

EDDIE STERN & DR. DARSHAN SHAH

YOGA AND THE NERVOUS SYSTEM

The following article is from a transcription of a talk given by Dr. Darshan Shah and Eddie Stern in Austin, Texas, on September 4th, 2016, hosted by Priya Jhawar and Ashtanga Yoga Austin.

Eddie Stern is a yoga instructor raised in New York City. He studied Yoga, chanting, philosophy and ritual under Sri K. Pattabhi Jois, of Mysore, from 1991-2009. His yoga school is called Ashtanga Yoga New York and the Brooklyn Yoga Club. He co-publishes *Namarupa, Categories of Indian Thought*.

Darshan Shah, MD, MBA, ABFM, ABIHM is a new father, Ashtanga Yoga practitioner, entrepreneur, and Board Certified Family Physician who practices Integrative Medicine in Austin, Texas. Aside from being a diplomate of the American Board of Integrative and Holistic Medicine he is also certified by the Center for Mind-Body Medicine. In his private practice, Whole Health Austin, and in his work with the local indigent population at CommUnityCare, he demonstrates and teaches patients Mind-Body practices, including asana and breathing techniques, that give them control over their physiology. He collaborates with his wife, Priya Jhawar, who runs Ashtanga Yoga Austin, to create a community focused around wellbeing and resilience. Darshan also co-chairs the physician collaborative, Integrative Providers of Austin, a group that brings together physicians who are practicing Integrative and Holistic Medicine.

DARSHAN SHAH:

WELCOME. MY NAME IS DARSHAN Shah, and this is a talk on consciousness, yoga, and the nervous system. I'd like to give you a little introduction to Eddie and myself. To start, I'll tell you a little bit about myself. I'm a board certified family medicine physician, and I practice integrative and holistic medicine here in Austin. My yoga journey started in 2009, when I was in family medicine residency in Dallas. That was when I started to practice Ashtanga Yoga. I was guided by my wife, Priya Jhawar.

It was really difficult. Sometimes I'd say it was torture when I first started. My legs would shake. I would get frustrated. But what I quickly realized was that it lowered my background anxiety level.

I was in residency at the time, and it was clear to the people I was working with when I didn't practice yoga, so they really preferred when I did. The effect would last twenty-four to forty-eight hours after a practice. Since that time, I've furthered my study. I've realized that yoga has made me more resilient to stress, to anxiety, to depression.

I FIRST MET EDDIE IN UTTARKASHI, India, last October. We were there for a Namarupa Yatra with Sharathji and Saraswathiji. Eddie and I started talking about yoga, the nervous system, our biological drives and desires, and their interplay. For the past seven years I've been closely observing this effect on myself. Eddie has been doing this for over twenty-five years. He's a New York City-based Ashtanga Yoga instructor who studied under Pattabhi Jois and continues to study under Sharathji. For a long time, he's been deeply interested in the nervous system. From early on, he had the instinct that yoga had a lot more to do with the nervous system and our internal physiology than with just the physical body and the external appearance.

To Eddie, postures were a different way of having an effect on our biology. His instincts have driven him to dive deeply into the ancient yogic texts, and to conduct research. He has published several books on Pattabhi Jois and Ashtanga yoga, including a translation of Pattabhi Jois's 1960 treatise, *Yoga Mala*.



Eddie also leads a team that writes curriculum for public school health and wellness programs. These curriculums have been used as protocols for several large-scale research studies on yoga's effect on school attendance, emotional regulation, stress reduction, disciplinary action, and G.P.A., and also for one study on pre-hypertensive conditions in African-Americans. When I started talking with Eddie in Uttarkashi, I didn't know any of this background. But I quickly figured out that Eddie was well read and knew what he was talking about.

I started to pick his brain, and we just had a beautiful dialogue back and forth for the time we were there. Today is actually a continuation of that conversation that we started on the banks of the Bhagirathi River.

EDDIE STERN:

DARSHAN, YOU MAKE ME SOUND A lot better than I am! I am extremely nervous to talk about this stuff in front of so many doctors. All of Darshan and Priya's family are either astrophysicists or doctors. My niece, Julia, is here and

she is at University of Texas, studying endocrinology and neuroscience. I'm really interested in neuroscience as well, but I'm an amateur. I asked her, "Oh, have you guys been reading Stephen Porges?"—he's the guy who basically came up with a theory about a branch of the parasympathetic nervous system called the vagus nerve, that he coined as the Polyvagal Theory.

And she said, "Oh yeah, he's such a nice guy! Would you like me to introduce you? His wife is lovely." And I thought, oh my God. I tried to get her to give this talk instead of me, and she said, "I don't know if I'm coming, but if I come, I'm not going to talk. Anyway, you can't afford me."

BASICALLY, WHAT WE'RE GOING TO talk about are ideas about where consciousness meets our biology. Or, not so much where it meets our biology, but how it expresses itself through our biology, our physiology—in the functions of our nervous system and our internal organs. Consciousness presents itself through the functioning of some of our imperceptible organs as well, like the subtleties of the sense organs.

We normally perceive the world through our sense organs. We think of our eyes and ears and nose and mouth and skin as the way we're getting information from the world. Of course, we are getting information from the world in these types of ways. But a lot of the information that we're getting, it's not concrete information. For example, when we look at something that can be measured, like this room, or the space of this room and how big it is, this is something that could be called quantifiable. Like a quanta. The quanta is a packet of energy.

We may be able to measure this room, but how do we describe the experience we have in it? Can we measure the feeling that we have by attending, say, a yoga class? Can we measure love? Can we measure compassion? Can we measure the color red? Can we measure the taste of chocolate? Can we measure a sunset? We have no real way of measuring the experience of these things in the same way we measure the space of a room.



Adi Shankaracharya

Rather than a quanta, there something called qualia, or a quality.

This qualia is experienced in our field of consciousness. Locating that field of consciousness is a very difficult thing to do. In fact, no scientist or philosopher has agreed as of yet where exactly that is, or how exactly to locate it. As phrased by the scientist David Chalmers, this is called the "hard problem." We're not going to solve it today. But we're going to talk a little about how the yogis thought about this hard problem.

VEDANTA IS ONE OF THE ANCIENT philosophical systems of India. Adi Shankaracharya, who taught a particular type of Vedanta, said that everything is consciousness. All manifestation that we see around us, and that we experience through the five senses, through qualia, through quanta, is all consciousness taking form.

Consciousness takes form in different ways for the sake of self-knowledge,. Consciousness expresses itself through the world for the sake of expressing itself, so that it can know itself. Basically, consciousness is playing a game of hide

and seek within us, and we have the faculties to begin to investigate it.

We don't know how other beings investigate consciousness. We don't know how cats and dogs do. We don't know how a butterfly does. We don't know how a leaf does. We don't know if they're conscious in the same way we are. But we do know that many, many different types of beings have nervous systems. Some of those nervous systems are very complex, and some are very simple. Within yoga, the nervous system is considered to be that particular part of our physiology where consciousness can experience itself. There are different ways of working with the nervous system so that we can begin to have deeper experiences of ourselves. That's basically what we're going to talk about today.

DARSHAN SHAH:

While you were speaking, I was reminded of my first experience doing yoga in Dallas when I was in residency. When I practiced, it actually felt like it was expanding my consciousness. And my breath. When I first started to do

yoga, I felt like I could breathe for long periods of time, and just the sensation of taking a breath felt wonderful.

But I've been breathing my whole life. The asana enhanced my consciousness of my own body, my own breath. Now, many years after that start, it's more subtle. But it's like an expansion into all the sensory experience of the body, and feeling it. Growing into what we have, and enjoying it.

EDDIE STERN:

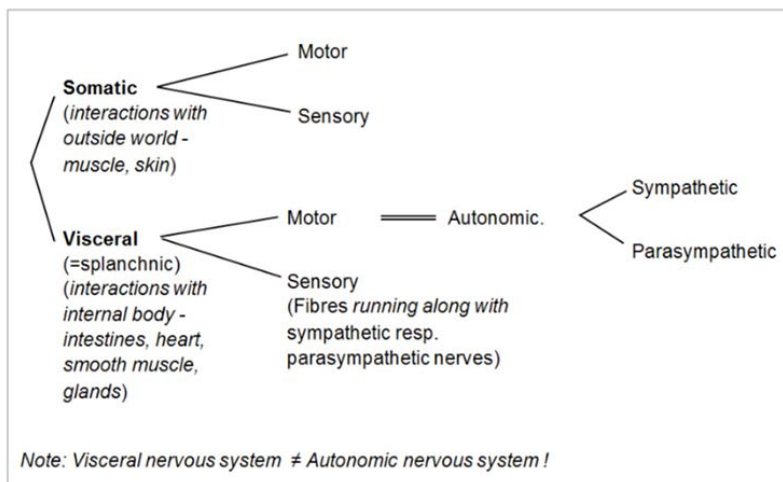
WE HAVE THREE TOPICS WE'RE going to cover: heart rate variability; the vagus nerve; coherence breathing. Let's go to the first slide, and take a little bit of a look at the nervous system. [1]

DARSHAN SHAH:

Within the nervous system, we have different parts. The part that typically is considered under conscious control is the somatic nervous system, made up of motor and sensory nerves. That governs our gross interactions with the world. We feel something, we decide we want to move part of our body.

Then we have our visceral nervous system. The part of the visceral that we are going to focus on today is the autonomic part. The autonomic part is like our Nest thermostat. Who has a Nest at home? It's an automatic thermostat that senses and regulates everything that's going on in your house: the temperature; whether the water's on; whether the garage is open. It's stuff we don't have to think about. We don't have to think about breathing. The drive to breathe happens. We don't have to think about our heart pumping. It happens.

That's the automatic, autonomic part of our nervous system. It has two branches, the sympathetic and the parasympathetic. The sympathetic is, generally speaking, what makes everything go faster, and is excited under stressful conditions. The parasympathetic slows things down and is stimulated when we're under restful conditions. There are different kinds of fibers for each. We won't get into the detail about the actual fibers that make



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this up. But this is the general overview.

EDDIE STERN:

Both the somatic and visceral systems have both sensory and motor branches. Somatic, which is mainly relating to our interactions with the outside world, also has an associated sense organ aside from the five senses, which is the vestibular organ in our inner ear, which, acting in conjunction with the eyes, is where our sense of balance comes from. From this organ, we also develop a sense of something called proprioception, which is the knowledge of where our body is in space. As an example, just stick your arm out to the side, close your eyes, and try to touch your finger to your nose. See if you can do that.

All right? Good. Everyone passed the sobriety test very nicely. Now, stretch your arm out to the side and try to touch your ear with your eyes closed. Okay, could everybody do that? Yes. You could all do that wonderfully. How could you do that? Your eyes were closed. How did your body know where it was in space, so that when you said to yourself mentally, "This time, I want to touch my ear," your finger knew where to go?

You have sensory nerves in all the joints of your body which are telling your brain where your body is in space. This is how we know how to navigate through the world. Spatial awareness is something that is very important for almost everything that we do. The reason you can walk through your bedroom at night with the lights turned off and

not bump into anything is because of spatial awareness, and this memory that you can have of where things are placed and where your body is in relationship to them.

The visceral nervous system is everything that is happening inside of us, and the sense that we have associated with the visceral nervous system is called interoception. Very roughly, proprioception is our ability to balance our body with the outside world; interoception is our ability to balance with our inner world. Interoception is something which is developed largely through generating self-awareness, through things like mindfulness practices and meditation, doing yoga with awareness, etc., where you can begin to get a sense and a feeling of what's happening inside of you.

This can be, "My stomach is upset." Or, "My digestion feels off." Or it could be an emotional thing, "I feel a little sad." "I feel a little tired." The ability to identify what's happening internally is a very important executive function for us to have. It's one of the things that yoga is reinforcing as an internal practice. While all the yoga postures are helping with our outer sense of balance, like when we balance on one leg, or when we gaze at one point to help us stay on that one leg, the internal practice is awareness. The yoga practices are helping both of these senses, proprioception and interoception.

So then, within the visceral nervous system, we have both motor and sensory. And then within the motor, we

have as a subset the autonomic nervous system, the ANS. The autonomic nervous system rests just in one area of the motor portion of the visceral nervous system, and is broken up into sympathetic and parasympathetic. They are complementary. Sometimes you hear people say, "Sympathetic nervous system is fight, flight, or freeze." That's only when it is on high alert. You hear parasympathetic is "Rest and digest." That's only when it's activated that way. In actuality both of these branches are happening all the time. Every time we inhale. Every time we exhale. Every time we blink. Every time our heart beats.

Let's move on to heart rate variability (HRV), which my niece knows a lot more about than I do. Correct me when I mess up, Julia, okay? The reason that heart rate variability becomes very interesting to doctors and scientists is because it is a snapshot of what's happening in the autonomic nervous system.

We can't see the activity of the autonomic nervous system so easily, but we can get a sense of it by looking at the beat-to-beat difference of the heart rate. If any of you have ever had an EKG, or seen a scan of your heartbeat, you'll see a little line, and then couple of little bumps, and then a high spike, and then a few more little ones, and then a high one, and then a few little ones, and a high one. Right? Everyone's seen that?

Each of those peaks has a different letter associated with it, P, Q or R. The highest point is called R; the difference between the R to R is called the heart rate variability. That's where it's being measured. What is the difference between this R and that R?

Normally when we inhale, our heart rate is going to speed up. When we exhale, the heart rate is going to slow down a little. We inhale, it speeds up. We exhale, it slows down. When we're more active, it should speed up even more. When we're resting and sleeping, it should slow down even more. This activity is an indication that our nervous system is doing what it needs to be doing, and it's being reflected in the heart rate. There should be change

Heart Rate Variability

- Beat to beat difference in heart rate
- Heart rate should not be the same all the time
- Increase on inhale, decrease on exhale
- Healthy heart rate is somewhat chaotic
- Ability of the heart rate to change is a measure of our physiological and emotional health

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in the heartbeat. There should be a little bit of chaos. We don't want things to be totally the same all the time.

For example, something that would be totally the same all the time with your heartbeat is if you're flatlining. Now, unless you want to be dead, that's not a particularly good sign of a heartbeat. Flatline is total consistency, no chaos. We want there to be some chaos. When a doctor is looking at your heart scan—so I assume, I'm not a doctor, I'm just guessing, you can correct me—they're going to look to see, is there variability between these beats? And if there is variability in the right kind of a way, this is good. [2]

DARSHAN SHAH:

Yes. One of the tests they do in pregnancy is a fetal stress test. They look for heart rate variability. The more heart rate variability—the more responsiveness—the better the prognosis. In adults, when we look at heart rate variability, independently it's an indicator of cardiovascular risk, aside from all-cause mortality. That's how important heart rate variability is.

There is an interesting organization called Heart Math, and they've done studies on this. They've looked at the different patterns of heart rate variability, and how it relates to emotional states.

The amplitude of somebody who is angry may be the same as someone who is feeling appreciation, but the type of wave pattern is different. When somebody's feeling appreciation, we will see a nice sinusoidal pattern, even

though the amplitude is the same as that of feeling anger. What's even more interesting is that the heart is a very electrical organ. It has a huge magnetic field. This field can be measured, and extends five to six feet outside of the adult human body. It also permeates the entire body and interfaces with the fields of those around us. In this way, an individual's heart and the magnetic field it generates can influence another person's body, heart, and mind. This has profound implications with respect to how we interact with other human beings, living organisms, and our environment.

EDDIE STERN:

Super cool. I want to mention one other thing. There was one nervous system that was missing from slide [1], which is the enteric nervous system, the nervous system of the gut. Maybe a lot of you have heard about the microbiome. The nervous system in the gut has about 100 million nerve endings, which is roughly the same number of nerve endings as our spinal column has. And it operates independently, in many ways, of the brain.

As Darshan said, the degree of heart rate variability is a measure of our resiliency. That means our ability to bounce back. We can bounce back in many different ways. We can get sick for a little while and bounce back quickly. We can get angry. How quickly do we get over it? Someone hurts or insults us, how quickly are we able to forgive them, and really mean that forgiveness

and feel it? Things like gratitude and appreciation have a very strong effect on healthy heart rate variability.

WHAT ARE SOME OF THE EFFECTS of breathing on HRV?

One of the ways that HRV was discovered—there are a few different ways, but this is the story I like the best and I've been in touch a little bit with these scientists. They are a couple of Russians who now live in Princeton. When they were working with the cosmonauts in the 1960s, they had no way of monitoring what was happening with the cosmonauts while they were in space. They didn't know how they were doing health wise, or when they were performing optimally. The cosmonauts were beaming back their EKGs and these scientists were studying them. They were noticing that there were certain times when the cosmonauts were performing very well, when they had a really interesting pattern of heart rate variability. They found that, through doing certain things with the cosmonauts, they were able to help them get into this zone when they needed them to be there, through breathing. In the 1960s, in Leningrad (St. Petersburg), they started studying the effects of breathing on HRV with people who were in outer space, or orbiting at the outer limits of our atmosphere.

These scientists have done something like 180 studies on HRV. I've read a bunch of them, and they're really interesting. Later, they noticed that when they brought meditators into the lab to be wired up and tested, the meditators would very naturally go into the same breathing rate that the cosmonauts would go into when they were very focused, when they were on task. This was roughly six breaths per minute. Something like a six second inhale and a six second exhale. That's five breaths per minute. It could be inhaling for four and exhaling for six. Somewhere between five and a half to seven breaths per minute was considered to be breathing at one megahertz per minute, which has a coherent effect on heartbeat, on heart rate variability, and

Effects of Breathing on HRV

- Calm, resilient, centered feeling can be accomplished by breathing at a certain rate
- Meditators naturally go to this breathing rate
- Focused attention has the same effect, as do Loving Kindness practices

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brain waves, and also some reflection on what is happening with the vagus nerve at the same time.

They also noticed this not only with meditators who were focusing on something like centering meditations, but also with meditators who just did a loving kindness meditation, where they sent loving kindness to themselves, and feelings of loving kindness to other people. This also automatically brought their breathing pattern into the same coherent type of a cycle. They began calling it coherence breathing. [3]

DARSHAN SHAH:

When we start regulating our heart rate variability through our breath, we can also see electroencephalographic (EEG) changes. What I was referencing previously about the heart being electrical and magnetic, and influencing other cells in the body, well, it also influences the brain and the electrical activity in the brain. And you can see this on EEG recordings.

EDDIE STERN:

That's an important aspect of the coherence.

We don't want to look at HRV or breathing at six breaths a minute to be some goal that we're setting, like doing a really hard asana. We want see HRV as a snapshot of the health of our nervous system. There are all different kinds of practices which are going to restore health and balance to our physical heart, and to the nervous system as well.

RETURNING TO THE COMPLEMENTARY actions of the autonomic nervous system, we have the sympathetic and parasympathetic. The sympathetic is anything which leads towards action. It can be any type of energy expenditure outward into the world. The inhale is part of the sympathetic nervous system. When the sympathetic nervous system becomes dominant, it can lead to different types of responses to the environment. An extreme example is when we are in a very dangerous, life-threatening situation—both animals and humans do this—we feign death. We become totally immobilized. We can become immobilized by fear. Some animals actually seem to be dead when they go into this immobilized state. In fight, flight, or fright terminology, this is fright, which is basically immobilization. In fight, you become very reactive towards the environmental demand, or load, and you fight against it. In flight, you run away from the danger.

We can see all these things if we just look at children in school. I see this a lot because I work with kids in schools. Many of you are parents. You might have seen that when you ask a child if they've done their homework, sometimes they might say, "Oh, yeah, I was going to do my homework, but I can't find my pen. It's over here somewhere." And they go through their book bag. They begin employing all these tactics that draw them away from answering the question: "I have to go to the bathroom." "It's in my cubby." "I'm going to go over there." This is flight. This is running away. In fright, they just look down don't even answer.

In fact, the first indication you can see of immobilization in students is when a question is asked—"Does anyone know the answer to this question?"—the student slouches in the chair. That's basically how I spent my entire school career.

We employ these strategies automatically as a function of the nervous system's not knowing how to cope with the situation.

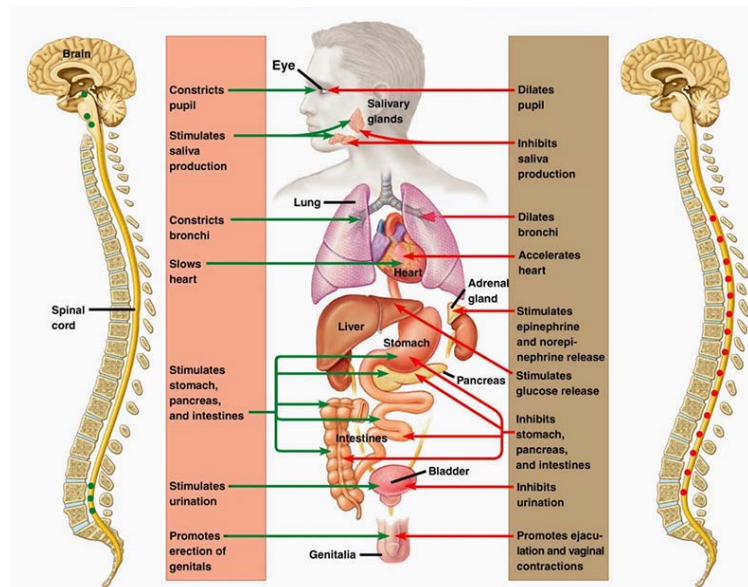
Parasympathetic is the slowing down, relaxing, calming branch of the nervous system. It moves us towards rest. It's associated with the exhale. When you need more energy, take a deep inhalation. When you need to relax, lengthen the exhalation—that's very soothing and engaging for the parasympathetic nervous system. The parasympathetic nervous system also rules our digestion; it rules elimination, and slows the heart rate.

Here is a very interesting fact: the sympathetic nervous system basically rules our heart rate, so that, without the parasympathetic brake, it would have our heart beating about 100 beats per minute all the time. Our parasympathetic nervous system slows down the heart rate to about sixty-five to seventy beats per minute in a relatively healthy individual. The parasympathetic nervous system is our brake. It slows us down. The sympathetic nervous system is our accelerator. It's going to speed us up.

When we are stressed out and going fast too much of the time, it's not that we have an acceleration problem, it's that there's something wrong with our braking mechanism, our parasympathetic nervous system. Doing things like yoga, or meditation, or tai chi, is going to slow down the exhale, enhance and fix our braking mechanism so that we can apply that parasympathetic brake to begin to regulate everything in our body. Then we can respond to environmental demands as they need to be responded to, and not freak out about them.

DARSHAN SHAH:

It makes me think of what we do as doctors, or sometimes used to do as doctors. We'd see patients in the emergency room who would have racing



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hearts, or supraventricular tachycardia. One of the things we used to do was either push on their eyes, or rub their carotid arteries. That would stimulate the parasympathetic nervous system to put on the brake and slow the heart rate down. Nowadays, we just give drugs.

That's why this conversation has been so exciting to me, because through personal experience, I've seen yoga's effect on physiology. What else can yoga do? How else can we play with our physiology?

EDDIE STERN:

Here is an image of the sympathetic and parasympathetic systems. [4] On the left side is the parasympathetic nervous system. One of the main things I'd like you to notice is how the cranial nerve endings come out from the base of the skull at the top of the neck, and from lumbar two to lumbar four at the very base of the spine. This is where the parasympathetic nerves are coming out.

Anytime you do a forward bend and you relax your head down towards your leg, you are opening and relaxing both the L2 to L4 area of the lumbar spine, and also the back of the neck all the way to the base of the skull. You're relaxing all of these parasympathetic nerve endings.

In the primary series of Ashtanga Yoga, we mainly have all these forward-bending positions. And we know that all the forward-bending positions are

calming and relaxing. But they're also having an effect on our internal organs. When you look into *Yoga Mala*, Guruji's book, and you read about the benefits of the primary asanas, they're mainly related to the liver and the spleen and the stomach and the intestines. The lungs and the heart are only spoken about very peripherally. Mainly, he's talking about all our visceral organs and the organs of digestion, about their health being stimulated and restored through the forward-bending positions which are compressing this area, and relaxing the parasympathetic nervous system as well. All of the twisting motions too, dig into these areas.

If the sympathetic nervous system is dominant, it's going to be drawing blood flow and energy away from all the digestive organs. When the parasympathetic nervous system is functioning well, our digestive system is also going to be healthier. But what happens when you're super stressed out? How is your digestion? Really super awesomely good? No. And how are your bowel movements? Like, super amazingly regular when you're chronically stressed? Not so much. This is because sympathetic is going to be dominant at that time, and your blood flow is being used to flee from, or fight against, a situation.

When you look to the other side of the diagram [4], you see the sympathetic nerves coming mainly from around C7,

C8—a little higher, actually—all the way down to L4, L2. You can see how the back bending positions are going to be stimulating for all of the sympathetic nerves in the middle of the trunk. So bending forward is calming for the nervous system. Extending, bending backwards, is energizing for the nervous system. Twisting is balancing and organizing for the nervous system, and also balancing for the corpus callosum, which is the bundle of nerves that connect both hemispheres of the brain, and pass information back and forth.

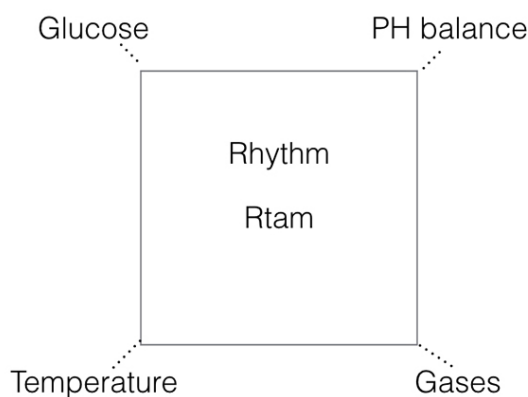
It follows that, through the forward-bending movements and the backward-bending movements, we are balancing sympathetic and parasympathetic. We do that for our whole practice. And through all of the twisting, we're organizing the nervous system as well. This is why all of these effects combined make us feel centered, calm, stable, and focused.

DARSHAN SHAH:

With respect to homeostasis, again, for me, this whole process has been very experiential. The Ashtanga Yoga system is well thought out in regards to how it makes somebody feel after doing the series. And that's what homeostasis is—when we feel at equilibrium, and we're adaptable, and the body is back to a state of balance, balance between the sympathetic and parasympathetic. Generally speaking, all of us are in a sea of sympathetic overdrive. As an example, when we are out on the street driving, we're in a sympathetic overdrive state because we don't want to get into an accident. We have to look at the lights. We have to pay attention. We have to be very vigilant. We have to have very quick reactions. Stimulation of our sympathetic nervous system gets our heart rate up, our blood pressure up, and provides more blood to our vital organs, ultimately leading to faster responsiveness to perceived immediate threats.

Then there is television. What's on TV is stuff that's trying to frighten us or scare us. Night and day, we get bombarded by news of war, murders, things like that. This is the sea that we're

Homeostasis - maintains stable environment for complex interactions



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swimming in. When we're swimming in a sea like this, how do we wash ourselves off? In a way, it's no different than brushing our teeth twice a day. To bring our bodies and our minds back to homeostasis—regulating our nervous system—the Ashtanga Yoga system is fantastic. It's been designed for that. It cleanses the *nadis*, the nervous system channels.

People often initially come to yoga looking for certain physical or external benefits. Then, as they do yoga, they start to sense how they feel. And then they start to realize some of the nervous system benefits: the anxiety reduction; the reduction in depression; the benefits with respect to hypertension. These are ready examples of yoga's beneficial effects on the nervous system and homeostasis that have been well researched.

EDDIE STERN:

Here's a little diagram of homeostasis. [5] One of the reasons I started thinking about homeostasis in regards to yoga was because Guruji said you should practice at the same time every day in the twenty-four hour cycle, because it will keep your body temperature the same. I thought that was super interesting. I hadn't heard that type of statement before, and I didn't know why he would be saying it, until I started reading about homeostasis and saw that temperature and maintenance of temperature was one of the four main components of homeostasis.

WE BASICALLY ARE BEINGS THAT operate in rhythms. For example, we have the circadian rhythm. What's the circadian rhythm? It's primarily to do with sleep—for simplicity's sake, we go to sleep when the sun goes down and it's dark and we wake up—hopefully before the sun rises if we're yogis. Otherwise we wake up when the sun comes up. But there are many important hormonal changes that occur with the circadian rhythm, including the release of melatonin not only for sleep, but also for the repair of our cells. There's a nucleus in the brain called the suprachiasmatic nucleus, which is basically monitoring the sun, and where our place is in the universe. This is cosmic proprioception. We all have it, and it's super cool.

What else do we have? We have lunar rhythms. Women's menstrual cycles will quite often follow the lunar rhythms. The tides follow the lunar rhythms when the moon is waning and waxing. The moon exerts a tremendous gravitational pull on the planet, as you all know. And our planet is made up of 70% water, as is our body and our blood. We're going to feel that gravitational pull, emotionally as well as physically.

Then we have seasonal rhythms. We are going to feel energetic and outgoing in the spring and summer, and when fall comes, we all get a little cooler and quieter. Then winter comes, and we become a little more introverted. These are our seasonal rhythms.

And then, last, we have something called the ultradian rhythms, which

are some of the most interesting for yogis. That is how the nervous system changes over from sympathetic to parasympathetic dominance. It's not that one turns off, but how the dominance changes. That dominance is reflected in our nostrils.

If you just check your nostrils now, you'll see which nostril is dominant. How many people have their right nostril dominant? How many have their left? Good, it's pretty evenly split. It's only at certain times of the day when you'll have even flow through both nostrils. The right nostril is connected to the left hemisphere of the brain, in the same way that the left hemisphere of the brain controls the right-hand side of the body. And the left nostril, in the same way, is connected with the right hemisphere of the brain, in the same way the right hemisphere controls the left-hand side of the body. An ultradian rhythm is a rhythm which falls within less than a twenty-four-hour cycle.

A large part of the science of pranayama is working with nostril dominance, and also fixing your particular activities through the day so that you only do certain activities when one nostril happens to be dominant, and there are a lot of examples given in some of the yoga texts.

DARSHAN SHAH:

You do your math homework, for example, when your right nostril is dominant. Left brain.

EDDIE STERN:

And conception should happen when your left nostril is dominant. Have you all checked?

There have been interesting experiments with unilateral breathing, or single-nostril breathing. They've done studies where the participants of the study would breathe twenty-seven times through one nostril four times a day, and another group does the opposite nostril. They found that the people who do the left nostril breathing through the day have an increased spatial awareness, and the people doing right-nostril breathing, have improved cognitive skills. The nostrils have a very

direct effect on the brain. We can look more deeply into these rhythms and into breathing—the yogis were looking at these things.

We can hack our nervous system by doing these things to get a particular effect that we're looking for. And what happens when we transcend cognitive ability and spatial awareness? What happens when we transcend the dominance of just one aspect of how we interact with the world, and go into another zone? What happens when we go into the zone of total balance?

DARSHAN SHAH:

I don't know. Sounds pretty cool, though.

EDDIE STERN:

It sounds really cool. The word "rhythm" in Sanskrit is "rtam." We see that word in the Vedas, and we see that in *Yoga Sutras*, in reference to when you achieve a certain level of total cognitive absorption. *Rtambhara tatra prajna*—the light of wisdom shines through completely when you are completely in tune with nature.

DARSHAN SHAH:

Boom.

EDDIE STERN:

Boom.

[Question from the audience.]

EDDIE STERN:

You want to know more details on the lunar effect in the body?

DARSHAN SHAH:

The position of the moon affects the electro-gravitational field of the earth. That's why we have tides. With new moon and full moon, that effect is maximal. There's a cardiologist named Dr. Sinatra who has noticed that, in certain of his patients, there's a higher incidence of arrhythmias on full moons.

I've always wondered why it is prescribed that people should not practice on full moon or new moon days? That's a day of rest. After reading what Dr. Sinatra has written, it made

sense. These practices being intense, and affecting the sympathetic and parasympathetic nervous systems, there can be increased risk of arrhythmias, especially if the electro-gravitation has been altered.

We're practicing in certain external electrical environments. And when that changes, there can be effects on the body. Now, have people practiced on new moon and full moon days and not had problems? Sure. But when we look at the ancient scriptures, they also say don't practice in a cave. Eddie can speak more about this. There are all these other restrictions—don't practice a certain number of feet from the kitchen.

EDDIE STERN:

Don't practice on the second floor.

DARSHAN SHAH:

Actually, along those lines, there's an exponential benefit when we practice connected to the earth. And again, that comes back to electro-gravitation. I recommend reading books on earthing, and what that does to the electromagnetic potential of the body, with respect to inflammation, among other things. Back in the day, yogis used to practice on skins. Skins allow for electrical connectivity, as opposed to rubber mats, or certain types of flooring.

EDDIE STERN:

NEXT WE GO TO THE VAGUS NERVE, which is important in relation to HRV because heart rate variability is a vagal phenomenon. I just want to read you something from Stephen Porges' book, *The Polyvagal Theory*, because he says it much better than I can: "RSA {HRV} is a vagal phenomenon in contrast to heart rate, which is determined by several sources including vagal, sympathetic, and mechanical forces." Our heart rate and our heart rate variability are two distinct things. There is part of the vagus nerve that originates from a portion of the brain called the nucleus ambiguus, which travels down to the SA node, which is controlling the heart rate, and we also have other sympathetic influences like caffeine, lack of sleep, stress, etc., which

are going to affect our heart rate, as well as mechanical forces. Heart rate variability is not going to be affected by mechanical forces or by other things. It's only going to be under control, if I'm understanding it right, of the vagus nerve.

DARSHAN SHAH:
Correct.

EDDIE STERN:

"Vagus" in Latin means "wandering." We have twelve cranial nerves, and each of these nerves mainly has one destination, to the eyes or the ears, for example. The vagus nerve is different because it is a family of many branches of sympathetic and parasympathetic nerves that go through the whole body. It comes from the brain stem. It goes to the soft palate. It goes through the trachea, through the esophagus. It goes into the lungs, into the heart, into the liver, kidneys, pancreas, intestines, with afferents that connect all the way down to the anus and the genital organs. [6]

This is a nerve that covers a lot of territory. And one of the interesting things about it is that the vagus nerve is part of the autonomic nervous system, so remember what part of the nervous system it's in? Visceral motor. Motor means activity.

However, 80% of the vagus nerves are sensory nerves, which means that wherever this vagus nerve is connecting to any organ or structure in the body from the brain, not only is the brain sending information to those organs, but those organs are sending information to the brain for the brain to decide what to do with it. It's bi-directional: information coming from the gut, coming from the heart, is getting sent to the brain, or maybe not even to the brain, telling the body what to do and how to perform. So it's very, very interesting.

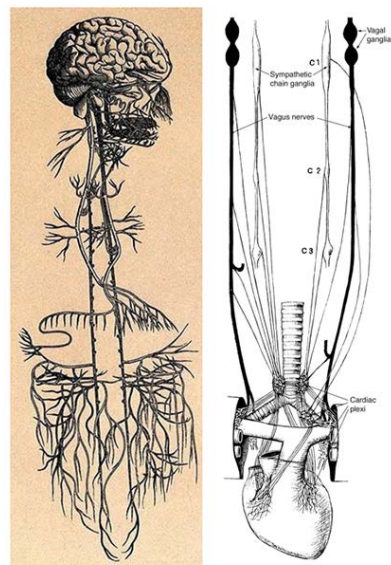
By the way, if anyone feels like they need to yawn, please don't stifle your yawn. I see a few people who are stifling a yawn; you should go ahead and yawn, Darshan and I won't be insulted. In fact, I read a very interesting study on yawns last week. It's an NIH published

Vagus Nerve, the 10th Cranial Nerve

Originates in the brainstem
Travels independently of the spinal cord to many organs, including the trachea, larynx, heart, lungs, diaphragm, pancreas, liver, spleen, stomach, and intestines

Complex bi-directional system of both 80% afferent (sensory) and 20% efferent (motor) fibers

The vagus that originates from the dorsal motor nucleus are functions associated with digestion and respiration; the vagus that originates from the nucleus ambiguus is associated with processes of motion, emotion, and communication



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study that showed that yawning affects a very small area of the brain called the precunius, which is associated with memory retrieval, consciousness, and self awareness, among other things.

So anytime you feel the need to yawn, just know that it's going to help you with your memory retrieval, and also with being conscious, meaning staying awake. But if you stifle a yawn, it won't be so good for you. In ayurveda, they say never stifle any automatic body process. I mean, you know, within reason.

DARSHAN SHAH:

The vagus nerve starts in the brain stem. As Eddie was saying, there are many, many thousands and thousands of nerve fibers in there. 80% are sensory. Again, as Eddie said, they report back what's going on in the body. Interestingly, when we're kids, we respond to our nervous system very rapidly, and without blocking the sensory input. If we have to go to the bathroom, we go to the bathroom. Potty training hasn't happened yet. If we need to go to sleep, we go to sleep. You see little kids who just plop down and go to sleep.

Somehow, as we become adults, we learn to start disregarding the sensory input. When we start disregarding the sensory input of the autonomic nervous system, specifically the parasympathetic nervous system, that's where I, as a

physician, start to see the long-term, problematic effects—problems with the gut, problems with hypertension, with basically, you could say, autonomic constipation.

EDDIE STERN:

The strength of the vagus nerve, which is known as vagal tone, is measured through HRV. High vagal tone makes your body good at regulating blood glucose levels, reduces the likelihood of diabetes and cardiovascular disease. It also helps reduce inflammation in the body, and increases your immune system resiliency. Low vagal tone has been associated with epilepsy and rheumatoid arthritis, and other inflammatory type diseases. Increasing, or strengthening, HRV has been used in treatment of these types of things.

In fact, last year when I was in Houston, I was giving a talk to a group of physical education teachers. I told a story about a discovery that had been made with the vagus nerve, and how cases of epilepsy and rheumatoid arthritis had been reduced by stimulating the vagus nerve through magnetic implants, right next to the carotid artery.

Later, a woman named Bethany Kok did another study. She wanted to see if it was possible to increase vagal tone without having to implant magnets into your neck like Frankenstein. So she took a group of people and taught them

Neural Exercises

loving kindness meditation and had them do it twice a day for six weeks. She found a same increase in vagal tone. Now, these were not people who had rheumatoid arthritis or epilepsy. They were just people whose vagal tone she was measuring.

So I told this story, and the district head in the back of the room raised her hand. I thought, "I'm done for. I'm just going to get kicked out of the district now." And she said, "What Eddie is saying is absolutely true about increasing the vagal tone, that you can use breathing—specifically the type of breathing with sound that we do in yoga—and yoga postures, and loving kindness meditations. I know this because I'm an epileptic. Ten years ago, my doctor told me to start doing yoga and start meditating in this particular way, because he thought it would be good for my vagus nerve. And I haven't had an epileptic fit in ten years."

I was blown away.

We should be clear that inflammation is not always a bad thing. We need inflammation to fight off viruses. But too much of a good thing is, of course, a bad thing.

Some of the responses in our physiology from high vagal tone include improved digestion, relief from low back pain. Why would that be? Because the parasympathetic nerve endings are in the lumbar. Pain associated with trigger points has been shown to lessen with higher vagal tone. What are trigger points? Basically, a trigger point is where the nerves come out from the muscle and are innervating the muscle. When the nerve exit points get stress or tension, they become tight. This tightness leads to referral pains in different parts of the body. High vagal tone improves baroreflex, a process which helps us maintain our blood pressure. It helps with epilepsy, inflammation, etc.

How can we interrupt high vagal tone? We can be really anxious. We can get angry quickly. We can be stressed out all the time. We can have absolutely no appreciation for anything that anyone does for us ever. These are great ways to interrupt the health of your parasympathetic nervous system. Good

- Behavior: heart-brain axis; neural exercise of emotion; *yama*; *maitri*, *karuna*, *mudita*
- Vocalizations: Laryngeal nerves; respiration; chanting; singing
- Breathing: Respiration; abdominal afferents; pranayama
- Posture: Carotid baroreceptors, blood pressure; mood change; *bhavana*; asana

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ways to augment it are appreciation, gratitude, loving kindness, and forgiveness.

THIS NEXT SLIDE IS LEADING INTO something which Stephen Porges has called neural exercises. [7] The neural exercises are things which we actually see in all of the different yogic practices. Number one deals with behavioral things: How are we living in the world? This is *yama* and *niyama*. They are emotional things like appreciation and gratitude and forgiveness. They can be found in practices in the *Yoga Sutras* 1.33, or in the Brahma Viharas of Buddhism—to have feelings of friendliness to those who are happy, feelings of compassion to those who are suffering, feelings of sympathetic joy for those who do good things in the world, and feelings of equanimity towards those who are doing bad things in the world, so that our minds stay steady. Notice here the use of the word "sympathetic"—like the sympathetic nervous system. It acts outwardly, in positive way, to relate with people, and the world.

The yogi asks, "How can I keep my *chitta* (mind) calm, so that I can know who I am?" When my *chitta*, my field of mind—of consciousness—is not calm, but is filled with too many conflicting *vrittis*, or patterns, I don't know who I am. When I don't know who I am,

and I don't know where I stand in the world, then I am not happy, and I don't have a sense of what my purpose is here in my life.

These are the three main questions that anyone who is on a spiritual quest—in fact, that any human being—should ask themselves: Who am I? What am I doing here? And what do I do next?

DARSHAN SHAH:

This is what I really felt profoundly when talking with Eddie. I knew about the limbs of Ashtanga. But when I first started practicing the *yamas* and *niyamas*—observances and how we should behave—I was looking at that from a superficial level. I never looked at them as neural exercises. Since talking with Eddie, there's been a profound shift in how I look at *yamas* and *niyamas*, at what practicing them is doing to our consciousness and to our nervous system. It's pretty profound.

EDDIE STERN:

A lot of our identification comes from the feedback our nervous system is giving us, so we should question that feedback. Vocalization affects the laryngeal nerves, which are right where some of the first nerves of the vagus reach as it comes out from the brain stem. These are going to be stimulated through respiration, like smooth, even, calm breathing,

especially breathing with a little bit of sound—pranayamas like Ujjayi or Brahmari—and chanting and singing. Often, vocalizations that are done in groups are particularly powerful. This is one of the reasons why singing kirtan with groups of people is so enjoyable, because not only are we vocalizing and stimulating all these nerve plexuses, but we're joining in with other people at the same time, which releases certain types of hormones like oxytocin, and as well giving us connection to other people.

Breathing itself, respiration, is going to have an effect on the afferent nerve from the abdominal regions. Afferent means sending messages to the brain. Efferent means brain sending messages to the body. Efferent can be remembered because it is an effect.

Pranayama is a very important neural exercise, because it directly accesses the nervous system. Even just taking a long, smooth exhale, or extending your exhalations for five or ten minutes will calm down the nervous system when you're feeling stressed out. We have direct access to our nervous system through the breath.

The last neural exercise is posture. This is going to help stimulate and balance the baroreceptors in the carotid artery, which balance our blood pressure. For example, even just sitting up straight and having good posture, just that simple act, and breathing, is going to be very healthy for the nervous system. It will help to regulate blood pressure. I've actually experimented with this on my own with my blood pressure monitor, and have seen that I can lower or raise my blood pressure very simply and quickly by adjusting my posture. Now, this is also particularly important because our blood pressure is also associated with our moods, and posture, by working on the baroreceptors, will also help with mood change.

In Sanskrit, mood is associated with the word *bhavana*. Bhavana means feeling, mood, and emotion, but specifically it means that when you have the experience of something, and there's an emotion or sensation associated with it, every time you repeat that activity, if you keep identifying it with the mood or

Pancha Kleshas as Brain Stem Imperatives

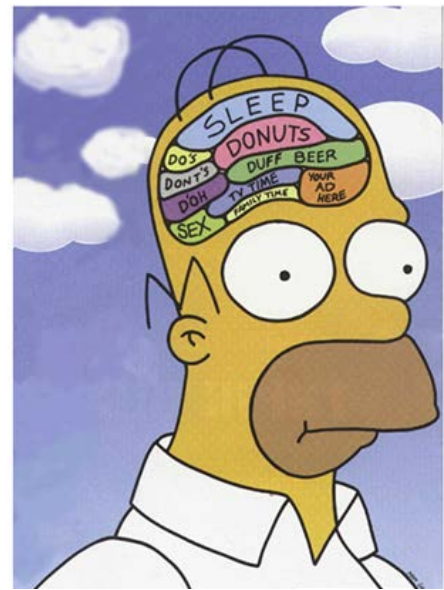
Avidya
Asmita
Raga
Dvesha
Abhinivesha

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emotion that was first associated with it, whether it's pleasant or painful, you're going to create a particular mood.

For example, when you do your first yoga class, and you come out feeling really, really great, that is a mood, an emotion, a sensation, a feeling that has come about as a result of doing yoga. The next time you go in, you actually want to try to repeat that same mood, because you want to wire into your nervous system the association of an activity with a response. Now, when we don't do that, what happens is second, third, fourth yoga class, all is cool. Fifth yoga class, hmm, I wonder if I can push this a little harder. Sixth yoga class, "Hey, that person next to me is doing that a little bit better. Maybe I can do it that way also. Maybe I'll learn this posture. Maybe I'll learn that posture. You know what, I think I'm going to change my name and call myself Sivadas. If I start wearing white clothes and malas all the time, I'm really going to be spiritual. 'Cause I do yoga, after all. And I'm going to wear a top-knot. And maybe I should learn some more mantras. If I learned a few more mantras, then I'd really be getting somewhere. And after I learn some mantras, I'm going to learn how to do a fire ceremony, 'cause then I'll really be top level."

Or, it could be the opposite way. "I've gotten really good at this. Maybe, if I could just get sponsorship from



Lululemon, then I would really be bona fide, you know. Maybe I just need a few more likes on my Instagram page. And then, once I hit 25,000 followers..." So, very quickly—from zero to 60—we go from, "I feel so loving, and my world has expanded, and I feel forgiveness" to "Hmm, I wonder when that Lululemon sponsorship is coming."

We've lost the bhavana. So it's very important that when we practice, we re-install ourselves with the feeling that we had when we first did it, which is always very pure. So bhavana means the feeling associated with the repetition of a particular spiritual exercise, or any of these neural exercises.

WE ARE GOING TO FINISH WITH Homer Simpson, where every lecture on the nervous system should end, as far as I'm concerned, and *Pancha Kleshas*. [8] "Klesha" means "obstacle" or "obstruction." The yogis talk about five of them. Patanjali speaks about this in chapter two of the *Yoga Sutras*.

The first is *avidya*. Avidya is not knowing who you are. It's quite often translated as ignorance, which I don't think is a great translation, because it implies that we are all ignorant, but we aren't. Everyone here knows something. A lot of you, most of you, all of you, perhaps, are very intelligent. There are doctors and scientists and yoga teachers and all sorts of people in this room.

How Can We Activate the Parasympathetic Nervous System?

- Be kind to people
- Hold positive thoughts in our mind about ourselves and others
- Practice yoga with awareness
- Coherence breathing
- Pranayama
- Chanting and singing
- Live a balanced life
- Allow yourself to experience joy and pleasure in your practices



You all know something. You're not all ignorant.

If you think, "Oh, I have avidya," and define avidya as ignorance, then you limit yourself. However, while we each know a lot about our field of expertise, we don't know a lot about our inner self. Avidya means that, though you may have a lot of *vidya*, or knowledge, it's knowledge other than knowledge of the self. Avidya is a lack of knowledge not about everything, just a lack of knowing who or what our true, inner self is, which is pure consciousness, spirit.

When we don't know who we are, then what happens? What do we do? We have to have some sort of identification, so we begin to form a false identification based on our experiences of the world, which is *asmita*. *Asmita* is identifying with something other than who you really are. And what is that going to be? It's going to be whatever narrative you develop as you go through your life. Whatever joys or successes or traumas we have, our parents, our upbringing, our environment, are all going to create our internal narrative.

We begin to believe this narrative. We start to develop likes and dislikes associated with the variety of experiences

that we have. The things that we like, we move towards, and we want to do more of. We become attached to, or even addicted to, those pleasant experiences. They define who we think we are. The things we don't like are the things we want to stay away from: "Oh, I don't like okra. I'm not going to eat that." Part of not liking something is an attachment to that thing also. All of our likes and dislikes begin to define our sense of who we think we are, which is *asmita*, or "I-ness."

Likes and dislikes are called *raga* and *dvesha*, attachment to pleasant experiences, and attachment to unpleasant experiences. They are both attachments. How often do we find that we really hold on tightly to not liking something?

The last thing on the list is *abhinivesha*, sometimes translated as "fear of death," but also spoken of in different commentaries as "fear of extinction." Fear of death largely comes from not knowing what happens after we die, so fear of death is fear of the unknown. The fear of extinction is, who will I be, and what will I be, if I'm not *asmita*? Who will I be if I'm not my own narrative? What will I be then? Because

that's everything I'm holding on to. And if that disappears, I will be extinct. And that makes me afraid. It is a fear of annihilation.

All of these *kleshas* are associated with particular functions of our nervous system. We don't always look at it that way. But our narrative is also associated with things like breathing and sleeping. All of our survival functions, for example, respiration and digestion, elimination, sexual reproduction, heart rate, are all controlled in our brain stem, and are the things that hold us to our unconscious root of identity. The yogis were seeking to control these things through different practices that directly accessed, or sought to control, the brain stem functions. They sought to control respiration through pranayama. They controlled food. They controlled sleep. They were *brahmacharya*, or celibate, to control sexual reproduction. They would stay awake for days or years on end.

All of the different practices that were done by the ancient yogis were to control and transcend the functions of the brain stem, the autonomic functions. Part of *tapas*, or austerity, is to see what will happen when I transcend these

functions for even a little while—What will I be then? So the Pancha Kleshas are wrapped into all of our autonomic nervous system functions. That's why we have to use our biology, we have to use our physiology. We have to be able to hack all of these things in order to begin to weaken the hold that the Pancha Kleshas have over our operating consciousness.

In *Yoga Sutras*, chapter two, it says: *Tapas svadhyaya ishvara pranidhanani kriya yogah*. The *kriyas*, actions, of yoga, are tapas—things like postures and pranayama, svadhyaya (study of self), mantras or vocalizations, and ishvara pranidhana—like bhavana and surrender, and acknowledging I can only get so far on my own steam—all of these practices are said to thin, or attenuate, the kleshas, and make the mind fit for *samadhi*, or unity consciousness. The practices of yoga work on helping us to change our self-narrative from that of a separate individual, to that of a being who is a part of something larger, who is non-separate from the rest of the manifest universe, and non-local as a state of consciousness.

Asanas, pranayama, restricting our food, restricting our sleep, all help thin *asmita*. As *asmita* begins to thin, we get a greater idea, a greater sensation and feeling, of who we are. Then *avidya* begins to thin as well. When *avidya* disappears, replaced by *vidya*, or true knowledge, then, as the sutra says, *rtambhara tatra prajna*—on its own, the light of knowledge, or the light of the self, shines through the coverings of the mind.

All of the yoga practices are going to help us gain mastery over the brain stem functions, so that we can begin to reduce *asmita* and *avidya*, so that the light of knowledge, of self knowledge, shines through. This is basically how the yogis were using all of the physiological functions to reduce things that can't be seen, like *asmita*, so that we can know who we are, and know what our purpose is. And then know what to do next.

DARSHAN SHAH:

This has really resonated with me—that we can access our brain stem and

modify the functions of the brain stem. This is not what we find in the typical medical literature. This is cutting edge, or bleeding edge. Scientists just reversed our position on neuroplasticity; we used to think that brain cells that died couldn't regenerate. That's been proven false. So medicine and science are moving in a good direction. But what is fascinating is that this stuff was written thousands of years ago, and talks about our nervous system and our drives, both philosophically and physiologically. That we can translate that ancient insight to what we see today in modern physiology, and thus interact with our nervous system to figure out who we are. That's profound. ❧

