the nature and quality of our experiences. In the brain that you and I have right now with our ideas, beliefs and motor capabilities (or lack thereof), these things don't just pop into existence. They don't just have a genetic

predisposition, so that we're able to speak English, or type, or form and maintain healthy relationships automatically. All these capabilities are a function of a genetic potential, and the expression of that potential based upon experience.

Therefore, the young child who is never spoken to, will never learn to speak a language. The young child who is never held, rocked and given the physical manifestations of love will not develop the neurobiological capacity to form intimate relationships, and will be incapable of love. The child who is never given the opportunity to walk (and sadly enough I've actually seen kids like this), will not develop the motor vestibular capability to walk. The brain develops and the templates (like the rump-sitting template I mentioned earlier, which accesses the motor vestibular memory that we use all the time) - come into being. The first time you were sat on your rump, your brain received a whole bunch of new signals, and it went, "Whoa!" Have any of you ever seen how babies respond when first placed in a sitting position? Their eyes get wide, and their arms flail, and they look at you as if to say, "What is this?" This is because we have a tremendously redundant and over-developed apparatus to read and respond to threat, and I'll say more about that later. This means that any new pattern of neural input that comes into the brain is judged as potentially threatening, until proven otherwise.

The brain is a very conservative organ. Any of you who have tried to introduce EMDR to your community as an effective therapeutic approach know this is true**. When people see, hear or experience something new, their brain will almost invariably default to it being a bad thing - until it's proven to be safe and harmless to them individually.**

The templates we have are put in place during development. This is a very important point, and one of the most important points that I'm going to make today. **The brain develops sequentially. The brain stem has templates (just like every other part of the brain), and you need your brain stem when you are born to be functionally organized. You don't need your cortex at first, you don't need to engage in abstract thought as an infant, you don't need to have fine motor control, you don't even need to regulate sleep and light as an infant. But you do need to regulate your blood pressure, your heart rate and your respiration. Therefore, because the brain develops in a use-dependent way in response to experience, when an infant is born there will be certain template memories that have been ingrained in the infant's brain stem based upon experiences in utero.**

In Utero: Brain growth is so rapid in utero that there are moments in the third trimester when 20,000 new neurons are created per second. **Sixty-five percent of the calories you consume as a newborn are used by your brain, whereas only 18% of the calories you consume as an adult are used by your brain**. Take a look at this chart and compare the brain of a newly fertilized egg in a small fetus with the brain of an infant. This growth takes place over a period of two years. If I changed as much over the next two years, I'd be the size of Iowa!

Primary Relationships: During this process of explosive growth in the first years of life, the brain is creating template memories that will be used throughout life. Many of you, who are interested in attachment and attachment theories, know this is one of the basic reasons why primary relationships early in life are so important. Primary relationships create the relational template against which all subsequent human interaction will be compared. If this template makes an association between an intimate connection with another human being and fear, unpredictability and threat, it's going to have significant consequences in your ability to form and maintain healthy relationships. On the other hand, if you have had a care giver who is loving, nurturing and attentive, one who has met your needs, your internal template for what human beings are like will be positive.

In short, the sequential acquisition of memory is what development is. This means that the early experiences that first shape these organizing systems have a disproportionate power, because they become the filter against which all subsequent input is compared.

Maternal Heartbeat: This is very important for understanding the mechanism for the action of EMDR. In utero, the most powerful, patterned, repetitive sensory signal that the developing brain is exposed to is the maternal heartbeat. As the aorta moves it creates a powerful vibrating and auditory rhythm, which activates the brain stem for months and months, which in turn creates and organizes the brain stem and diencephalic system - which will ultimately be used in regulating sleeping and waking, and other kinds of rhythms. These neuronal networks, these core foundational templates are organized in response to patterned, neuronal activities which are guided and shaped by the maternal heart beat. Because of the way in which the brain makes an association between things that co-occur in time, this pattern becomes associated with being in utero where the fetus is warm and safe, and not hungry, etc., etc. See where I'm going with this?

This gives us a powerful insight into how to recreate a sense of safety in someone, to recreate a sense of calm and comfort. Isn't it interesting that every single Aboriginal healing ritual that involves grief or loss, involves patterned, repetitive dancing or drumming at a frequency of roughly 80 beats per minute, which is comparable to the maternal heart rate in utero?. Isn't it interesting that when children who are retarded or autistic get overwhelmed and engage in self-soothing behavior like rocking or head banging, it's at a frequency of 80 beats per minute? Isn't it interesting that when someone chants or says their rosary beads, it's at a frequency of 80 beats per minute? All of these things are self-soothing and we do them almost automatically, because they make us feel better. I'll go into this further when I discuss EMDR.

One of the most important and challenging things about development is that the templates you use in your brain for emotional, social and cognitive functioning are put in place in response to your first experiences - primarily during the first year of life. If you look at the growth of the body from zero to twenty, it's linear. But if you look at the

growth of the brain from zero to twenty, it plateaus, so that by the time you're four years old, the brain is 90% adult size. Of course, it's not 90% adult functioning yet, but this is analogous to what would happen if you built a sky scraper and initially took 90% of your budget, 90% of your time and materials to build the foundation and the super structure (the wiring and plumbing, etc.). While you're not quite ready to occupy the building yet, when you are ready to occupy it, the functional capabilities of the building would be directly related to the job you did in the beginning. And this is exactly the case with children.

Therefore, because of the sequential development of the brain and its tremendous malleability early in life, early life experiences play a remarkable role in shaping how the brain functions. Early experiences create a cascade, or sequential set of cognitive, emotional, social, and physiological templates that we carry around with us, and use as we go through life.

This is a little introduction to the development of the brain, how important the ingrained templates are, and a suggestion about how certain rhythms are associated with powerful chains of neuronal connections that can affect parts of the brain that cause people to feel calm, soothed and comforted, and now let's look at trauma.

Trauma: As previously stated, the brain changes in a use-dependent way. Therefore, when you are exposed to traumatic experiences, the neural apparatus in your brain that is designed to help you perceive, process and react to threat is activated - and it is activated in a sustained way. Consequently, depending upon a variety of circumstances, these systems can be turned on for a long period of time, and/or they can be turned on for a short period of time in response to specific patterns. For example, children raised in a home where there is domestic violence will often have their neural systems associated with threat activated for days and weeks and years, and this literally changes how their brain is organized - how their neural systems mediating threat are organized, and how they function.

Hyperarousal and Dissociation: Your brain has multiple choices in response to threat. Depending upon your previous history with trauma, depending upon your age and the nature of the trauma, you will use one or a combination of both the adaptive responses: hyperarousal and dissociation.

Both hyperarousal, the classic flight or flight response, and dissociation are mediated by neural systems that originate down lower in the brain and involve activation and changes in neural functioning from the brain stem to the diencephalon, to the limbic system, and to the cortex. Use dependent changes are likely to occur throughout all of these regions in response to threat.

The classic fight or flight response involves increasing your heart rate, and sending blood to the periphery of your body to prepare you to fight, or run away. However, if you are involved in an inescapable situation, it would be foolish to move all your blood to the periphery of your body, because you could bleed to death, if physically injured. Therefore, it makes more sense to decrease your heart rate, keep your blood in the trunk of your body, and release opiates so you can tolerate pain - and hopefully use other defense mechanisms.

If you are in an inescapable situation you can freeze and play dead, and in that way not attract predators. There are many reasons why the dissociative response is highly adaptive under certain circumstances, and why the fight or flight response is highly adaptive under different circumstances.

Both dissociation and hyperarousal have a continuum, and both are normal. Right now, many of you are dissociating to some degree, and this is absolutely normal. You are probably modulating how much to focus on what I'm saying, and how much to focus on your own inner thoughts, ideas and dialogue. This is appropriate.

However, if you are forced to spend a tremendous amount of time in a dissociated state, because you are in an overwhelming and inescapable situation (like a young girl who is being repeatedly sexually abused) the dissociative neural biology in the brain becomes sensitized, and you might begin to use that adaptation in response to any kind of incoming threat or challenge.

Similarly, if you spend a lot of time in the fight or flight response, you develop a neurobiological alteration that makes these systems hyper-reactive in response to any kind of threat, any kind of challenge, any kind of cue, and any kind of novelty. And this is a profound problem.

Based upon what I've covered, I think you can appreciate that there's a difference between a child who grows up in a traumatizing situation, and adults who are exposed to trauma. If an adult has no pre-morbid experiences with trauma there is every reason to believe that their internal templates and internal biology regarding their response to stress is pretty normal, until they are traumatized. Then they have a trauma, and there will be use-dependent changes in their brain, which will change these systems.

However, if you have traumatic experiences early on when the neural systems that are responsible for the fear response are developing, **this will create pervasive hypersensitivity to threats,** to challenges, to all kinds of things. Some believe that borderline pathology may be a result of this type of experience. ***We certainly know that high risk children, who come from chronic chaotic environments literally change their baseline responsivity to every single cue. Whereas adults, like a combat veteran from Vietnam with good pre-morbid functioning develops hypersensitivity only to combat-related cues.***

This slide illustrates some important points about how likely someone is to carry forward trauma-related changes in their brain. As previously stated, the brain changes as a function of use. The neural systems that respond to threat, if activated in a persistent and repetitive way, are much more likely to change than systems that are transiently activated and then restored to normal. This is a primary justification for the use of interventions in the immediate post-traumatic period - any intervention in the immediate post-traumatic period that can help someone feel safer, that can decrease their level of arousal, that can decrease the inappropriate over-activation of their hyperarousal system, is likely to lead to less long-term trauma related symptoms. And there are a variety of interventions that can do this.

The Arousal Continuum: This diagram illustrates the arousal continuum. It ranges from calm to vigilant, to alarm, to fear and terror. These are simply labels for different points along this continuum. **The important point to remember is that the neurobiological systems that are activated when you are calm are very different from the neurobiological systems that are activated when you are in a state of terror. Therefore, the use-dependent changes that take place in the brain when you're in a state of terror are different from those that take place when you're in a state of calm.**

September 11, 2001: For example, if you were a child sitting in a classroom in Soho on 9/11, and you saw two planes crash into the World Trade Center, your sense of safety would have been challenged. If your father worked in the World Trade Center, your fear for his safety would have been very high. Such a child would have gone to the state of terror (at the end of the arousal continuum) and stayed there, especially if there was no word about his father for a long time. And then if he heard that his father had died, it would be even worse. Such a child would not only stay in a high state of arousal for a long period of time, but he would have fewer supports because, as you know, the major mechanism for decreasing a child's sense of threat and fear after trauma is his parents. So if the traumatic experience impacts a parent in a way that makes it impossible for that parent to attend to you, you are much more vulnerable.

If a child sitting next to you had no parents working in the World Trade Center, he might have an immediate sense of threat, but if there was a rapid response from his family (if they came to the school to pick him up), he would feel safe - and over time he would move back down the arousal continuum fairly quickly.

The middle child shown in this chart has pre-existing problems. He has a hyper-sensitive threat response system, because he lives in a home where there is domestic violence. Therefore, his ability to modulate a current traumatic experience is impaired, and he spends a longer period of time in a high level of stress. Those of you who follow the literature know that the children who had pre-exiting problems were the most likely to have enduring symptoms after the bombing in Oklahoma City.

The next category pictures those who were physically distant from the World Trade Center, people who probably had a transient sense of distress at first, but did not go all the way up to terror on the arousal continuum. And then after a week or two they went back down to calm, and few developed trauma-related symptoms. As I said, the brain changes in a use-dependent way.

The Branch Davidian Disaster: This slide depicts our clinical work with the Branch Davidian children. You may remember the ATF disaster where the Branch Davidian compound was raided. There was a shoot-out, and over the next three days (after the original assault), 21 children were released, and went into the care of the Child Protective Services in Texas. We led the clinical team that worked with these children.

Among other things, we took the resting heart rates of these children at various times throughout the day. The black line on this slide depicts a heart rate of 100, which is average. Anything above 100 is abnormal for children this age. Five days after release, the group mean for these children was still 134, which is very high. And this figure includes the resting heart rates of children who were dissociated - so you can imagine how high the resting heart rates were of the children who were hyperaroused. Not only were their heart rates high, but the readings listed on this chart were at five day intervals, so we're talking about many weeks in a high state of arousal.

The interesting thing is that these children were waking up in the morning, washing, dressing, eating breakfast, interacting with others, playing games, and sometimes even laughing. They actually looked quite normal, if you didn't know what was going on inside of them.

State vs. Trait: If a child (or an adult) spends an extreme amount of time in a state of high arousal what happens is that what was once a state (the state of fear) becomes a trait. That is, they perpetually walk around with the internal physiology of fear, which impacts the way they think, the way they feel, and the way they behave. Most of us are fortunate enough to have a linear relationship between external threat and our internal state of arousal. For example, if you look at the arousal continuum on this chart - here is where I began this morning. I woke up at 3:00 o'clock and didn't know where I was (which sometimes happens when you travel too much). Once I realized where I was, I knew that I had three more hours to sleep. I went back to sleep, and then woke up a little late. I rushed to get dressed, and when I thought about giving this talk (which I've never done before), my anxiety rose to this level. Now, I'm actually giving the talk and my anxiety has risen to this level. And when I finish, I'll have to rush to catch my plane, and I'll be up here. Then I'll have a beer on the plane, and my anxiety will lower to here.

This example shows a linear relationship between how I feel inside, and what's going on outside. ***But children and adults who have been traumatized tend to stay in a high state of alarm. Therefore, they can move all the way up to the fear state in response to a relatively minor shift in distress. And they can become terrorized in response to moderate***

stressors. This is why they frequently have a disproportionate set of responses, cognitively, emotionally and behaviorally to threats and challenges.

State Regulation Memories: One thing that happens with people who have traumatic memories is that they have state memories. They don't just have a cognitive recollection of the event. When they have a cognitive recollection it taps into their affective memory that makes them feel distressed and anxious, and this taps into a state regulation memory that taps into the physiology of fear. Therefore, ***the process of merely thinking about the traumatic event can recreate the physiological state that was present during that event.***

Case Example of Dissociation: This diagram shows the continuous heart rate of a three year-old child who witnessed the murder of his sister. This is during the free play part of his session when I was sitting with him, and engaging in parallel play. We weren't talking, we were simply coloring together. Where the blue line jumps up and changes to green was when I asked him a "neutral" question, which is sort of a joke. We have a fantasy that if we ask a child what they like on their pizza, or what their favorite movie is that that's a neutral, child-friendly interaction. It isn't, not when the person asking the question is a six foot adult. This diagram clearly shows that the mere act of asking him a question increased his state of vigilance, and moved him further along the arousal continuum. And here we see a movement artifact which occurred when he stood up and walked around.

We knew that one of two people had killed his sister. At this point, I asked him the name of one of the suspects and his heart rate went way up, and he froze. (This person turned out to be the actual murderer). As you may have noticed with children like this, they have a certain fluid movement, and then when you ask them a pertinent question they literally freeze. They stop blinking, and their heart rate begins to go down. As this child moved down the arousal continuum, he began to dissociate, which is a very common pattern. Different people begin to dissociate at different points along the arousal continuum, and this is where he began.

I ***didn't ask any further questions; I just let him sort of melt. After a period of time he came back and began to have fluid behavioral interaction again. Here I asked two more neutral questions, and then I asked about the murderer one more time. The point is that the mere act of cognitively stimulating his recollection of the trauma was enough to activate a chain of memory down through multiple areas of his brain, including all the way down to his brain stem, which increased his heart rate.***

As stated, individuals who are exposed to repetitive traumatic experiences, or even one traumatic experience that has the capacity to persistently activate these neural systems will lead to a resetting of their homeostats, their templates for regulating and modulating stressors.

Dissociation and Hyperarousal: Depending upon which system you use, you will end up with predominately dissociative symptoms, or predominately hyperarousal symptoms, or a mixture of the two. Several things appear to be associated with making a choice between one adaptive response, or the other. Females tend to dissociate more than males, and there are several reasons for this.

The younger you are when traumatized the less effective the flight or fight response is. A two year old can't effectively flee or fight, so they tend to dissociate. Whenever you are in an inescapable situation, and when there is actual pain involved, you are much more likely to dissociate than to use a hyperarousal response. The pattern of symptoms that evolve after a traumatic event will reflect the system which has become most altered, and most sensitized.

A little boy who witnesses domestic violence (but who is not being assaulted himself), and his flight or fight response is activated again and again and again, will end up with hypervigilance and behavioral impulsivity. He will look as though he has Attention Deficit Disorder and Conduct Disorder. And when he is sent to see a psychiatrist, that's what he or she will probably say. He'll be given Ritalin and there will be partial efficacy, and there will probably be no appreciation of his trauma-related history.

On the other hand, a little girl who is repeatedly sexually assaulted will be excessively compliant. She will have dissociative symptoms with a low resting heart rate, and may have little periods of tuning out where people think she is day-dreaming. These children frequently get written up for absentia. They can also have syncope (a transient loss of consciousness due to inadequate blood flow to the brain).

This little boy might walk down the street and see two people fighting. Since he is sensitized to this kind of experience, his heart rate will increase, because that's the way he habitually responds to violence. But if you're a little girl who has been serially sodomized by someone who uses Old Spice Aftershave, and you walk through the mall and someone wearing Old Spice passes by, your brain will activate your habitual response to threat, and your heart rate will decrease, and you could faint. Syncope of unknown origin is a very common presentation of a sensitized dissociative neurobiology.

This is a potentially useful diagram that articulates what happens when people move along the arousal continuum. What happens to people when they feel increasingly threatened? Let's look at each stage of the arousal continuum (from calm, to vigilant, to alarm, to fear, and then to terror).

How Arousal Affects Behavior: When you're in a safe environment and feel calm; when you don't feel threatened, the smartest part of your brain is in control. This is when you have your best ideas; this is when you're most abstract; this is when you're able to take in information and put it together. You all know that your best ideas, your "Ah ha" moments don't come when you feel threatened. They come when you're out for a walk; or they come over the weekend, or they come in the morning when you're taking a shower, or they come when you're driving home from work. They never come at work. We think that we do our best thinking at work, but the truth is that we get dumber at work because we go to arousal.

What happens at work is that we worry about what's going to happen during the next appointment; we have a bunch of phone calls we have to make; people are interacting with us, etc. The more external stimuli, whether human or non-human, the less capable we are of having the quiet, safe solitude that is required for remaining calm. ***The more frenetic things are at work, the more overloaded we feel, the more we move along the arousal continuum. If we are asked to make decisions in the middle of chaos, they will tend to be emotional and reactive. So most people at work go through automatic, concrete activities, and are less creative than when they are away from work and feeling calm.***

Vigilance: None of you are in a calm state right now; you're in a vigilant state, a low level arousal state. You're focusing on what I'm saying to some degree, and you're taking information into active working memory. Later on when you're working out, or having some quiet time, some of the things I've said will pop into your brain, and you may say to yourself, "That's an interesting idea, I wonder if that's why A, B or C occurs?" Your brain will work with this information later on when you're quieter.

Alarm, Fear and Terror: The more you move along the arousal continuum toward the alarm state, the dumber you get. This is because the lower you get in your brain the lower the locus of control is. And when you are in a state of terror, you are incapable of abstract reasoning; you respond reactively. You have no sense of time; you're basically in a state of primitive panic.

Think about what it's like for children and adults who are traumatized. When they wake up in the morning and go to school or work, they're already in the alarm state at baseline. Their brain continuously scans the world looking for potential threat-related cues. So they will over-read an expression. If they're in therapy with you and you happen to look at your watch, they'll interpret that as a rejection and think something like, "Clearly they don't want me here; clearly they're bored with me; clearly they're doing this just for the money, etc., etc." It depends upon how sensitive they are, but they will misinterpret all kinds of cues.

People who are in a state of vigilance focus on different things than people who are in a state of calm. Traumatized children tend to develop a tremendous sensitivity to non-verbal information, and end up with higher performance scores than verbal scores on their IQ testing, which can lead to a whole cascade of problems (and we can talk about that at the workshop later). There are several things that are important about this with regard to therapy. Very often we will do things during a therapeutic interaction that will move people along the arousal continuum, without being aware of it. It may be something as simple as the way we are dressed, or the way we move. It might be a whole set of simple things that are related to the patient's memory.

How the Brain Changes: The difficult thing about approaching maltreated children or anyone who is traumatized, is that we have the challenge of trying to help them change their brain. That's what we're trying to do, right? ***We're not trying to change their pancreas, or strengthen their bones, we're literally trying to influence the way their brain functions. So we need to know how the brain is organized, how it changes, and what the challenges are that a person in a high state of arousal poses to someone who is trying to help them change their brain, particularly the part of the brain that mediates their high arousal.***

Belief vs. State: When it comes to change, the challenge is that <u>not</u> all parts of the brain are equally changeable. The brain is plastic and malleable; the brain can change - we wouldn't be here if we didn't believe that. But it's important to appreciate that it's much easier to change a belief than it is to change a state. **Because of it's organization, the brain is much more malleable in cortical areas (where we have <u>50% of our neurons</u>) than down in the brain stem. If you think about it, this makes good sense. Once the brain stem is organized, you don't want to fool around with the neurobiology of heart rate regulation, or body temperature regulation. You don't want to be responsive to big environmental shifts in temperature; you want to be stable.**

On the other hand, in the cortex, where you're making associations between things like the growl of a saber tooth tiger, and a saber tooth tiger, you don't have four or five opportunities to learn that. You pretty much want to get that on the first time around. So the brain needs to make quick cortical associations, and change that part of the brain quickly. Therefore, the higher you get in the brain the easier it is to change, and the lower you get in the brain the harder it is to change.

Trauma-Related Symptoms and Conventional Talk Therapy: Trauma-related symptoms originate in the brain stem. They also involve the diencephalon, the limbic areas and the cortex. **So trauma-related symptoms literally permeate the entire structure of the brain, making it much more difficult to change them.**

One thing that makes it most difficult to change trauma-related symptoms is that <u>you cannot change the brain stem, unless you activate the brain stem</u>. **I can't change the motor-vestibular biology in your brain by talking to you. If the symptoms we're trying to change are in the brain stem, and we're doing nothing to activate the brain stem,**

it should be no surprise that it doesn't change. This is one reason why conventional therapeutic approaches do not work as efficiently as they could with people who have trauma-related symptoms.

Trauma-Related Symptoms and Medication: The way we've chosen to reach and change the brain stem (rather than doing it experientially, which is the best way to change the brain stem), is through medication. But there's not a single medication that can create a new memory. ***Medications can be very helpful adjuncts to treatment, but the truth is <u>they're not going to make the primary changes that are required for enduring change</u>.***

Pre-Cortical Associations: We've covered the fact that when the brain has a set of experiences for the first time, it creates a template. That template is essentially a homeostasis, a pattern of neural activity that is familiar. Whenever you depart from that familiar range of neural activity in any given area in the brain, it creates a new memory. If an incoming signal doesn't shift or change any homeostasis, you're not going to get a new memory.

As I said earlier, you're not changing your vestibular memory for sitting right now, because you're not getting out of your homeostatic range for sitting behavior. If you were all sitting on chairs with a 10% tilt, your brain would receive that information and think, "This doesn't feel right; this chair is supposed to be even and it's not even," and you would feel awkward and uncomfortable. But ultimately, your brain would move its homeostasis to include this 10% shift in sitting behavior.

Novel stimuli activates the arousal system. This is something that is very important therapeutically, particularly with someone who has a sensitized arousal system. If you introduce new things to such people, you may push them further along the arousal continuum, which sometimes makes it much harder to work with them.

As previously stated, the brain has a remarkable capacity to make associations between things that co-occur in time. Our eyes and our ears have completely different sensory input into the brain. However, our brain takes the incoming input and is able to connect these two things in certain parts of the brain. If there is efficient sequential sensory processing, the sights and the sounds that occur simultaneously get to the brain at the same time, and are integrated there.

If you have a sensory processing inefficiency like a lot of traumatized children do, the sound will get there a millisecond slower than the sight, and you'll go through life as though it's a poorly dubbed Japanese movie. This sometimes happens to traumatized children. **They see lips move and then they hear the words - it's a dis-synchronous experience. But for most of us with pretty good sensory processing - the information comes in and gets associated simultaneously.**

During a traumatic experience, because you are activating systems in your brain in a way that you haven't done before, you shift homeostats throughout different parts of your brain. And you may make associations between things that occur during the trauma that may not be relevant to threat. **That is, you may make false associations and generalize from one unknown person of one ethnicity (who happened to be the person who robbed you in a parking lot), to all unknown males of that same ethnicity. This is a false generalization; it's not healthy, and it's not productive. It results in you being continuously bombarded by cues that reactivate your fear response. Therefore, one of the most important things about therapeutic approaches is to stop the inappropriate generalization of trauma-related cues.**

The second really important thing about associations is that the first time information comes into your brain its first stop is in the brain stem. Sight, sound, feeling - all sensory experiences from a traumatic event go to the brain stem first. As I mentioned, the further along you get on the arousal continuum, the lower in your brain is the center of control. Even at the level of the brain stem, there is a level of association, and processing, and acting on incoming information; traumatic memory creates a regional association. In other words, within the region of the brain stem, associations will be created by traumatic experience.

As I said earlier, a traumatized Vietnam veteran might be walking down the street and hear a car backfire, and all of a sudden his heart rate goes up, he has a startle response, he jumps, and he feels anxious. This is because the associations in his brain stem and diencephalon of a loud noise lead to an automatic pattern of action <u>before</u> the information can reach his cortex for him to be able to think, "It's 30 years later; I don't need to be afraid of this noise." Once you activate such a pre-cortical process you are already in a state of arousal. Let me give you a couple of examples of how powerful this phenomena is.

Pre-Cortical Associations of Combat: I had a patient who was a Vietnam veteran. He had served a couple of tours of duty in Vietnam, and he was a really good guy. He came back and married his high school sweetheart, and went to work at a local factory in a small town in Connecticut. He became a foreman, and was living happily ever after, until one day he woke up at four in the morning. His brain was flooded with images of Vietnam, and he was in a cold sweat, in spite of the fact that he had not thought about Vietnam for years. He was pretty stirred up, but he got dressed and went to work. He kept thinking about Vietnam all through the day, and ended up having a couple of beers after work to make him feel better.

The next morning, he work up at 4:00 A.M. with the same memories. And this happened repeatedly, and pretty soon he was overwhelmed. He was drinking too much, and he began to get into trouble at work. So in an act of desperation he went to his local VA Hospital, where I was working. That was my first assignment after leaving medical school. During my training, I had been on an ICU unit making 50 decisions a day, but I had no experience in the practical use of psychiatry. You know how it is when you're first starting out. The first week at the VA, I was given a list of patients to see, and told to meet with my supervisor at the end of the week. Well this patient didn't know what to expect, and I didn't know what to expect - and it was pretty pathetic.

Nothing I tried worked, and he got worse and worse. After about six months of this, I opened the newspaper one day and noticed an article about Sikorsky helicopters, and the small town where he lived. I called them up, and sure enough, to the day that my patient remembered waking up early, they had changed their test flight patterns so that they flew over his house at four in the morning. So he was asleep, and his brain pre-cortically processed that experience, and the sound of the helicopters activated his trauma-related symptoms.

Pre-Cortical Associations of Abuse: Another case involved a child who had been sexually abused by his father for the first few years of his life. He was finally removed from that setting and placed in a foster home, where he was physically abused by his foster parents. At one point, he was pushed down a flight of stairs and ended up in a hospital, in a coma. So here's a child in a coma, attached to a heart rate monitor and non-responsive cortically. The whole top of his brain was basically dysfunctional. And yet we could place one of his father's T-shirts under his nose, and his heart rate would go from 84 up to 136. This is pre-cortical association, and it happens all the time. This is what first impressions are.

First Impressions: You have a whole set of stored experiences in your brain that your brain is continuously matching to new experiences. So when you meet someone for the first time, and he looks a certain way, and moves and talks a certain way, your brain compares him with all your previous acquaintances, and you may walk away and think, "I kind of like that person," when you really know nothing about him. He could be someone like Ted Bundy for all you know.

Memory Chains: During a traumatic experience, the brain stem mediated threat response systems are activated in extreme ways. The incoming information creates brain stem memories. In processing this information, it moves up through the brain and forms a set of associations across regions. This essentially makes a chain of traumatic memory: a cognitive memory component that's connected to an affective memory component, that's connected to a state memory component. You can tap into and activate this entire chain in a variety of ways. You can have an **olfactory cue** that will activate this chain from the bottom up, like the comatose child, and you can have a cognitive recollection that will active this chain from the top down, like the child I asked about his sister's murder. The longer someone is untreated, and the more pervasive their exposure to traumatic cues is, the more they are going to reinforce this chain of memory. It's going to become ingrained and powerful. **And here comes EMDR**. You know where I'm going with this, right? **You can't change any part of the brain unless you activate it.**

Trauma-Related Symptoms and EMDR: My understanding of the EMDR therapeutic approach is such that EMDR therapists cognitively activate that traumatic chain within their clients, and then provide a very powerful competing brain stem signal, which essentially short-circuits that chain.

Remember that because a traumatic experience is such an extreme event, you move out of your homeostatic state not just cortically and affectively, but all the way down to the brain stem. So you have a chain of cognitive, affective and state memories that span the brain - that go all the way through the brain: the cortex, the limbic system, the diencephalon, and the brain stem. That is, the incoming sensory input from the trauma creates an inter-connected neural network that sends a set of memories to different domains within the brain. And you can activate that chain of memories through a whole variety of cues.

Ways to Stimulate Memory: In the article I gave you, I talk about ways memory is stimulated from the bottom up. Patterns of brain stem activation that are reminiscent of the trauma can activate a chain of memory so that you actually <u>feel</u> distressed as you think about the event. The example I used was of a woman who was raped, and one of her recollections was that her heart was beating so fast she thought it was going to come out of her chest. After that whenever she exercised and her heart rate rose to a certain level, she would begin to feel distressed, and think about the rape. By activating memory at a state level, the brain stem signal that is reminiscent of the trauma can tap into that chain. Similarly, a cognitive recollection of that traumatic experience can tap into that chain, or an affective (emotional) interaction that's reminiscent of the event can tap into the chain. You can tap into the memory chain in these various ways, but once you've done so the memory is activated. So be aware that when you ask someone to recall a traumatic event, their physiology will change and they may feel the same distress they felt initially.

How do you break that chain? The truth is that it's very appropriate for people to recall what happened, but somehow you want to disconnect the cognitive recollection from the extreme distress, and prevent the pervasive generalization, or inappropriate generalization to all kinds of other situations.

EMDR short circuits traumatic memory. What does EMDR do when someone activates the neural chain? What is a much more powerful chain of memories? Right, **the maternal heart beat.**

The brain stem is a pretty dumb organ; it can't contain two states at one time. The most powerful and deeply ingrained pattern of sensory activation in your brain stem is the memory of the rhythmic maternal heart beat that you experienced in utero, which was reinforced during the first years of your life as you were held and rocked by your mother. **For people who had a healthy experience in utero, and good perinatal attachment experiences, the most powerful way to compete with traumatic brain stem activation is to provide a patterned, repetitive, sensory signal <u>that competes for association between a cognitive recollection and an affective state</u>.**

Predictions: Based on this concept you can make certain predictions about how EMDR will work, and the people who might be easiest to work with, and people who might be harder to work with. And you can predict that other kinds of

activities that have similar characteristics might also have therapeutic potential (like drumming and dancing). As I alluded to earlier, **one of the most powerful sets of interventions that I've seen in dealing with traumatic experiences are Aboriginal healing rituals, which involve the three core elements that EMDR involves**. Since the traumatic chain involves cortical memory, affective memory, and state memory, you need to have an intervention that taps into these areas.

Conventional therapy has components that are cognitive and affective (transference is the affective medium). This form of therapy works in many cases where the symptoms reside in the higher parts of the brain. However, what has been missing in treating traumatic experiences with conventional therapy is the component that activates and changes the brain stem. I believe that EMDR activates and changes the brain stem.

The best practices of EMDR involve forming trusting relationships with your clients. You talk about the procedure, and give them information. So there are cognitive elements to it, there are affective elements to it, and then there is this powerful brain stem element. This is why I think EMDR is an effective intervention.

Aboriginal healing rituals all involve the same elements: there is a belief system, a cognitive understanding about why this person is ill. There are values and beliefs that are part of the healing ritual that are made explicit and repeated. There's also a very powerful affective, relational and social component, because other members of the community are brought in. And they drum and dance together, or do some variant thereof, which activates the brain stem. It's very interesting that diverse cultures all across the globe that have no social or cultural interaction with one another develop the exact same elements in their healing rituals independent of what continent they are on, or what their overall belief system is. I'm convinced that this is because it works.

We've started to use music and movement with our traumatized children, and it has worked better than conventional approaches. We still have a lot more to understand about these interventions, but this is something that the conventional medical community is not likely to enjoy hearing. The pharmaceutical industry is not going to like it either, but there is neurological plausibility to this approach.

It's an absolutely biological certainty that you cannot change the brain stem (where traumatic symptoms originate) without activating the brain stem. EMDR provides a positive or neutral patterned, repetitive, predictable brain stem experience, at the same time that the patient is recalling a painful cognitive experience, and this short-circuits the destructive chain of memory. I think that's how it works.

Predictions for Efficacy: You might predict that people who did not have a healthy pre-natal period in which to build their original template will not respond as easily to a patterned repetitive intervention. This would be true if there was extreme chaos during pregnancy, or fetal alcohol syndrome, or some other experience where a child was born with a temperament that caused him or her to be extremely difficult to soothe, to have difficulty with state regulation, and where there was no remediation after birth.

This means that a lot of high-risk children who were exposed to pre-natal substance abuse and/or pre-natal chaos are not going to respond to a consistent pattern like a normal maternal heart rate. The heart rate they were exposed to was all over the place, so they were unable to build in a capacity to utilize that healthy template. Therefore, you might find this population relatively unresponsive to EMDR. However, this population might respond very well to somato-sensory patterning, <u>various things that can help build in a healthy capacity to regulate their brain stem (like music and dance)</u>. Similarly, people with profound attachment problems are not going to have as fixed or powerful a chain of association between maternal heart rate and positive things, so they may be relatively less responsive than other populations.

Another thing you can predict based on a study of the brain is that a single traumatic event is much more likely to be responsive to treatment than multiple traumatic events. The weaker the traumatic chain is, and the shorter period of time between when you intervene and when the chain was originally laid down, the more likely you are to have a positive outcome - and the fewer traumatic chains there are the more likely you are to have a positive outcome. And these are some of my musings and conclusions about children, trauma, neuro-development, and a possible mechanism for the effective action of EMDR.

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