

Relaxed and Content (Part One): Activating the Parasympathetic Wing of Your Nervous System

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Introduction

It's amazing but true: there is actually a neurological system in your body that you can trigger at will to help yourself feel less stressed, more peaceful, and more happy.

It's full-bore title is: "the parasympathetic wing of the autonomic nervous system" or PNS, for short.

In this article, you'll get a crash course in your own nervous system and how the PNS fits into it, mixed with lots of ways you can use to activate your own PNS.

The Autonomic Nervous System

If you like, take a moment to observe your breathing as it is, right now. Next, relax and let your breathing slow down. Then, for another moment, deliberately breathe faster.

Doing this shows the workings of what is called the "autonomic nervous system" (ANS). This system regulates many automatic bodily processes, and it usually operates outside of your awareness. But actually, you can exercise conscious influence over the ANS – and that remarkable fact puts you in the driver's seat for the core machinery of emotional well-being in your body.

Overview of the Nervous System in General

To operate that machinery, it helps to have some background information about your own nervous system:

- Individual neurons act to *inhibit* or *excite*, to put on the brakes or hit the gas, red light or green light.
- Those functions of individual cells get writ large in assemblies of thousands, even millions, of neurons.
- The nervous system (NS) is divided into the Central NS and the Peripheral NS.
- In turn, the Peripheral NS is divided into the Somatic NS and the Autonomic NS.

- The Autonomic NS (ANS) contains the sensory and motor neurons that “innervate” – that are woven into and guide – the internal organs and the digestive tract.

Then, the ANS is divided into the **sympathetic, parasympathetic**, and enteric nervous systems. This article focuses on the first two of these, but as a parting bow to the enteric system, I’ll mention that it pervades your digestive tract and has enough autonomy that some scientists call it a “second brain.”

The ANS Itself

The ANS is responsible for maintaining the equilibrium of our vital functions, including breathing, the heartbeat, glandular secretions, salivation, and perspiration. On autopilot, it’s directed by the brain stem and spinal cord. That’s why someone with a massive head injury can still keep breathing in a vegetative state for years.

It carries out its responsibilities through three kinds of nerve assemblies:

- Sensory – These bring information in, and are called “afferent.”
- Decision-makers – These process sensory information and decide what to do.
- Motor – These carry out the plan of the decision-makers by sending instructions throughout your body; they’re called “efferent.”

Breathing: Exercise #1

As noted, you have control over certain ANS functions. For example, land animals like humans use breathing for more than oxygen and so they need to be able to turn off the autopilot and take the wheel themselves for things like sniffing the air for smells and making sounds such as speech.

It’s interesting that most spiritual traditions have contemplative practices that work with the breath. Perhaps one reason for this is that the breath is a point where conscious intention meets primal nature – with its poignant reminders of disease, old age, and death.

If you want, you could take a moment to activate the parasympathetic wing of the ANS by exploring our first major method – deep, full breaths:

- When you inhale, fill your lungs fully, hold for a second or so, and then exhale in a relaxed way.
- Try breathing in this way for 60 seconds.

It's striking that such a simple and brief method is so powerful for most people.

It works because deep, long inhalations expand your *bronchioles*: the passageways in your lungs to the tiny alveoli where oxygen enters the blood and carbon dioxide leaves it. The PNS is in charge of constricting the bronchioles, so by making them swell up with a big breath, you trigger the PNS to bring them back to their "resting" size.

Parasympathetic and Sympathetic Systems: Structure and Functions

Getting A Sense of Each System

If you tried the deep breathing exercise just above, you got a sense of what lighting up the parasympathetic system feels like. For the sympathetic system, imagine something stressful, like being put on the spot by your boss, or a car cutting in front of you in traffic, or getting upset with a family member. Try to get into the experience, and then notice what it feels like in your body and mind. When you want, take a couple full breaths to get back to center.

That back and forth – calm from breathing deeply, then aroused by stress, and then calm again – illustrates how the parasympathetic and sympathetic systems work in balance with each other, much like the brakes and the gas pedal of a car. By learning how to control them more skillfully, you can increase your positive experiences, reducing negative ones, and – if you like – develop the steadiness of mind and equanimity that are vital for contemplative depth and realization.

The PNS

The PNS conserves energy in your body and is responsible for ongoing, mellow, steady-state activity. The feeling of it is relaxation, often with a sense of contentment. (And signals for it originate in the Nucleus Ambiguus – love the term – in the brain stem.)

The parasympathetic nervous system:

- Opens (dilates) blood vessels leading to the GI tract, aiding digestion.
- Stimulates salivary gland secretion and accelerates peristalsis, helping the absorption of nutrients.
- Engorges the male and female genitals
- Constricts the bronchioles of the lungs.

- Dampens the sympathetic nervous system.

The primary hormone/neurotransmitter of the PNS is **acetylcholine**. For example, levels of this rise when we are sleeping, helping to slow the heart and decrease the force of its contraction.

Relaxation: Exercise #2

Relaxation is at the heart of most stress management trainings. Since you *use* the PNS in order to relax, relaxing engages its circuitry and thus *activates* the PNS.

Relaxing also has a significant indirect activation of the PNS: relaxed muscles send messages to the alarm centers in the brain that nothing is alerting the body to a threat.

Many people have their own key methods, and here are a few of the most common “quickies” for relaxing without going to yoga camp:

- Relax your tongue
- Relax your eyes
- Relax the diaphragm area
- Imagine being in a very comfortable setting
- Feel everything draining out of you and sinking deep into the earth

You might like to try one or more of these right now, maybe one you’re not so familiar with, and see how it feels.

The SNS

The SNS deals with immediate, *rapid* responses to changing environmental conditions. It lights up when an organism – a mouse in the field and the cat hunting it, or you and me – has to do something *actively* to preserve its equilibrium.

Much SNS activity is not particularly dramatic. For example, standing up would cause a big drop in your blood pressure if the SNS did not compensate by momentarily increasing it. Similarly, just before you wake up, sympathetic activity increases, getting your body ready to be active.

The sympathetic system deals with “fight or flight” reactions, but it’s more versatile than that. Even in high-drama survival situations, such as a rabbit seeing a snake, the SNS may trigger not fighting nor fleeing . . . but freezing. (This latter response can become increasingly habitual in victims of inescapable trauma, such as mistreated prisoners or children in an abusive home.) In some fish, the SNS can cause a swift change in color. Your SNS activates whenever you’re upset – like irritated at a co-worker, saddened by an unexpected loss, or worried about how to pay the bills

On a happier note, SNS activation in women can be accompanied by a release of the soothing hormone oxytocin and increased “tend-and-befriend” behaviors. Partial or mild SNS activations may lead to negotiation among social animals, or even a kind of play, such as kittens – or preschool boys – tussling with each other.

Working Together

Broadly, the SNS deals with:

- tight engagement with the external environment
- high levels of energy
- mainly exteroceptive (external) sensory information

On the other hand, the PNS handles:

- disengagement from the external environment
- low levels of energy
- mainly proprioceptive (internal) information
- recovery from stressful experiences
- return to homeostasis

In short, the SNS prepares the organism to act upon its environment, while the PNS prepares the organism to act upon itself. Put more dramatically, if the SNS is for “fight and flight,” the PNS helps you “rest and digest.” Both systems evolved to keep animals, including humans, alive in very harsh and potentially lethal environments, and we need them both.

Nonetheless, we live in a culture that prizes the excitement, aggressiveness, high-stress worklife, pace, and general intensity that is fueled by the SNS. Further, unlike most other developed nations, it is a simple fact that our society has chosen not to take steps such as universal health care, family friendly laws, and an economic safety net that would lower much of the SNS-activating anxiety that gnaws at many people.

Yet if anything, the PNS is more fundamental to life. If your sympathetic system were surgically disconnected – as it was in years past as a last-resort treatment for hypertension – you would remain alive and pretty much yourself – though unable to cope well with commuter traffic, root for the home team, or have an orgasm. But if your

PNS were disconnected, you would die quickly. PNS activation is the resting state of the body-mind: in other words, relaxed contentment is your fundamental home base, your bottom line. Pretty sweet!

Most of us live in a chronic state of SNS over-activation. Conscious attention to the parasympathetic system brings the pendulum back to center.

Increasing and Balancing “Heart Rate Variability”: Exercise #3

The HeartMath Institute has pioneered a number of research-based techniques for influencing the heart rate in ways that improve physical and mental health. Most if not all of their methods engage the parasympathetic nervous system. For more on this, go to their website (www.HeartMath.com) and check out our adaptation of their techniques in the Methods article on our website, www.WiseBrain.org.

In brief, here’s a simple, three-part method:

- Breathe in such a way that your inhalation and exhalation are the same duration; for example, count 1-2-3-4 in your mind while inhaling and 1-2-3-4 while exhaling.
- At the same time, imagine or sense that you’re breathing in and out through the area of your heart.
- Meanwhile, bring to mind a heartfelt emotion like gratitude or love.

Try this for a minute or two, and you will probably be struck by the results.

Technically, you are both increasing and harmonizing the natural, tiny changes in the interval between heart beats: what’s called “heartrate variability.” Fairly large changes in that interval, and changes that vary smoothly from one beat to the next, link to cardiovascular health, improved immune system function, and elevated mood.

How the Sympathetic System Gets Triggered

Introduction

Since PNS activation is the baseline of your body, with SNS activation being a change in that baseline in order to cope with something “perturbing,” it’s really useful to understand the answers to these questions:

- What triggers the SNS?
- What happens then?

Activation Signals

As noted, much of the routine activation of the SNS is quiet and in the background (like maintaining blood pressure when you stand up). As usual, it’s the fireworks that get noticed! Still, it is those fireworks that cause us the most trouble – in our experience of living, in our health, and in our relationships – so we’re going to focus here on them.

Here's a survey of the different sorts of things that signal the SNS to WAKE UP AND TAKE CARE OF BUSINESS!:

- Imagine an extreme situation, such as you're driving along and suddenly a tire blows and your car starts to spin into oncoming traffic. Or you get a call from school and your child has had a terrible fall and is being rushed in an ambulance to the hospital. Or you're walking down a dark street and suddenly you feel someone grabbing you and trying to take your wallet or purse. These are mortal threats to yourself or people you love.
- Imagine less extreme situations, such as stubbing your toe (pain) or getting into an argument with your partner (emotional upsets).
- Imagine just having low blood sugar: you had a donut and a diet Coke for breakfast, it's 11:00 o'clock, and you're stuck in a boring meeting at work.
- Imagine something really exciting, in a wonderful way: you get the envelope saying you're accepted into the college of your choice, or your beloved asks you to marry him, or the Red Sox finally win the World Series (that one sure pumped me up).
- Imagine being trapped in stop-and-go traffic. Or having to write a difficult report under a tight deadline. Or being blasted with a bright light or a loud noise. Or having to do a lot of multi-tasking, or getting constantly interrupted (a description of raising young children . . .). Or anything else that's significantly stressful.

Danger, pain, upsetting feelings, low blood sugar, excitement – and *stress* in general – all activate the sympathetic nervous system.

And so does the anticipation of something bad (or really wonderful) . . . even if that anticipation is exaggerated or flat wrong.

Or even simply seeing the name of someone who we're upset with on an email.

Exacerbating Factors

This last effect of an internal, psychological variable – such as anticipation – points to the powerful role of psychological factors in modulating the impact of events.

For example, if we expected a job interview to be serious and demanding, then when it is, it's (probably) not that stressful. But if we expected a mere formality, a cakewalk, but it's actually serious and demanding, then that could be quite stressful. The

violation of an *expectation* activates the SNS, which deals with novelty; the violation of a positive expectation is especially stressful.

Additionally, studies have shown that the impact of events is increased when we:

- Do not have *emotional outlets*
- Feel like we've got little or no *control*
- Are not *supported* by others
- Lack *hope* that there's a light at the end of the tunnel

As Robert Sapolsky, PhD wrote in Scientific American (8/10/03):

"... a rat will be less likely to develop an ulcer in response to a series of electric shocks if it can gnaw on a bar of wood throughout, because it has an outlet for frustration. A baboon will secrete fewer stress hormones in response to frequent fighting if the aggression results in a rise, rather than a fall, in the dominance hierarchy; he has a perception that life is improving. A person will become less hypertensive when exposed to painfully loud noise if she believes she can press a button at any time to lower the volume; she has a sense of control."

So, with or without one of these of these exacerbating factors, let's say something has disturb your equilibrium. What happens then? (And we'll focus here on reactions to negative stimuli, since that's where most of the action is.) As we go through this discussion step by step, try to get a sense of this process actually happening in your own body. It's also a vivid way to learn about your nervous system.

Initial Arousal

First, within a fraction of a second, your brain orients to the novelty of whatever has occurred: "Oh, something new, something different, compared to my prior equilibrium."

Then, there is a deepening attentiveness to the stimulus. The nerve circuitry involved in processing a particular sort of information – let's say a troubling noise in the night, or the avalanche of thoughts about the audit notice you just got from the IRS – becomes *physically* more sensitive and active when attention is paid to that kind of information.

Feeling and Perception

Next, the stimulus gets flagged by the **hippocampus** and **amygdala** as "pleasant, unpleasant, or neutral." This is the "feeling tone" in Buddhism, the second of the Five Aggregates of existence. And with that feeling tone comes the related behavioral inclination: approach, avoid, move on.

So far, typically less than a second has elapsed. Jump first. Ask questions later. Notwithstanding the sometimes problematic effects today, this hard-wiring in the brain helped our great- great- great-grandparents survive in the wild.

Coming quickly on the heels of the feeling tone, there is a labeling – often culminating in a verbal tag – of what the stimulus is, and this is known as “perception” in Buddhism, the Third Aggregate.

Bringing up the rear, but hopefully gathering in influence as the seconds tick by, comes the analysis and commentary of the **frontal lobes**. This enriches, shapes, and edits the initial take by the hippocampus and amygdala. In Buddhism, this wave of activity is known as the “mental {or volitional} formations,” the Fourth Aggregate. (To round out the picture, the First Aggregate is all of physical reality and the bare sensation of it, and the Fifth Aggregate is consciousness.)

Primary Reactive Cascade

As soon as the amygdala and hippocampus register that something significantly unpleasant is happening – or threatened (including anticipated) – they trigger a primary cascade of changes throughout your body. All often in less than a second, sometimes much less.

Note that the follow-on waves of perception and mental formations that come seconds and minutes – or hours and days – afterwards can also influence the primary reactive cascade, but they are playing catch up, trying to slow down or redirect primal currents of neuronal information and hormonal/neurotransmitter discharges after the floodgates have already opened.

This primary cascade works both through the sympathetic nervous system, and through what is called the **hypothalamus-pituitary-adrenal** (HPA) axis of your endocrine (hormone) system. While the SNS and HPA are anatomically distinct, they are so intertwined that they’ll be described together.

So here we go:

- The **thalamus** – the major relay station smack in the middle of your head – sends a “Wake Up!!!” signal to the **locus ceruleus**, a cluster of just a few hundred neurons in your brain stem that plays a central role in arousal and alertness.

The **norepinephrine**-releasing neurons of the locus ceruleus spread throughout your brain, and when the LC lights up, those neurons disperse this activating neurotransmitter/hormone far and wide.

- Amygdala neurons extend (“project”) down into the midbrain and brain stem, and they activate the control centers of the sympathetic nervous system – whose major trunk lines run down your spine and send wiring into every major organ and muscle group of your body – and that makes the SNS light up.
- Meanwhile, within the HPA axis, the amygdala [PITUITARY?] has also released a neurotransmitter called “corticotropin releasing hormone” (CRH). This, and other signals from that axis and the sympathetic nervous system, cause surges of the major “stress hormones”: **Epinephrine** and, to some extent, **norepinephrine** (adrenaline and noradrenaline), plus **glucocorticoid** hormones, particularly **cortisol**.

Interestingly, both physical stress and social stress activate the HPA axis, though through different pathways. But this gives a neurological explanation for why getting rejected or shamed can feel as stressful as a root canal.

And you can see the central role of the amygdala, since it triggers both the SNS and the hormones of stress.

- In all, there are multiple, redundant pathways to get the organism ready to “do or die.” (That’s why it’s complicated to describe – and understand.) It’s that important to survival.

Secondary Reactive Cascade

OK, so now your brain is on red alert, your sympathetic nervous system circuitry is lit up like a Christmas tree, and tidal surges of stress hormones are washing through your blood. Great! Now what happens?

- *Epinephrine* makes your heart beat faster and stronger, makes your pupils dilate to gather more light, improves your visual acuity a bit, and makes you sweat to cool the body.
- *Norepinephrine* constricts the blood vessels in the skin, which makes the skin a little cooler.

Triggered by the locus ceruleus, norepinephrine also excites – in the neurological sense – your brain as a whole, making it more susceptible to stimulation and priming it for activation. By the way, this could be one of the primary sources of the experience of slowing your perceptual time clock in an emergency (e.g., car crashes, falls in rock climbing): since your brain speeds up, the world seems to slow down.

- Epinephrine and norepinephrine – called “adrenal hormones” – act quickly, while the *glucocorticoids* have slower effects. They suppress the immune system, perhaps to reduce inflammation from wounds.

Glucocorticoids also add to the activation of the locus ceruleus, making it release more norepinephrine into the brain. In a circular feedback loop, the locus ceruleus sends projections back to the amygdala, which tell it to release more CRH, which leads to more glucocorticoids, which activate the locus ceruleus further, and so on.

Unfortunately, glucocorticoids in pregnant women can cross the placenta to reach their young, and very high levels of these stress hormones can permanently alter the hippocampus of the fetus, with effects discernible in adulthood. (But please know that this refers to really, really high levels of stress hormones, not the normal fears and hassles that accompany many pregnancies.)

- Lots of changes occur in the *cardiovascular system*. For example, blood gets shunted from the interior of the body to the major muscles, dilating the blood vessels there for maximum strength. In fact, in the skeletal muscles in the core of your body, blood flow can increase by as much as 1200%.

Interestingly, the emotion of fear tends to increase blood flows to the legs, while the emotion of anger tends to increase them to the arms . . . the one to run away, the other to turn and fight.

- The *bronchioles* of the lungs get dilated, for more gas exchange . . . enabling you to run farther and hit harder. We also tend to hold our breath when we are anxious, to extract as much oxygen from it as possible.
- *Blood sugar* rises, to get more fuel to cells that need to burn hot.
- Sometimes you get *goose bumps* – the fancy term for this is “piloerection” – raising the hairs on your skin, a vestige of an ancient reaction that made our animal ancestors look bigger when they felt threatened.
- *Reproduction* is sidelined. The production of reproductive hormones in women decreases, and erections in males are suppressed. No time for sex when a lion is charging! And the effects of chronic stress on libido are apparent even without a mortal threat at hand; just ask those caring all day long for young children.

By the way, male arousal involves a delicate minuet between the SNS and PNS, charmingly explained by Robert Sapolsky in his marvelous book, *Why Zebras Don't Get*

Ulcers. In brief, men need some SNS activation to get sexually excited in the first place, but then the SNS needs to take a back seat for awhile to the PNS, which dilates (opens) blood vessels in the sex organs (though the SNS is responsible for dilating them in much of the rest of the body). Then, as orgasm approaches, the SNS is responsible for ejaculation. This complexity is one of the reasons why erectile dysfunction is not uncommon, and why stress and anxiety can have such an effect on sexual performance.

- *Digestion* is suppressed. Salivation is reduced, the reason for a dry mouth when you're afraid. Peristalsis (the rippling of the intestines that moves food along) slows down, which is why stress leads to constipation.
- Related *emotions* intensify - like fear, disgust, and anger - which sensitize your sensory circuits to threatening information, so they will pick it out more quickly. From an evolutionary perspective, emotion is a very effective development.

But emotional reactivity also has its drawbacks. It makes you prone to over-estimate threats and not see positive resources. Also, circular and snowballing processes often reinforce any initially distorted perspectives. For example, if your original appraisal of the other person's action was that it was a "5" on the Badness Scale (but actually it was really just a "2"), then you're likely to get extra huffy . . . which in turn could irritate the other person, who's probably thinking: "Hey, that was barely a '1'!" And that irritation could reactivate him or her further, seeming to confirm your original - but actually exaggerated - appraisal.

Mindfulness of the Body: Exercise #4

Since you've been reading about the body, maybe you've been bringing your attention to it a little - a good segue to mentioning another method for PNS relaxation: mindfulness of the body.

Since the PNS deals mainly with internally directed activities, bringing attention inwardly - especially when not related to something alarming, like worrying if you have an ulcer - activates PNS networks. Plus mindfulness is generally relaxing, which also activates the PNS (as we discussed above).

Probably you've already had some formal practice with mindfulness of the body (e.g., while meditating, doing yoga, in a stress management class). It's simple: just be attentive to physical sensations. And you can focus, if you like, on some sensations in particular, such as the breath in general or even localized to the area around the outer nostrils and upper lip.

Conclusion

In the next issue of the Wise Brain Bulletin (Vol 1, #6), we'll finish Part Two of this article, and cover:

- The long-term effects of chronic stress
- Perspectives on working with the sympathetic and parasympathetic nervous systems
- Major methods for activating the PNS, including meditation, cultivating positive emotion, and (truly) fiddling with your lips