Hypnosis and the Autonomic Nervous System

The Triune Brain Model

To understand how hypnosis influences the brain and the nervous system, let's begin by looking at neuroscientist Paul MacLean's triune model of the brain. As may be aware, the human brain develops in three phases. Sitting at the base of the skull, the reptilian brain supports our most basic survival needs and includes the brain stem, cerebellum, and basal ganglia. You can think of this region as the "body brain" because it connects the brain to the spinal cord and controls the nervous system and essential functions in the body that keep us alive, even when we're unconscious.

Next, mid-regions of the brain develop that MacLean called the mammalian brain, or what I like to call the emotional brain. In addition to being the seat of our emotional responses and attachment instincts, this area of the brain is also involved in procedural learning, motivation, and memory. The limbic system and the amygdala are located in this region, and it is this area of the brain that assesses potential threats and triggers the fight-flight-freeze response. We are going to talk a lot about the emotional brain in today's lesson, and throughout the course.

But first, let's discuss the last region of the brain to develop-- the neocortex, or "thinking brain." It includes the top, outer most regions of the brain. The prefrontal cortex sits right behind your forehead and it is where we engage our logical, analytical thinking, verbal reasoning, and conscious decision making. When we are at a mild to moderate level of stress, we can use our thinking brain to regulate the emotions and impulses coming from our mammalian and reptilian brains. But, when stress is high, the emotional and reptilian regions of the brain can hijack our thinking brain and cause us to act impulsively or irrationally.

To explain this to clients, I like to use Dan Siegel's "handy" model of the brain. First, you want to make a fist with your hand, with your thumb turned in toward your palm and nestled under your closed fingers, and invite your patient to do the same with his or her hand. Next you can use the following script to show the patient how the three regions of the brain are structured and interact under stress.

"To help you understand how stress affects us, we can use this hand model of the brain. Humans actually have three brains in one. In this "hand" model the wrist represents your spinal cord. The base of your palm represents your reptilian brain, or your primitive survival "body brain." Your reptilian brain is fully developed by the time you are born and controls your blood pressure, circulation, digestive system, and nervous system and is most concerned with basic survival needs.

Above that where your thumb is and the rest of your palm, you've got what we call the emotional brain. We also call it the mammalian brain because all mammals have this region too. This area of the brain governs our emotional responses and as well as our instinct to attach to one another. Where your thumb is represents an area called the limbic system, which contains a structure we call the amygdala that tells your reptilian brain to deploy the fight-flight-freeze response when it detects a threat to you, your environment, or someone you care about. On top of emotional brain, we've got the neocortex, where your fingers, hand, and knuckles are. But,

only humans have a well-developed prefrontal cortex, which sits right behind your forehead and is in charge of your rational, analytical thinking.

But here's the problem, because the reptilian brain and the emotional brain develop first, have been around a lot longer, and are interested in protecting our survival, these two lower regions can cause us to flip our lid when we detect a threat in our environment. In other words, when we have a strong emotional response, our thinking brain goes offline and gives the primitive regions of the brain precedence to mobilize a survival response. To regulate the stress response, we have to use tools that directly target the reptilian and emotional brain and teach it how to restore a state of calm. That's what tools like hypnosis can do."

The Stress Response

Let's unpack the stress response in a little more detail for you as a healthcare provider by looking more closely at the brain regions involved in the stress response. We'll start with the amygdala, which is an almond shaped region deep in the emotional brain that assesses the emotional significance of a stimulus. You have an amygdala in both the right and left hemispheres and their job is not just about detecting threat in the environment. They assess the *emotional significance* of a stimulus.

For example, if you see a friend walking down the street and you suddenly feel excited and want to move towards them, that's your amygdala saying, "Hey, I have good memories and feelings associated with that person. Go move towards that person." But if the amygdala senses that something is more dangerous, like a poisonous snake, it's going to direct you to move away from it and alert your nervous system to give you extra energy and strength for that. In sum, the amygdala is signaling whether to move away from something or towards something based on past experiences, and whether there's a positive or negative association with it.

If the amygdala detects a threat, it signals the hypothalamus to activate the fight-flight-freeze response. Then, your hypothalamus signals your pituitary gland to release corticotropin releasing hormone (CRH) and adrenocorticotropic hormone (ACTH). These hormones signal the adrenal glands to release adrenaline and cortisol to mobilize you towards action, to get all that energy running in your body so that you can run away our fight if you need to survive.

The problem is that repeated activation of the fight-flight-freeze response releases that adrenaline and cortisol in your body constantly, which can then contribute to high blood pressure, diabetes, digestive issues, and other stress-related illnesses. The reason why it feels like we flip our lid is because those stress hormones also interfere with processing in the prefrontal cortex. It overrides your prefrontal cortex's ability to regulate emotion, to make decisions, and to problem solve.

The Vagus Nerve

To calm the sympathetic nervous system down, we need to activate the parasympathetic nervous system, the part of our nervous system that's associated with rest and digest. To turn on the parasympathetic nervous system, we activate the vagus nerve. The vagus nerve is a cranial nerve that runs from the base of your skull down to your intestines. It interfaces with parasympathetic control of the heart, lungs, and digestive tract.

The ventral vagus nerve is the top part of the vagus nerve. It connects to your facial muscles, your eyes, your ears, your larynx, your diaphragm, and your heart. When we use a soft facial expression, a soft gaze, and we moderate the prosody of our speech so that it's slower and softer, it signals safety to the nervous system. Consequently, we utilize all of these nonverbal elements of communication in hypnosis. Speaking in a softer voice at a slower pace and using kind, relaxed facial expressions automatically cause the person that you're talking to feel calmer, safer, more relaxed themselves.

Deep diaphragmatic breaths also activates the ventral vagus nerve. We're going to be encouraging slow diaphragmatic breathing in hypnosis as well. The rhythm of a relaxed heartbeat, about 70 beats per minute, also communicates to the vagus nerve that everything is safe. So again, when we speak in this slow way that you're going to learn when we do hypnotic inductions, it is designed to stimulate the vagus nerve which will activate that parasympathetic nervous system and help the patient access a calmer state of mind.

Now the other thing that you want to understand about hypnotic suggestions is that they are designed to speak the language your emotional brain understands. Your subconscious mind is essentially the mammalian brain and the reptilian brain, those subcortical areas of the brain. These regions of the brain process information like an animal. They don't understand analysis or verbal reasoning—these brain regions learn from *experience*, *association*, and *repetition.* That's a lot of what we do in hypnosis. Hypnosis uses the language that this part of the brain understands—imagery, multisensory communication, metaphor, sound, and felt experiences.

The Relaxation Response

In the 1970's Cardiologist Herbert Benson demonstrated that meditation lowered stress, blood pressure, and pain back he wrote this book about it titled *The Relaxation Response*. He also did some studies that found self-hypnosis and meditation are equally effective in decreasing anxiety.

Dr. Benson discovered that eliciting the relaxation response involves these essential elements: 1) Mental focus on a stimulus like the breath, a phrase or an image and 2) A passive, detached attitude towards distracting thoughts. We do this not only in meditation, but also in hypnosis. You're going to learn that hypnosis always starts with focusing your attention on something and detaching from distracting thoughts or stimuli in the environment. Now the other piece of the relaxation response that Benson identified is to give yourself sufficient time practicing this state of detached mental focus, such as 10-20 minutes. Hypnotic inductions also tend to last about . 10 to 20 minutes.

We have more recent studies demonstrating similarities between mediation and hypnosis too. For example, in the year 2000, Sara Lazar and her colleagues did fMRI studies that showed meditation activates neural structures involved in attention and control of an autonomic nervous system--- so does hypnosis. Recent studies using brain imaging to look at what the brain's doing under hypnosis have found that the instruction to focus attention engages prefrontal attentional processes, so this frontal region of the brain gets much more active. Meanwhile there's *decreased* activity in regions of the brain associated with vigilance towards distracting thoughts or external stimuli. But, once someone gets into a hypnotic state or trance, functional brain activity gets redistributed across the brain depending on the suggestions.

Here’s the long and short of it. When we start a hypnotic induction it's very similar to meditation, in that where you're focusing your attention on something and getting more and more absorbed in it. The more absorbed you are in something, the less attention you pay to background noise or thoughts that have been distracting.

Neurophysiology of Hypnosis

But where meditation and hypnosis differ lies in the use of suggestions. In meditation the task is to maintain that focused, absorbed state, where you're just focusing on one thing like the breath or a mantra. In hypnosis we're going to go into that deeply-absorbed state and when you are in that state, your mind is actually more open to suggestion, creativity, and looking at things from different perspectives. Once we guide our patient into this deeply absorbed state of inner awareness, then we can begin to suggest things that the client could do to improve their well-being. For instance, we could suggest they imagine making an area of their body feel numb to control some pain. Or, we could suggest they visualize their desired future self, and really feel what that would be like to elicit hope and motivation.

Even though hypnosis starts out looking like meditation, other regions of brain are going to start responding to suggestions you invite the patient to explore. So, you'll see different areas of the brain light up depending on what kind of suggestions you're giving the patient. That's why it's been difficult for researcher to identify one specific neural signature of the hypnotic state. You can use hypnosis to get people really relaxed, but you could also use it to get people more motivated and excited. Both responses are going to look different in the brain.

Brain Waves

Before we end this lesson, I'm going to talk about one more area that hypnosis and meditation have in common, and that has to do with brain wave activity. Brain activity is measured by an electrical wavelength. So most of you are probably familiar with an electroencephalogram test (EEG), in which you can put sensors on the brain and measure electrical activity in the brain.

Early EEG studies suggested that hypnosis is associated with alpha state activity. This is a state associated with meditation and relaxation. On the right side of the PowerPoint slide 14 in Module 1C, you can see an image with different examples of brain wave activity for reference. In normal, waking states we're usually in beta brainwave states. On an EEG, beta brainwaves are represented by a rapid wave pattern of 16-30 cycles per second (hertz), and are associated with alertness and concentration. When we start to slow down our focus, we move into alpha brain wave states at 8-15 hertz, and begin to enter states of mild relaxation.

In moderate to deeper states of hypnosis, we drop into theta wave brain wave states, which are 4-7 hertz. Now this state is associated with meditation but also with intuition, our really vivid imagery, accessing memory and actually changing memories, updating memories, which we're going to talk about when we get into how to treat trauma with hypnosis. Scientists have also done studies that associate deep meditation and deep states of hypnosis with gamma waves of electrical activity that is quite rapid at 31-100 hertz. Gamma waves are associated with insight, peak states of experience like flow, expanded consciousness, or feeling connected to all that is. For example, researchers Jensen and De Benedditist both did studies in 2015 that suggested hypnosis was associated theta wave and gamma wave activity, and actually less so with alpha wave activity.

Closing comments

For those of you interested in the brain science behind hypnosis, we're going to go even further in the next lesson. I'm going to get a little bit more detailed about some of the new studies that show us how hypnosis looks different in the brain from just meditation or guided imagery. It's super interesting, so I can't wait to share that with you! For now, you can celebrate because you have completed module 1C! In this module we looked at how the brain responds to stress, how to elicit the relaxation response, and began to look at some of the neurophysiology of hypnosis. Next, in module 1D, we'll look deeper at the neurophysiology of hypnosis and how the brain processes hypnotic suggestions.