

Relaxed and Contented: Activating the Parasympathetic Wing of Your Nervous System

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Introduction

It's remarkable but true: part of your nervous system exists to you feel peaceful and alright. Its formal title is: "the parasympathetic wing of the autonomic nervous system" or PNS, for short.

You can trigger the PNS at will, which immediately lowers your sense of stress, brings health benefits like reducing blood pressure and strengthening the immune system, and lifts your mood. This gives you more control over your inner landscape – a nice thing at times when the outer world seems driven by forces that are beyond your influence, from local traffic jams to global warming.

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. These everyday techniques include: intentional relaxation, balancing heart rate variability, mindfulness of the body, yawning (really!), and increasing positive emotion.

If you want a clear picture of what is happening inside you every single time you are hassled, pulled in too many directions, irritated, worried, threatened, injured, or upset, then you might want to read carefully the descriptions of your bodily processes when your SNS flips its switches. On the other hand, that might be more detail than you really want, and if so, you could skim through it and focus on the methods themselves, which are numbered as exercises.

For further information, take a look at the slide shows from our workshops (http://www.wisebrain.org/slide_shows.html) or read the Summary of Methods article (<http://www.wisebrain.org/WiseBrainMethods.pdf>).

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 “heart rate 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 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.

Long-term Effects of Chronic SNS Activation

In a nutshell, the SNS shunts resources away from long term projects – like building a strong immune system, or digesting food, or making babies – in favor of short term crises, like getting away from an attacking lion a million years ago. Crises that were usually resolved quickly. One way or another.

But long after the lion has pounced on someone else and left you alone, you're still shaking like a leaf! That's because the effects of the SNS diminish *gradually*, while the effects of the PNS diminish *abruptly*. For example, in a frightening situation (= SNS arousal), it takes your heartbeat awhile to go back to normal even after the danger is over. But when you wake up – and are no longer so regulated by the PNS – your heartbeat increases briskly.

One reason for this is that, unlike many other hormones, the dominant SNS hormones – epinephrine (adrenaline), norepinephrine, and catecholamines (which include dopamine) – do not exert any negative feedback to reduce their own synthesis.

Bottom-line, lighting up your SNS is not just a fleeting experience, but something that has a real *stickiness* to it, a lasting impact.

For example, chronic activation of the SNS burdens five major systems of your body: gastrointestinal, immune, cardiovascular, endocrine, and nervous. Let's look at the lingering effects of that wear and tear for each system, with an emphasis on the nervous system, since that's where it feels like we live as conscious beings.

Gastrointestinal

Chronic stress and other sources of SNS activation increase your risk for ulcers, colitis, irritable bowel syndrome, diarrhea, and constipation.

Immune

Routine SNS arousal weakens your body's defenses in numerous ways. This finding is well-documented in numerous studies, and we've all had the personal experience of catching a cold when we're run-down.

Cardiovascular

Hardening of the arteries and heart attacks are all more likely if you experience chronic stress – especially when combined with a steady dose of hostility.

Endocrine

A steady diet of SNS increases risks for Type II diabetes, especially when combined with lots of sugary and refined carbohydrate foods. In the erotic department, it leads to impotence in men and low desire for both sexes.

And it's probably not very good for your longevity, either. The body makes cortisol (one of the stress hormones) and DHEA from the same raw materials. DHEA is sometimes called the "anti-aging hormone" due to its beneficial effects. But under stress, production is shifted toward cortisol, so there's less DHEA.

Nervous

The amygdala. Repeated experiences of fear (and perhaps other negative emotions such as disgust or anger) increase what's called the Long-Term Potentiation (LTP) of neurons in the amygdala; in other words, the synaptic connections there are strengthened. Further, repeated stressful experiences lead amygdala neurons to grow more connections with each other. As a result, in a vicious cycle, repeated experiences of fear and stress make the amygdala more sensitive to and more reactive to fear- and stress-related information.

Now, the amygdala plays a central role in the formation of **implicit memories**: the registration of lived experience (especially the emotional and sensate parts) beneath conscious awareness. When the amygdala has become sensitized and energized in a fearful and negative direction, then it shifts implicit memory that way. Over time, this "dark shading" can lead you to feel a free-floating anxiety, depressed mood, and irritability.

Your implicit memories and negative emotions also create the conceptual lenses through which you see the world. These perspectives seem self-evident – of *course* most relationships are disappointing, of *course* you'll get in hot water if you say what you really feel, etc. – and are thus typically unquestioned, which is what makes them most problematic; like the proverbial fish, we swim in the waters of our belief systems without realizing we're soaked in assumptions.

When you peer at the world through subtly shadowed glasses, it looks more daunting and less friendly, which naturally makes you too cautious or too aggressive . . . sometimes with serious consequences. And in a feedback loop, any “tinted” information coming through your lenses increases the negative sensitization of the amygdala, which in turn darkens your worldview, leading to incoming information that’s even more shaded.

The hippocampus. Compared to the amygdala, stress hormones – notably cortisol – have an opposite effect on the hippocampus, a part of the brain that is vital for forming **explicit memories** of events: a clear record of what actually happened. In other words, stress hormones *reduce* long-term potentiation (LTP) in the hippocampus. In the extreme, intense and longstanding stress or trauma can literally shrink the hippocampus.

Further, recent evidence has shown that at least some portions of the brain actually do grow brand-new neurons (contrary to long-held belief), including the olfactory bulb (for smell) . . . and the *hippocampus*. But glucocorticoids due to stress prevent the birth of new neurons in the hippocampus, impairing its ability to produce new memories.

The effects of all this can be quite extreme. For example, in people who have a history of severe depression – which could be regarded as both a result and a cause of stress and painful feelings – the hippocampus can shrink by as much as 10 – 20%. This shrinkage could be one of the reasons for the poor memory associated with depression. Unfortunately, hippocampus atrophy persists after depression resolves; it appears to be a permanent consequence of intensely painful experiences.

The amygdala-hippocampus one-two punch. When the amygdala is over-sensitized and the hippocampus is compromised, it’s a horrible combination: painful experiences can get recorded in implicit memory – with all the distortions and turbo-charging of an amygdala on over-drive – without an accurate explicit memory of them! Then it may feel like: “Something happened, I’m not sure what, but I’m really upset.”

This could be a reason why victims of trauma sometimes feel dissociated from the actual events surrounding their trauma, yet are very reactive to any trigger that reminds them unconsciously of what once happened.

Depression. Routine activation of the sympathetic nervous system is closely linked to depression, for three kinds of reasons. First, an underlying source of SNS arousal – such as getting fired or needing to care for a demented parent – could also be depressing in its own right; in this case, the two effects, SNS arousal and depression, are associated simply because they share a common cause. Second, the experience of

chronic stress has psychological consequences – e.g., no chance to let down, feeling irritable, sense of hopelessness – which can wear down your mood over time.

Third, the physical effects of sympathetic activation undermine the biochemical basis of an even-keeled, let alone cheerful, disposition:

- Glucocorticoids slowly deplete the norepinephrine released throughout your brain by the neurons of the locus ceruleus. Norepinephrine makes you feel alert, attentive, and mentally energetic, so when stores of it run down, you tend to feel a certain dullness, flatness of emotion, weakening of concentration, even apathy – which are hallmark symptoms of depression. (This could be a reason why taking glucocorticoid hormones for arthritis can lead to depression as an unwanted side effect.)
- Stress reduces the amount of serotonin – the neurotransmitter that is relaxing, regulates sleep, and buttresses your mood – in your brain. Additionally, it reduces the number of serotonin receptors in the frontal lobes, so they are less responsive to the dwindling stocks of serotonin that do arrive.

Serotonin also encourages the locus ceruleus (LC) to release norepinephrine. When serotonin levels drop due to stress, that leads to even less norepinephrine from the locus ceruleus, which has already reduced its norepinephrine flows due to increased glucocorticoid stress hormones (which we discussed in the bullet just above).

In short, less serotonin means more tension, worse sleep, more vulnerability to a blue mood, and less alert interest in the world.

- Moderate and brief stresses – in other words, manageable doses – lead to a release of the neurotransmitter, **dopamine**, in the pleasure circuitry of the brain. That's one source of the "high" in some stressful activities like race car driving, difficult skiing, rock climbing, etc.

But – prolonged exposure to glucocorticoids flattens dopamine production. Then, as the classic criterion for depression says, there is a loss of enjoyment in activities once found pleasurable.

Summary

We evolved to handle short bursts of intense stress, and live to tell the tale. But the modern lifestyle of fairly steady levels of moderate stress is completely unnatural, and it has many bad consequences for your physical and mental health. That's perhaps the most fundamental reason for increasing the activation of your parasympathetic nervous system.

Yawning: Exercise #5

So now, as another method for activating the PNS – and one that could be happening on its own as you try to assimilate all the material we just plowed through – try yawning!

Yawning activates the SNS on inhalation and the PNS on exhalation. Taken as a whole, it sure feels like a net PNS intervention.

Strategic Perspectives

Even though you've just had a fairly nightmarish tour through the potential collateral damage of the sympathetic nervous system, we still need that system, and it's got to work well, whether it's to get through a minor crisis at work or rise to meet the challenge of a late-night call from a teenager who needs a ride home from a party-gone-bad.

Nonetheless, we really do live in a time of SNS gone amok, and we would really benefit from reducing its over-reactions. How to do that?

For sure, it makes sense to deal with your **environment**. That could mean looking for a job with a less insane commute, parenting a spirited child in ways that help him learn more self-control, or simply fixing the leaky faucet that's driving you crazy at night.

You could also take **medications**. For example, tranquilizers like the benzodiazepines work by relaxing muscles and by inhibiting the locus ceruleus excitation of the amygdala, reducing its reactivity. Another class of drugs called beta blockers fit into some of the neuronal receptors for epinephrine and block its effects – like a bandaid covering a lock so the key can't get in. (Interestingly, beta blockers reduce the formation of memories of upsetting events, and are being explored in the treatment of trauma.)

That said, there are a lot of limits on working with the external world, and lots of benefits in working with the inner world (see the article, **Why Inner Skills**, at <http://www.wisebrain.org/articles.html>). And there are well-known problems with prescription medications; for example, the benzodiazepines are sedating and addictive.

Therefore, I believe that both research and personal experience tell us that it is the *inner skills* – not environmental fixes or medical treatments – which make the greatest difference to our resilience, well-being, and long-term health.

In terms of bringing a better balance to your autonomic nervous system, you can be skillful inside your own body/mind in three kinds of ways:

- In the moment, dampen the immediate SNS response. For example, focus on moderating factors like social support, the sense of what you can do, and hope for the future. Or distract yourself, or remind yourself not to sweat the small stuff.
- Over the long-term, soothe SNS reactivity. For example, really emphasize positive emotions in your life and practice taking in the good to help those good experiences register deeply in implicit memory, both of which should reduce amygdala reactivity over time.
- Activate the parasympathetic nervous system. As we've discussed, PNS arousal has inherent benefits, plus it puts a blanket on the SNS. Inner skills for triggering the PNS have been the focus of Parts One and Two of this article.

Further Methods for Parasympathetic Activation

Introduction

By the way, you may have already noticed that many techniques of PNS activation work together. For example, relaxing is itself usually a pleasant experience, thus triggering mildly positive emotions.

To review, we have already covered:

- Breathing
- Relaxation
- Lowering heart rate
- Mindfulness of the Body
- Yawning

Now we'll explore three more methods.

Meditation: Exercise #6

Meditation activates the PNS for many reasons, including pulling attention away from stressful subjects and activities, sitting quietly, relaxing, and bringing awareness into the body.

An interesting, possible additional reason has to do with a common method of meditation: paying attention to the sensations of the breath around the nostrils and upper lip. In your brain, the olfactory bulb – which receives sensory signals from the nostrils – sends neuronal projections directly to the amygdala, probably due to the evolutionary importance of detecting disgusting, frightening – and sometimes, pleasant – aromas. When you bring your attention to the breath around the nostrils, you activate the sensory networks in that area, including the olfactory system.

As a result, you are flooding the amygdala with information that has a neutral quality to it (that quality is called “feeling” – distinct from emotion – in Buddhism), or a positive quality if you meditate with incense. That would tend to crowd out unpleasant information within the amygdala. It could also sensitize the amygdala increasingly over time to neutral information, leading its processing to be increasingly dedicated to neutral information compared to negative information.

This is not the place to give instructions about meditation, which you’ve probably been exposed to already. And you can get good information from the books of Christina Feldman, Jack Kornfield, Jon Kabat-Zinn and many others.

Here, I would simply like to encourage you to meditate regularly. Even for just one minute a day. But every day.

And consider joining a regular sitting group in your area. There are an amazing number of meditation groups sprouting up around the country.

Positive Emotion: Exercise #7

Positive feelings activate the PNS directly by lowering cardiovascular reactivity. They also do so indirectly by priming a person to experience life in more optimistic and pleasant ways, and the effects of that include reducing the sensitization of the amygdala to negative events. Anything that gives you a positive feeling – especially of a more relaxed sort, like contentment, gratitude, lovingkindness, or tranquility – will usually arouse your PNS.

Yes, sometimes it is hard to have positive emotions. And that difficulty alone can cause some negative emotion! But just do what you can. There are two great wings to psychological growth and spiritual practice: being with and working your inner and outer worlds. While *being* with is primary, there is still a great role for working with, including the cultivation of positive feelings. (For more on this point, please see the Two Wings article in Bulletin #2, at <http://www.wisebrain.org/bulletin.html>.)

If you like, experiment with cultivating positive emotion for a few moments, and whatever you experience is really fine.

Perhaps focus on what you feel grateful for. Or feelings of lovingkindness, perhaps for yourself or some people you are close to.

And to really reap the rewards of experiencing positive emotions, help yourself by taking them in (see the articles on taking in at <http://www.wisebrain.org/articles.html>).

Fiddling the Upper Lip: Exercise #8

Last, here's a cool but kind of goofy method: fiddling with the upper lip, including producing that "blub blub blub" noise kids love to make. The evidence for it is anecdotal – mainly from people who work with horses or with troubled children who bite – but interesting.

This method could work by:

- Stimulating the PNS nerve fibers that innervate the lips, and thus send activating reverberations throughout the whole PNS.
- Triggering positive emotions associated with nursing, feeding in general, thumb-sucking, etc. Note that children and even adults can comfort themselves through touching their lips.
- Stimulating salivation, which is controlled largely by the PNS.
- Simply distracting yourself from stressful stimuli through its sheer absurdity.

Concluding Perspectives

Over the Long Haul

Many of us balance a driven and routinely stressful way of life with vacations or the occasional day off. This is a kind of "binge and purge" approach to stress management, but it is not at all effective. You cannot undo the accumulating effects of chronic stress with intermittent respites, even in Tahiti.

There is no way around it: each of us needs to have minimal chronic stress combined with a steady state of relaxed, alert, contented coping that emphasizes PNS activation with just enough SNS arousal to get the job done – whatever it is. In a single sentence, that's your best-odds prescription for a long, productive, and happy life.

Foreground and Background

Consider puffy white clouds against a blue sky: the element that's least present – the clouds – pops to the foreground and dominates the picture. And if you've ever tossed three coins to produce the six lines of the hexagram used in the I Ching, the ancient Chinese system of divination, you've encountered a similar phenomenon, this time from a great wisdom tradition: if heads represent yang (the light and active principle) and tails represent yin (the dark and receptive principle), then one head and two tails would be a yang line, since it is the yang element – in the minority – which stands out.

Or consider TV shows or movies which spotlight conflict and lack of communication . . . but against a backdrop of routine daily cooperation in human societies. Cooperation

is so ubiquitous that it becomes the “sky” against which the clouds of conflict stand out – and capture and dominate our attention.

Recall the point made in Part One: if your SNS were shut down, you would continue to live and function (though maybe be sluggish in an emergency). But if your PNS were deactivated, you would quickly die. Your parasympathetic nervous system is absolutely fundamental to life.

The PNS is wallpaper, sky, taken for granted, undramatic, in the background. Human culture, and definitely the modern media of television and movies, are largely about the SNS. Action, conflict, sex, million dollar moments, death, crisis, fairy-tale endings, etc. are different and dramatic. It’s therefore easy to start thinking that chronic stress and living awash in the SNS are what’s really natural, the bedrock of existence.

But in reality, cooperation, relaxation, and equilibrium are the hub of the great wheel of life.