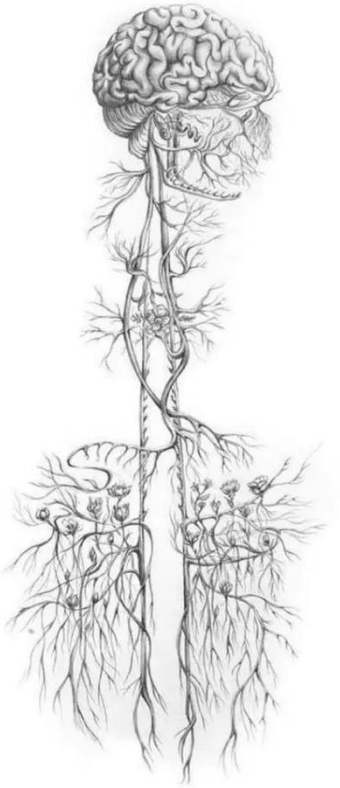
MASTERING THE VAGUS NERVE



HOW SINGING IS HEALING

MASTER THESIS B.M. SOÓS

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"I'm singing in the rain

Just singing in the rain

What a glorious feeling

I'm happy again"

Arthur Freed

Prologue

Physical and emotional wellbeing are deeply connected. When you are not feeling well, if your body is in pain, it can be a real challenge to enjoy your day: to have fun and to show interest in other people. But when we have had a good night's sleep, some body movement and a good meal, we feel better and are more social. This connection is well known.

What only a few people know is that it is mostly one specific nerve that is responsible for our body functions and so for our health and emotional well-being. It's called the vagus nerve. This nerve must function well in order for us to feel healthy and emotionally well and to have positive relationships with our family, friends and others.[1] What I will explore during my master research and thesis is what this nerve exactly is, how it works and explore more about how using our singing voice has measurable positive effects on our nervous state.

The reason I want to investigate this matter is because as a professional singer, I have also known moments of low mental state. Singing is commonly assumed to be accompanying a state of happiness, but as a singer, even if you are not feeling well, you have to sing and produce the energy that is necessary to sing an aria and act as if you are deeply in love, even while on a personal level you might be having a huge life crisis. It can be a tremendous challenge to keep yourself on track.

In moments like that I often wondered, how it is possible that most people mostly sing out of joy, excitement and while I feel blessed to call this my work, it still can be exhausting to put all the effort in getting started even just with my daily practice.

Are there ways to make this easier? Is it possible to get started in the right mood? How do we change our overall mood when most mornings you feel too depressed to get out of bed?

As I started reading about this matter, what I call the more abstract way of getting results, because it is not a straightforward result of getting immediate and concrete results after your work, I started experiencing and learning more about the vagus nerve and the immense effects is has on our nervous system and so our mental health. I started to get very excited to learn even more about this in practice. I find it absolutely fascinating to experience how it works with immediate effect and even more on the long haul. And there is so much we don't even know about. What I also realize, is that not all science leads to measurable and visible results. There is no way of telling how things would be different, when you would have ceased to practice or when you do so every day. Therefore, it can be vague, also because emotions, stability and mood can be fluent, changing and the way we perceive them, as well.

I'd like to start with investigating the neurological and physical part of stress. Secondly, I want to dive deep into what researchers and therapists have experienced before regarding this matter. Lastly, I would like to conduct my own research to find out in how much time it is possible to experience some level of improvement of the mental state by singing regularly and what exercises are the most beneficial.

[1] Rosenberg, Stanley "Accessing the healing power of the vagus nerve: self-help exercises for anxiety, depression, trauma and autism", North Atlantic Books, 2021

CHAPTER 1: The theory

What is it?

Music can take away stress and anxiety.[2] When somebody is singing, we see it as a sign of happiness, being relaxed and having a careless, positive mindset. Research has shown that the happiness-level in the brains rises, it gives us the feeling of being rewarded, the same feeling we get when somebody gives us a nice compliment. A mother singing to her child has an emotion-regulating effect. Research has shown that fetuses in the mother's womb already react to singing of the mother, which is measurable by a higher heart rate.[3] Even with toddlers, the calming effect is the highest when the mother was singing to them instead of saying soothing words.[4] Thus, listening to singing, especially of someone we are close to has a soothing effect. But what about when we sing ourselves? What does science say about that?

Something that has been proven by several researches is that certain nervous chains are more connected in the brains of professional singers.[5] Amateur singers' blood pressure significantly dropped while they were singing in a choir, as well as their cortisol levels, a commonly known stress hormone. For both groups the oxytocin level was rising, meaning the well-being for both groups got better; they both felt more relaxed and had more energy.

We can conclude that many studies underline the positive effect of singing. But what happens exactly and why is that so? Let's dive deeper into the neurobiological background of singing.

First, let's look at the social aspect. Social support, bonding, synchronization to each other's energy level by singing: you see it in churches, but in football stadiums as well. It seems like it is a significant part of bonding: sharing something that unites us all.

Humans are mammals and therefore social animals. We need each other to survive. Not only in the jungle where threat is at every corner. For that reason, mammals mostly still live in herds, warn each other for danger and help each other to move forward as a collective. It is for certain, that as individuals we definitely need our community around us. Also in today's world, we might all have our own challenges and insecurities but to broaden our chances to survive and thrive, we need interaction with each other: family, friends, neighbors, colleagues and our social network.

Think about it: the way you react emotionally in certain situations is an important matter in your behavior. We leave the practical, problem-solving analytical mind aside and focus purely on the emotional reaction in a certain situation. Do you look for people when you are in need? Do you search for help? You most likely look for someone understanding, helpful, caring, listening. In those moments we are not looking for criticism, rough words, how truthful they might be. We want to be held, listened to, ventilate our thoughts and feelings. Above all, we all want to share good times with loved ones with whom we feel safe.

[2] Scherder, Erik "Singing in the brain", Athanaeum Amsterdam 2022
[3] Kisilevsky, S. et al. "Maturation of fetal responses to music", Developmental Science, 2004, 7(5), 550-9
[4] Treuhub, SE. Et al. "Musical affect regulation in infancy", Annals of the New Yor Academy of Sciences, 2015; 1337, 186-92
[5] Loui, P. "A dual-stream neuroanatomy of singing", Music Perception, 2015; 32(3), 232-241

Communication and behavior towards loved ones are led by five brain nerves, that facilitate our hearing, influence our speaking and have a role in interpreting the other person. All this works best when you are in a safe environment, which makes the brain to function at its best.

Social interaction is the most natural way of regulating your nervous system. When something upset you, mostly it's enough when you can ventilate to a friend. But there are many other ways to calm the nervous system. Forms of this differ in different cultures: meditation, tai chi, yoga techniques for breathing (pranayama). All ways to make you relaxed and stop the automatic fight, flee or freeze response. Fighting or fleeing are stress responses. We will dive deeper into this later.

We use our voice as a medium to communicate non-verbally as well. In relaxed moments, our speech is in so-called *prosody*, the calm way of speaking. When we want to warn others for danger, are in panic, or in any other way of distress that causes our voice to get outside its *prosody*, then another person immediately hears or 'feels' this.[6] Hopefully, we all have that friend who knows that something is up just by hearing your 'hi' over the telephone. Isn't it magical, how all that can be heard over a device? Timbre, vibration and phonation all influence how you co-regulate with others. Communication via sound helps you send and receive messages regarding your safety.

The autonomic nervous system

The autonomic nervous system is a part of the whole nervous system that connects the whole body that we cannot control directly. Although, science is starting to acknowledge the fact that there are ways of doing that, which contradict the currently prevailing scientific belief. The exception is present to a limited extent, as it has been proven by Wim Hof, the Ice Man[7], who succeeded in consciously effecting his autonomic nervous system multiple times during scientific different researches. The methods he used to investigate this were cold therapy and breathing exercises. However, as this is not the subject of this thesis, I will leave it out of consideration.

It takes care of many functions of the body without us realizing it. It is constantly scanning the outside world based on what we see, hear, feel, encounter, including the commonly called 'gut feeling'.

It is 'that feeling' we cannot rationalize, explain or analyse, but we feel the urge to act in a way. That is all about activating our autonomic nervous system. Autonomous, because it acts on itself, we cannot consciously effect it in any way. We don't think about breathing in after each outbreath, to pump up our blood pressure when lifting something heavy, to take the digested food from one organ to the other.[8] It all happens 'automatically'. These are happenings that are necessary for the body on a daily basis. But throughout our days, we also need to be aware of our surroundings, may it no be the tiger anymore that sees us as prey, our world nowadays also has many challenges that need us to keep our awareness up. That is monitored by our autonomic nervous system. It is divided in two main parts; the sympathetic and the parasympathetic part, responsible for our fight, flee or freeze responses, which I will discuss at a later point.

[6] Llewelyn, C.J., "Chakra's and the vagus nerve: Tap into the healing combination of subtle energy & your nervous system", Llewellyn Publications, Woodbury, MN, 2023
[7] Jong, Koen de 'Wim Hof, koud kunstje', Lucht, 2015
[8] Anatomy, Autonomic Nervous System, Joshua A. Waxenbaum; Vamsi Reddy; Matthew Varacallo https://www.ncbi.nlm.nih.gov/books/NBK539845

The parasympathetic and sympathetic state

Let's go back to the basics first. Our brain is connected to the entire body by nerves, like an immense network of cords. The brain controls the body functions by sending messages down these cords to even the smallest body parts and vice versa. There are 7 trillion nerves in the entire body and the main nerves run along the spine. These connect the bigger parts of the body.

There are many different types of nerves, which will now be left out of consideration, as the focus is on the autonomic nerves. Autonomic nerves include two sides: the front and down side (*ventral* = 'belly') of the nerve, responsible for the parasympathetic reaction and the back- and top side (*dorsal* = back) of the nerve, responsible for the sympathetic reaction, both innerving all inside organs.[9]

There is an easy mnemonic to remember which is what: the P of parasympathetic stands for P of *pause* and the S of sympathetic stands for the S of *stress*.

In state of stress, the body is activated by the sympathetic side to fight or fly, or freeze (block). To calm the body afterwards, the parasympathetic state is responsible.

They function like a seesaw, one side up then then other goes down.

Source: playdale.co.uk

It is highly necessary to bring the body back into the relaxed status. As all other body functions besides immediate survival are put on hold during stress, it is of highly importance to bring the body back into the calm state, otherwise it can cause problems of various kinds on many different levels: physically and mentally.

The dorsal part is attached to the oldest part of the brain is present in every living animal. It causes a total shutdown when there is danger. All metabolic functions are cut off. It is like an immobilization by fear: the fear is so strong we don't do anything against it, we just give up. In case of a mouse that is caught by a vulture, it freezes so it won't get eaten: all vital activities stop in its little body. This physiological state of shock or *shutdown* makes them able to deal with trauma, danger, or annihilation, whether real or fictional. It can save lives and spares energy at the same time. It is a survival mechanism.

[9] Labee, Charlotte, "Brain under strain", Kosmos Uitgevers, 2022

However, when you cannot get out of this state for any reason, the stress is chronical, or you get into this state regularly, in other words: when the dorsal vagal activity remains and becomes chronic, your body literally doesn't hold space anymore for the 'fun part', as all energy is preserved to survive. In this case, life becomes less enjoyable, you become uninterested for things you used to enjoy before: you keep a negative, depressed way of going through the days. The dorsal side of the vagus nerve can make us eat more (or less), the digestion problematic, less energetic, inactive, introvert, sad, apathic, helpless, fearful, empty, hopeless, worthless, guilty, sensitive, ashamed, or restless. It can cause lethargy, a lack of energy, concentration, remembering details, making decisions, pain (fibromyalgia) that all can lead to (thoughts about) suicide.

Mostly, people having experienced trauma in some way and the dorsal-vagal nerve has been activated more regularly, it can be seen as the trauma has caused a 'shutdown'. Afterwards, the body is used to cutting itself 'off' and in that case, even the much smaller happenings can cause the natural reaction of dissociating from the body and the here and now, meaning physically, emotionally and psychologically blocking, exceptionally causing fainting as well.

When the nerve doesn't function well anymore and the dorsal side is activated chronically, the ventral side cannot come out of this immobilization caused by constant fear.

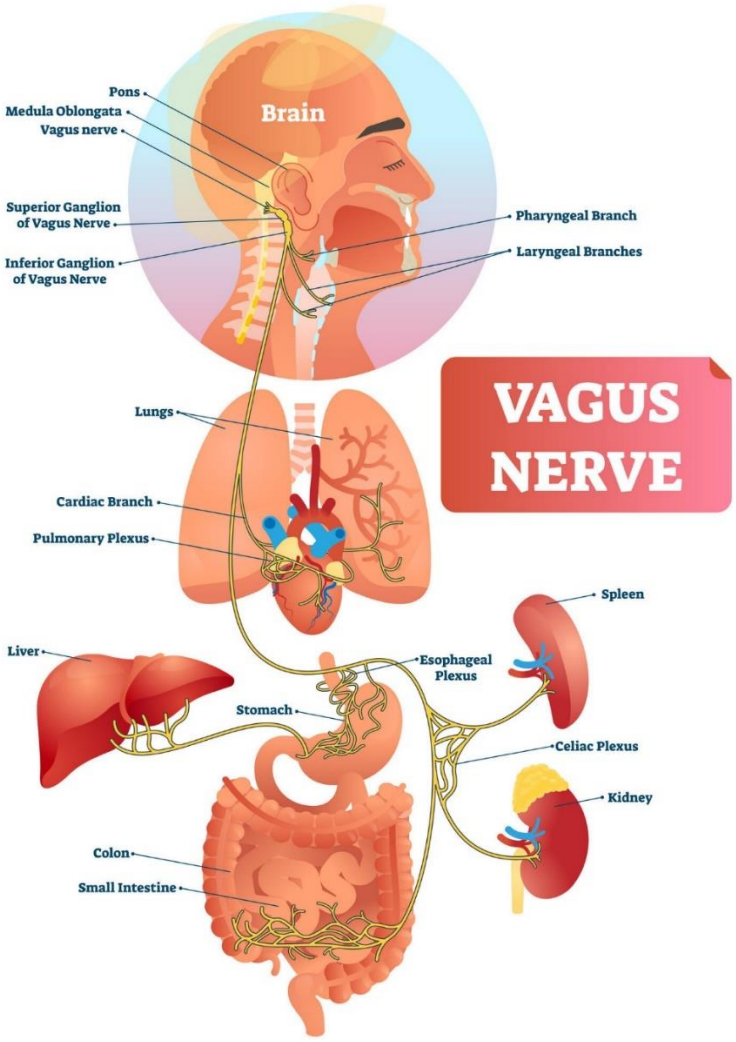
The vagus nerve

The first scientific mention of the vagus nerve was by Greek doctor Claudius Galenus (130-200 B.C.), who studied the vagus nerve of fallen gladiators. Although it was not quite clear to him yet what role this nerve had, his observations clearly showed that wounded gladiators' had way more disfunctions.

To be clear, this nerve is not a vague energetic line in the body. It is an actual nerve, visible and holdable, creating a connection between different organs on the body. It can be taken out of the body and investigated.

This tenth, 'wandering' (Latin: 'vagus') nerve is the longest nerve of them all. It is referred to as 'wandering' because it connects many different organs in the body and travels from the brains all the way down, it is the longest cranial nerve, running from the brain to the pelvic floor.

As it interfaces the heart, lungs, digestive tract and the laryngeal nerve, the muscles of the face and the middle ear, it is safe to say that making music and especially singing has a huge impact on it.



Source: morningsideacupuncturenyc.com/blog/acupuncture-and-the-vagus-nerve

That is because the laryngeal muscles, where the vocal cords are, are attached to various points along these structures, all of them are innervated by the vagus nerve and this again has branches that go into most of the pharyngeal and soft-palate muscles, all muscles in the back of the mouth hole, actively used by singers. Branches of the vagus nerve are also found in the very back of the tongue, your diaphragm, which plays a role in breathing, your heart, and the majority of the abdominal organs (esophagus, where the food goes downwards, stomach and intestinal tract).[10]

This nerve is also involved in the mechanism that controls blood pressure. It is one of the major parasympathetic ("rest and digest") conduits in the body. If your vagus was cut, your heart rate would be around 100 beats per minute at rest, way higher than it is in resting mode (60-70 BPM). Researchers have succeeded in removing the vagus nerve from frogs and it shows similar effects.

Contemplative practices like meditation, tai chi, and gentle yoga have been proved to have been attributed beneficial to signals sent along vagal pathways. Vagal tone is suppressed during quicker inhalations and facilitated during exhalation and slow respiratory cycles. Not surprising that breathwork and singing both show to be beneficial in this matter.

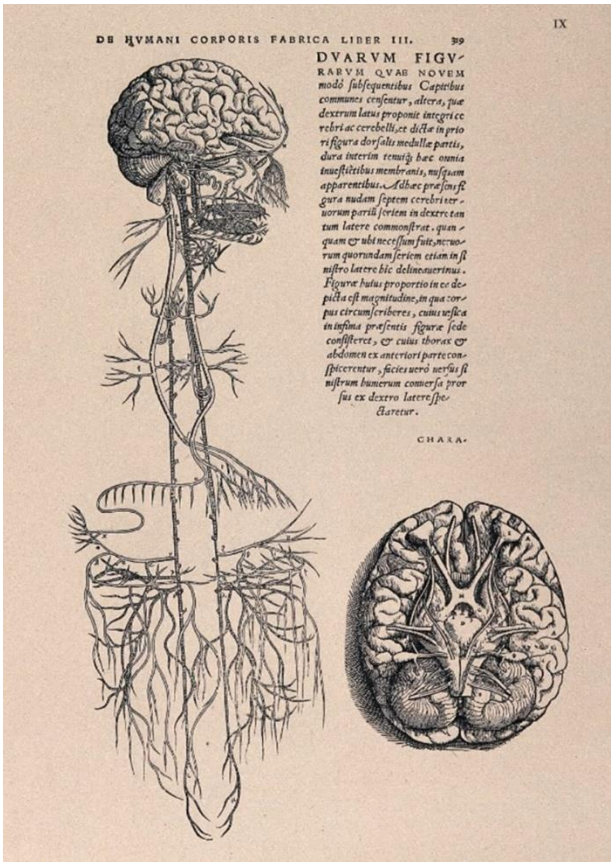
The vagus is also responsible for reducing inflammation, as it produces molecules (anti-cytokines) that work like drugs. The anti-inflammatory properties of the vagus are so powerful that electrical stimulation of the nerve can reduce or replace pharmacologic interventions in autoimmune conditions such as rheumatoid arthritis and lupus.[11]

80% of its fibers are designed to gather information about the well-being of the body (especially the throat and the visceral organs) and send that data to the brain.

[10] Byrne, Andrew "The singing athlete – brain-based training for your voice", Andrew Byrne Studio Inc., 2020
[11] Koopman, Frieda a. et al. "Vagus Nerve stimulation inhibits cytokine production and attenuates disease severity in rheumatoid arthritis." 2016: 8284-8289

The polyvagal theory

Stephen W. Porges' (1945) polyvagal theory, first published in 1994, explains the relation between the autonomic nervous system, emotions and behavior. Porges, professor in psychology at Indiana University and founder of the Traumatic Stress Research Consortium based his research on Darwin's observations. This research resulted in the polyvagal theory, that connects the evolution of the autonomic nervous system of mammals to their social behavior. In other words: it is important to look at the way our autonomic nervous system has evaluated during the past centuries, because it teaches us how humans experience and live under stress, also nowadays.



A graphical display of the brains and the nervus vagus by Andreas Vesalius (1543)

It all begins with the heart. The heart rate of a healthy person is around 70-72 BPM. In stressful situations this rate can go up, causing stress. As we cannot directly influence out heart rate, the only way we can do this indirectly is by influencing our breath.

Earlier scientists have researched World War I soldiers who were so severely traumatized they became unable to move or speak. Back then it was called 'shell shock', now we call it dorsal reaction, a complete shutdown of the nervous system.

Although many 'new' parts of the brain and nervous system have evolved in the skull, the evolutionary ancient parts of the brain include the autonomic nervous system that focuses on survival. It operates unconsciously and outside of our cognition. It is the first to perceive threat or safety and communicates it immediately to the brain to set things in action. Even when we cannot express the clear reason at that moment. In order to save time, those valuable milliseconds, our body is set in motion to act.

In case of a threat, primitive animal species survive by withdrawing, keeping quiet and putting the digestion on a stand-by mode to preserve energy. On the other side, the body is set to get into action, fight or flee, so the breath accelerates, the heart starts beating faster and the muscle tension builds up to enable rapid scanning of the presumably dangerous outside world.

As for mammals, another way to get safety is by connecting to other members of the species, according to Porges. He calls this the social engagement system.[12] It is those nerves that are responsible for social engagement and interaction with peers through the eyes, ears, larynx, throat heart and lungs. Co-regulation means we need to have a connection with somebody else to feel safe. The other way around: connection is impossible without co-regulation. When we don't feel safe, we are distrusting or jealous it makes coregulation impossible. It is the third and most important part of the polyvagal theory. 'We are wired to connect'- Stephen Porges.

Ventral state

When there is safety and social connection the nervous system is balanced. Should mobilization be necessary according to the body, then adrenaline primes muscles for action and 'unnecessary' functions as swallowing, chewing, eating and drinking fade to the background causing the voice to be disrupted.[13] Just think of a simple stressful situation: wasn't your mouth dry as a desert? More about this later, where I discuss the effects of various actions on the nervous system.

There can be tension in the face, the jaw, heart rate and blood pressure elevated, breathing becomes fast and shallow. Hearing becomes highly sensitive to some, causing hypersensitivity, hyperarousal, when we become easily irritated. All maximizing concentration to make sure nothing passes our attention.

In case of chronic dysregulation, the body has one option: dorsal shutdown. As everything costs relatively a large amount of energy, it is avoided at all cost. Mental dissociation and physically shallow functioning appear.

To be clear, the polyvagal theory might be a theory, but MRI scans literally show tremendous differences in specific brain parts when there is a case of a sympathetic state or a dorsal shutdown: the reptile part of the brain grows bigger and other parts, responsible for reasoning and relativizing shrink, in this way worsening the problems like a vicious circle.[14]

[12] S.W. Porges "Polyvagal safety, attachment, communication, self-regulation", W.W. Norton & Company, 2021
[13] S.W. Porges "Orienting in a defensive world: Mammalian modifications of our evolutionary heritage: a polyvagal theory", International Journal of Psychophysiology 32, no. 4, 1995
[14] Frank, Brankele "Over de kop", Das Mag, 2023

The dorsal state

As the seesaw, as shown on page 7, the 'vagal brake' can stop other neural networks by activating one for social involvement, that can help lift the chronic dorsal state. This chronic dorsal state, or the spinal sympathetic system is the above mentioned defensive system to regulate the body in a situation that challenges survival. The slightest negative experience can activate physical and emotional problems.

Many people experience trauma as a result of aggression, terror, neglect, loneliness or mental or physical violence. The effects can hold for a long time, even life long. The reason for this is that traumas push people into the dorsal side of the vagus and instead of being able to repair itself, the symptoms only become worse, as it is one long chain reaction of the body. The vagal brake simply doesn't work properly any more and it seems almost impossible to get out of this state of being.

Effect on the voice

In the above-described states, also the voice suffers. In the relaxed state, the voice is bright, normally pitched, not too high, nor to low, there is a melody in it, even when we're only speaking. There is a balance between the speaker or the singer and the audience.

But as the body moves into getting itself ready for action and economizes energy on all other tasks, the production of saliva, needed for digestion, stops and tension in the laryngeal area also causes challenges for a healthy vocal use.

We can conclude that the neuroception of danger, like growing up in an unsafe environment, or taking up a survival mode because of any other trauma experience or reason which causes suppressing our emotions can have a huge impact on the voice.

Co-regulation is the effect we have on each other by our nervous state and it goes for any profession and situation: an agitated teacher can make his students aroused and nervous (sympathetic response) or make them withdrawn and unresponsive (dorsal response), whereas a businessman with a conflicting discussion can get home in an angry state (sympathetic) where after taking his cat on his lap and stoking it can calm his nervous system (to get back into the parasympathetic state). It all shows your nervous state is influenced by the state of others: physically, emotionally and cognitively and the other way around.

The same goes for a voice: it can sooth an agitate (regulate and activate). Just think about listening to vocal music, how it can be both upsetting on one hand, but also soul-soothing and uplifting on the other hand.

Prolonged state of survival: sympathetic response

When we face chronic stress and our body remains in mobile fight or flight state it is economizing on energy in order to be able to do only the most necessary. There isn't any energy left for anything else, only survival. Besides the fact that it costs a lot of energy, the chronical state will cause chronical muscle tension, a higher heart beat and also a higher breathing tempo.

As for the voice specifically, there is less power over the volume and as the breathing is accelerated, it causes being out of breath even quicker. The speaker or singer is also less attuned to its audience. The focus might even be elsewhere, scanning for threats, even causing difficulties playing together in an ensemble.

Signs of a voice disorder include sudden but lingering changes in pitch, volume, tone, or overall vocal quality. Unless there is a medical background to it (asthma, allergies or bronchitis), firstly rest and rehydration are recommended before visiting an ear- nose- throat doctor to exclude physical abnormalities.

It might be interesting to add a personal experience about how I could not sing an E'' pitch during a difficult period in my life. As a mezzo-soprano, that pitch is a fourth under my higher passagio[15] and therefore not to be considered high for me at all. Upon trying unfortunately only air came out, the sound just vanished. With regards to my speaking voice: during those months there was always a light hoarseness in my voice which I couldn't get rid of. Now it is completely clear to me why that happened.

Prolonged state of survival: dorsal response

When the body is in dorsal, immobilized mode, the voice becomes more monotone, flat, even slower, withdrawn from contact. Breathing becomes shallow. As the singer also faces concentration problems, she or he may seem not present, not in touch with the audience and when hearing becomes over sensitive, slight sounds can be a distraction, also lowering the musical engagement quality.

As we cannot control the volume of our speaking voice as good as we could before in the parasympathetic state, the everyday speaking voice can become louder then usual and holding less intonational differences, becoming more monotone and shallower.

Literature on this topic shows that also growing up in a safe environment can cause a person to become more emotionally stable, with a balanced nervous system. Unfortunately, also the other side seems to be true: when someone grew up in an unsafe, changing, emotionally unregulated, unsafe environment the neuroception for danger remains very sensitive and without learning how to cope with suppressed emotions the body will remain in its survival mode. This can also have chronic impact on the voice and musical interpretation.

In short, the body's natural survival mode has a huge impact on communication, co-operation and the voice. Making contact with the audience or fellow musicians, making dynamic changes, exercise soft phonation and / or awareness become more difficult.

[15] *passage* in Italian: As there are three vocal registers, there are two points of transition for a natural singing voice

It works both ways

German spiritual teacher Eckhard Tolle sees the body and mind unseparated: “The body is a representation of the unconscious mind. As a result, the trauma stored in your unconscious mind had a representation in the body.”[16]

Neuroplasticity is the ability of the nervous system to change its activity in response to intrinsic or extrinsic stimuli by reorganizing its structure, functions, or connections after injuries.[17] Meaning, the brains have proved to be neuroplastic and are able to recover through the construction of new connections (nerves) to and in the brain.

To be short: good news! Even though a chronic sympathetic state can start a vicious circle in the body causing the mental and psychical state becoming worse and worse, there are ways to consciously, steadily trigger the nervous system to get out of the sympathetic state and get back into the calm, parasympathetic mode. When we find ways to learn to read our body, what it tells us and to act on it in a caring way, when we learn to sooth, regulate our nervous system by concentrating our attention and doing exercises that sooth our nerves, it becomes possible to turn the tables.

Dysregulations of the autonomic nervous system can arise from trauma, or what someone experiences growing up, in their families, during their lives and how they have learned to deal with difficult situations, in other words, how to regulate their nervous system. For this, not only words are necessary, but also the body needs to be ‘re-educated’ to feel safe again, so the parasympathetic side is activated.

When we become aware of our power to change the way our body reacts, providing the feeling of basic safety and the experience of successful self-regulation after disruptive experiences it becomes possible to work consciously on our nervous system. We start to recognize ‘triggers’ and explore ways of diminishing reactions until they, ideally, perish completely. Finding the right body-centered therapy, learning to regulate our nervous system is the key, because only talking about the trauma doesn´t seem to solve these kinds of dysregulations completely.

[16] Tolle, Eckhart “A new earth – Create a better life”, Penguin Books Ltd, 2009

[17] Puderbaugh, Matt; Emmady, Prabhu D. “Neuroplasticity”, Treasure Island (FL): StatPearls Publishing; 2024

"Singing provides a true sense of lightheartedness.

If I sing when I am alone, I feel wonderful. It's freedom."

Andrea Bocelli

Activation

Now we have learned how the autonomous nervous system works, why it is necessary and what the effects can be when it's not working properly anymore, but also that we can work on repairing it ourselves, it is time to look at the different ways to consciously do the work. There are many different approaches to soothing the nervous system, of which I have investigated some mental and physical ones. Of course, to me it is the physical, or to be more precise, the singing way that is the most important and interesting, about which I will also conduct my research.

After learning about our own nervous system and how to regulate and calm it, physical complaints are very likely to disappear: our breathing normalizes and tension in our muscles mildens. Overall physical and mental complaints are likely to reduce. Of course, as it is impossible to measure without comparison, results are barely provable, but always subject to relativity and individual experience.

Mental

First of all, knowledge. Understanding the working of the autonomic nervous system and its states can help us to recognize the state we are in, free of judgement, and when necessary, learn to apply exercises to calm the nervous system on a regular basis, instead of postponing, which can lead to worsening the effects of a prolonged sympathetic state. When there is no knowledge at all about this, we think in an other way, that makes it impossible to grasp this material and actually be able to do something about or mental health in a natural, non-harmful way.

When no significant medical problems are found, slight daily stress could also be relieved by a soulful talk or a walk in the forest, as even the color green is proven to calm the mind and sooth the nerves. These are great ways that serve as nerve regulating tools.

As it has been mentioned before with the example of the mammals, it has been made clear that in order to function and thrive as an individual, we need others around us. Not only for warning in the dangers of nature, or hear soothing words from our mothers, but to co-regulate our emotions. Our community, friends, family, mates provide us the necessary co-regulation, whereas it all happens subconsciously. When we speak about picking up someone else's energy, we are in fact co-regulating: we share in excitement, sadness, we listen, we ventilate, we share joy and if we do it right, end up energized and regulated at the end of the day. This is the significant mental part to regulate our nervous system, which is many times forgotten, when we don't realize how much harder it is do so for lonely people, who do not have the community around them to co-regulate on a daily basis, which is a necessity.

When we want to establish a safe connection in order to regulate emotions all we need to do is open up, talk to peers, have a conversation with a good listener and ventilate what´s bothering us. Therefore, we need to feel safety to connect. In specific circumstances it is necessary to be aware of how this works: regulation by talking to peers also goes for the singing teacher-student interaction: it needs to be non-judgmental, meaning feedback should be positive, and having a reflective attitude as a starting point. Also, it is necessary to regulate our own nervous state as a listener or especially, as a teacher as clients or students can be extremely sensitive to signals that indicate danger. The coach or teacher needs to recognize and be able to regulate their own physical, emotional and cognitive patterns.

Listening to soothing or activating music, depending on (desired) state also has a known direct effect on the nervous system, but since this is not the topic of this essay, I will not dive into it to deeply. However, there have been studies that show that listening to calming, meditative music, from which the parts have been erased that cause the automatic nervous system to react (the high and shrill sounds in particular) has an increased beneficial effect on the nervous system. This music can be found by searching for SSP music.[18]

As meditation is proven to make the brain stem thicker, by building more brain cells and provide them with more nutrients and counteracts shrinkage of the brain as we age,[19] it is a very efficient way of calming the mind and the nervous system on the long run. Even a couple of minutes per day of full awareness can make a huge difference in our daily lives.

Physical

How many times we've heard it, sports are good for us. But why, they've never told us. Although you might have experienced it yourself, there is a huge mental aspect of movement. Even simple movement, like walking, or playing sports, dancing, or even cleaning the house work as a drain and a discharge of accumulated nervous energy. Repetitive movement brings calmness and act as a meditation for the mind, while our stamina and muscles are trained by the physical challenges, of course, depending on the kind of sports you choose to do.

Body-oriented approach can also help to become aware of physical reactions to triggers. This could be difficult when the trauma is so deep that we can speak of dissociations. This is the case when someone experienced such a (mentally or physically) threatening situation that not feeling ´in the body´ was the only was to survive, it literally was the only lifesaving method. Mostly, in these cases, re-experiencing the trauma by speaking about it can cause re-traumatization and new tensions in the body, even when treated by a professional. Kinesiology is the therapy that focuses on this kind of treatment, specifically body-centered therapy to get rid of experienced trauma.

You have probably also heard about the significance of muscle building. Not only does it make you look slimmer, fitter, it is also necessary to maintaining your body's fitness. As people get older, muscles loosen. Unless, of course, we work on it consciously. A many seen problem however is that as the muscles become looser, amongst all other kinds of problems, the head bends slightly forward, causing muscles in the top of our backs and shoulders to tighten. Anteroposition (forward falling) of the head is the result of this. The upper part of the lungs doesn't get enough space, causing respiratory issues, which makes breathing in, and so getting oxygen inside the body more difficult. The more the *anteroposition* of the head worsens, the worse the breathing problems get as well. This becomes a viscous circle: the bad breathing causes a lack of fresh oxygen in the lungs and makes people feel tired, sleepy and having a lack of energy. This again causes the muscles to loosen even more, worsening again the head position. In order to keep the correct head position, it is necessary to see muscle training as necessary body maintenance.

[18] Safe and Sound protocol

[19] Marcinia, R. *et al.* : Effect of meditation on cognitive functions in context of aging and neurodegenerative diseases' Frotiers in Behavioural Neruroscience, 8., p. 17

By consciously guiding our breath we can impact our autonomic nervous system directly, giving our body the signal that the environment is safe, we no longer have to run. Our heart rate slows down and slowly we return to the parasympathetic state. There are many different breathing exercises, that immediately can bring down the heart rate.[20] In a calm state in which the nervus vagus works well and the state of rest is achieved easily the breathing out is longer than the breathing in. The heart rate goes up when we breath in and at breathing out the heart rate goes down again. In case of a failing nervus vagus you can work bottom-up by consciously making the outbreath longer, this way 'fooling' the nerve that everything is under control, resulting in a calmer body, calmer mind. "The danger is gone". Thus, breathing exercises that are focused on a longer outbreath have a positive effect on the nervous state.[21]

The most important effect of these breathing exercises is that they have an extended exhalation, just like with singing, where we make the inbreath strong and quick (especially when the music doesn't allow the singer to take longer and / or deeper breaths) and the exhalation as long as possible (which is the case when we need to sing a long phrase / melisma[22]). This prolonged exhalation causes the nervous system to calm down. It is interesting to see the relation to many of the stress relieving movement practices like yoga and chi-qong also are based on grounding and breathing exercises, be it in an indirect way.

One specific breathing exercise, called the 4x7x8 method[23] by Andrew Weil makes you calmer in the above-mentioned way by the following three simple steps: 4 counts breathing in, 7 counts holding it and 8 counts breathing out slowly. It appears that also the military students are taught this method to enable them to take decisions in stressful situations quickly, but with a cool mind.

Breathing 'in the belly' makes the diaphragm work, instead of the muscles of your ribcage, which happens during a shallow inbreath. You get more oxygen in and your inhale takes longer. Your brains get more oxygen, which means more cognitive power and thus more control over your emotions and stress. An interesting detail is that most women are unconsciously holding in their belly to appear slenderer. This can also cause a more superficial inbreath that is not beneficial.

Above that, the vagus nervus is directly connected to the diaphragm, therefore sensing these changes in the body immediately as well. There are types of yoga working specifically with the ujjayi-breath, that is specifically designed to accumulate blood circulation, massaging the organs and calm the nervous system. [24]

To conclude, breathing is also a way to co-regulate with others, as discussed hereabove in the previous section about mental ways of activating our vagus nervus. Just think about it: Have you ever paid attention to being together with someone intimately? Your breathing slows down and you even get your breathing simultaneously unconsciously.

[20] Sandeman, Stuart "Breathe in, Breach out", HQ, 2022
[21] Swinnen, Luc "Activeer je nervus vagus", Lannoo, 2023
[22] The singing of a single syllable of text over multiple different notes
[23] Aarts, Sander "Niet te breken", Boekerij, 2019
[24] Journal of alternative and complementary medicine, New York, 2012, p. 437-9

As the vagus nerve interfaces the heart, lungs, digestive tract and the laryngeal nerve, the muscles of the face and the middle ear, it is safe to say that making music and especially singing has a huge impact on it.[25] That is because every system in the body that is required for singing is connected to this vagus nerve.

Massaging the nervus vagus to calm it can also be achieved by humming, as some yoga practices accumulate and also as shamanistic practices from different corners of the world propagate as well. Although scientific knowledge wasn't accessible by the time, many ancient, or nowadays so-called alternative healers use sound to heal and to bring inner harmony to the sick and their surroundings.[26] The effect on the vagus nerve with this is possible due to the fact that organs around the mouth, and the ones necessary for the breathing are all intertwined with this nerve and the vibrations caused by humming therefore have an immediate effect on calming it and so providing an immediately calmed state of mind.

Vocal exercises and singing are calming the nervous system (except when there is a functional or medical issue) because of several reasons and actually a mix of the effects of breathing exercises and humming. The above mentioned role of a long outbreath, a vibrating massage of the larynx, where the vagus nerve runs through, expanding the diaphragm and so giving the message to the brain that everything is all right: all components to calm down an agitated mind. It is down-regulating by singing: feeling the voice vibrating in the body and prolonging the exhale.

Just imagine the stereotype image of a frightened little girl singing in a dark, abandoned forest. The reason we sing when we are afraid is because it calms you, soothes your nervous state. You just simply cannot be singing and be afraid at the same time.

This knowledge also is important for singing teachers, who all have a responsible role in bringing the singer's nervous system to ease. Trauma informed way of proceeding is not being responsible to heal the singer's trauma, but to be aware of our own role and responsibility to regulate our own nervous system, as it will have a positive impact on others' by conveying safety, offer support by recognizing common signs of trauma and help rebalance the other's nervous system. Establishing social engagement in the beginning of a lesson may help prepare students to tolerate the natural sympathetic activation that comes with the vulnerability of singing in front of others. Of course, this is true for all other exemplary roles and / or professions.

[25] Grooten, Heleen "The polyvagal theory and voice disorders", Trauma and the voice, edited by Emily Jaworksi Koriath, Rowman & Littlefield, 2023

[26] Soós, Jóska "Ik genees niet, ik herstel de harmonie", Karnak, 1985

"Singing is a way of escaping. It's another world.

I'm no longer on earth."

Edith Piaf

CHAPTER 2: Research

The hypothesis

After reading various books about the neurological, anatomical and holistic approach to activate the vagus nerve and so calming the nervous system and healing accumulated stress in the body that is causing vocal problems, my personal goal with this research is to find out which specific, practical part(s) play the biggest role in healing these problems, to find out to what extent singing can be used as therapy.

We can conclude that research has shown us in many studies that there are multiple ways to activate the nervus vagus, as we also read in the previous chapter in a two-way division of mental and physical ways. Therefore, I see it as a challenge to compare these different ways and also to find out what frequency is necessary in order to see results in a relative short way, depending, of course, also on the current mental state of the person in casu.

There are many ways we can influence other people´s nervous system. It can start with simple things like our own nervous state of mind, our ´energy´. In this study, the number will be brought down in order to measure the effects of the different approaches, and therefore the focus is only on the effects as described above in the sections about mental and physical ways to activate the vagus nerve.

At the start of the research, the following action points are planned:

- measure the current state of mind of the trial person, as it is at the beginning of the research tract
- give the different trial person different plans to add to their daily lives
- some trial persons will get a ‘placebo’ and questions regarding totally different things
- exercises will differ in frequency and function
- trial person’s state of mind will be measured on a weekly basis
- trial person’s state of mind afterwards will be measured (which is a relative measurement compared to the initial state of mind), at the end of the research tract

State of mind (SOM) will be measured in the following measurements, on a scale from 1 to 10, where 1 indicates not at all, 5 is neutral and 10 is very much.

The seven ways

The following approaches will be tested:

mental:	physical:
- co-regulation by talking to a friend	- simple movement
- listening to music	- breathing exercises
- meditating	- humming
	- singing

In order to measure the different effects of the different approaches, every trial person will be asked to do only one specific approach (and none of any other approach), so the results would show which way is the most efficient. To measure the additional worth of singing to the benefit of mental health as opposed to only using breathwork, these trial persons has been divided into a completely different group. In this case, the effect of singing specifically would become clear.

The control group will get similar questions about their state of mind, but will have completely different tasks to do frequently and are not allowed to do any of the above mentioned types of nervous system regulations. This is to get clearer measurement results of the 7 different vagus nerve activating ways.

Also, none of the participants is told beforehand what effects are to be studied, in order to keep the results as clean and non-biased as possible. Some will also get completely different tasks as extra distraction to keep the main focus off the actual goal. For this, I find it important not to share the goal of the study beforehand with the trial group as it can affect the outcome.

Apart from the singing task, all tasks were divided by online communication.

As singing is of course an add-up of breathing exercises, humming and directly massaging the vagus nerve by involving many different organs close to it, I expect the most results from my trial persons doing the singing as part of my research. Also, because it is music and music has also proved to have a beneficial effect on the mental state. However, this topic has not been discussed in this thesis. I'm eager to learn the exact results, because it might just be very surprising and different from what I expect.

The least effect I expect from the group that does only the simple movements. The reason for that is that the assumption is that we already do those simple movements in our daily lives. Even though doing them consciously might be a positive addition, the hypothesis of this thesis is that it will be the least effective of the seven ways of calming the vagus nervus.

Conduct

As there are 7 sub-groups to test all the 'calming ways', it was not easy to find a number of trial persons that could be shared by 7, so each group would consist of at least 2 or, even better, 3 persons. That means 14 persons were to be found, or even better, 21 persons. That succeeded and it was also possible to include persons with mental problems, which would make the outcome more interesting.

The actual trial persons, as well as the control group was asked to conduct the research for 6 weeks. To maintain consistency, the question was added whether or not they could actually complete the task, so it would not be a bad thing if that happened and they wouldn't feel the need to be dishonest about it. It would all be all right to skip one day of practice, which would lead to clearer results, because then it would be possible to interpret the outcome differently because of that and rely more on the rest of the results.

Two persons for each of the seven sub-groups received daily exercises and the remaining seven participants received daily exercises that had nothing to do with the research. Those included totally different exercises and were asked to *not* perform any of the seven ways to consciously regulate their nervous system unless it was something they would have added to their daily practice anyway. Thus, when they would go the gym twice a week, even when working out is one of the seven ways, that would still be acceptable. Participating in a choir once a week was acceptable because it would not be something different than what they did before. Also, it would have been too strict to participate with the research, yet not allowing the participants to do what they normally do (especially when it is something that they do for fun, is joyful, and… well, without them knowing, unconsciously regulating their nervous system).

The daily exercises consisted of the following:

- co-regulation by talking to a friend: connecting with a friend for at least 30 minutes a day. That could be conducted live or over the phone, but with full attention and no distraction of other persons or devices around

- listening to music: actively listening to music to be chosen personally, for 45-60 minutes a day without any other mental focus. Background music is acceptable, unless they were doing something that needed full concentration

- meditating: 2x 15 minutes daily sitting in silence in a comfortable position. Preferably in the morning and evening. All distractions should be outside of the room. Eyes closed or open, as preferred

- simple movement: take stairs instead of the elevator, doing groceries by bike, cleaning the house. Exact chores were planned according to the daily lives and possibilities of the trial person

- breathing exercises: Andrew Weil's 4x7x8 method[27] breathing exercise to be performed twice daily

- humming: daily exercise of humming one note, any sounds, tones or a song for 20-30

- singing: singing specific songs, to be chosen at own discretion, but consciously, 30 minutes daily

[27] Aarts, Sander "Niet te breken", Boekerij, 2019

The daily exercises for the 'placebo' group were:

- starting the day with a cup of hot tea (1 trial person)
- eating every meal in smaller bites than usual (1 trial person)
- getting out of bed without snoozing (1 trial person)
- keeping a diary for short daily thoughts and happenings (1 trial person)
- counting to 10 before every decision (1 trial person)
- using the phrase 'I have to think about this first' daily (1 trial person)
- eating fruit and vegetables first before every mail (1 trial person)

These 'placebo' exercises are fictional but because of the wellness focused mindset they could be possibly still beneficial exercises for the mind. The reason for that is that using absolutely banal exercises would make the trial persons pay less attention to the whole research and would have damaged the seriousness of the research, as some participants are acquainted with each other.

The scores provided by the participants for the mental health after each week doing the above mentioned daily exercises were as follows, based on (the mathematical average of) grades between 1 to 10, where 1 indicates not at all, 5 is neutral and 10 is very much:

	At start	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks
Talking to a friend	5	7	8	7	6	7
Listening to music	7	6	6	7	7	7
Meditating	4	6	6	7	8	8
Simple movement	7	7	8	7	7	8
Breathing exercises	4	6	5	6	6	7
Humming	6	7	7	7	8	8
Singing	7	7	8	8	8	9
Drinking tea	8	7	7	7	7	7
Small bites	6,5	8	7	5	8	7
No snoozing	5	4	5	5	7	6
Keeping a diary	5	6	7	7	9	8
Counting to 10	6	3	4	3	5	4
'I have to think about this first'	9	9	8	7	8	7
Fruit and veggies first	8	6	8	9	4	5

Conclusion

Although the preliminary assumption was that it would be a challenge to find enough participants, however, this luckily turned out to be false. The researches were not taking place simultaneously, but it turned out to be possible for each participant follow the research during six weeks in the period between December 2023 and April 2024.

It is important to keep in mind that also the seasons have an effect on our mental health. When it is cold, dark and rainy outside, we don't get to see the sun for very long, people tend to turn more inwards. However, when spring awakens, it is easier to see the brighter side of life. This parameter has not been taken into account. The timings of the separate research tracts have not been kept track of, but it is important to bring this point in.

The chart above shows interesting results.

First of all, it seems shocking that a lot of people seem to rate their daily lives quite low. That is sad and perhaps also disturbing. It was not the goal of this thesis, but it is enlightening to conclude that this thesis has proven to have found a way to improve their mental health. Also, this tendency was mostly to be found at the 'placebo' group. Of this group, the only thing that slightly seemed to improve the participants mental health was keeping a diary.

Of the group who performed one of the 'seven ways' on a daily basis it is the meditating group that showed the most significant raise in mental health: it doubled from 4 to 8. All other groups showed a clear raise of the mental state. However, confirming the hypothesis, it is singing that has shown the biggest raise and ended up highest in raking.

Effect of singing on the vagus nerve

Although the exact one-on-one effect that singing has on the vagus nerve could not have been measured by the research, the result show a significant result on the effects over six weeks: every participant that had one of the 'seven ways' to do daily has showed positive effects: gained a more positive mind set, mentioned to have more energy and some even had better sleep.

Should the actual and concrete effect of singing specifically on the vagus nerve be researched, it would require laboratory work and more precise medical knowledge, which is out of scope for this thesis. However, we can see that the vagus nerve has been activated, that the autonomic nervous responses are brought back to the parasympathetic state, which resulted in a more balanced and calm state of the mind. The longer-term effects are also not investigated, but the results show that six weeks are enough to see results on a short term. When six weeks already show short term effects and increase the mental state, then structural improvement could be achieved when it becomes a habit.

There was one week where one of my participants could not participate because of personal reasons, which showed a significant dropping back in mental health level. It seems that consistency, also here, is the key.

It would be very interesting to conduct another research on the effects of different aspects of singing: which vocalises, notes, pieces, techniques are the most beneficial? Or even broaden the question: does it make any difference at what age we sing, how long we do it, at which time of the day, which style era, something we like or even dislike? Do all these things make a difference? If not, what else does make a difference? What other aspects that we cannot hear, see or feel can make a difference? As shamanistic healers in the past have already grasped that knowledge by learning it from many years of practice, even though the science wasn't at that level yet to actually point the finger at a specific nerve we all have in our bodies, or to lay out plans for the brain, investigate the tiny neurons that are responsible for the messaging between the nerves and in the brain with a microscope. Without that knowledge, they already knew, which is fascinating.

With that open mind, curiosity and courage I hope to find out more about the healing power of singing by investigating, exercising and simply just singing more.

To conclude this essay I would like to mention that I found it very interesting to dive deep into this topic and I'm very grateful for this beautiful opportunity. The thought of the confirmation also makes me extremely happy and thankful that it is singing what I can do for a living.

Because singing is healing.

Epilogue

If you have read this essay, you have walked along on a piece of my personal path.

Music has been in our family for generations, but as a child, I wanted to let it pass me by. I have never been good with being pushed to do something and always felt a 'shutdown' when that happened. Obviously, the pushing became more when I resisted, and so did my inner resistance. I not only didn't want to, I *couldn't* anymore. At the age of 12 I quit all my musical activities, solfeggio, violin, piano, flute and singing.

Of course, blood is thick and you can't change who you are so I ended up singing anyway. I went through a dark period when I lost material assets, but mostly my trust in humanity. I see now that as a human being, losing faith in community has an even greater impact that the actual bad happenings only. You literally need others to survive, it is not just a nice way of expressing your gratitude for someone. Peers are a necessity for life. Also, I experienced singing to be healing. Learning to trust yourself and to let yourself be helped by others. It distracts from life's difficulties, gives energy and soothes the soul. No wonder it is greatly used as a tool to connect people in positivity. To me, music is now not only a nice extra, but a pure necessity in life.

Now I also understand the connection of traumatic experiences, the effect it has on our body and how that effects our mind, voice and mental wellbeing. It is truly underestimated and the long term effects are widely neglected. I also believe it is a source of many health issues where the Western health care doesn't emphasize. It explains my year-long intestinal problems, my concentration problems, fatigue, overall tiredness and forgetfulness, sometimes my anti-feelings for singing, during which when I did sing, my mood shifted. I actually thought about investigating this matter for a longer time than I even imagined having to write a thesis about it, for which I am actually very thankful. I'm also very thankful for the various people I met (in real life or virtually), who supported my research, believed in the subject and handed me lots of very useful information.

I truly believe it is a huge challenge to keep both of your feet on the ground in this world of hyper-fast changes, 'smartphones', making everything available immediately, shallow conversations, overlooking others, barely to non-existent and ever diminishing social skills, short-term concentration lines and people wanting results fast with the least effort. It is and will be an even greater challenge for mankind. People need to realize we all need each other, because without each other we are literally nothing.

But real achievements need hard work, on the outside, but also in the inside. In fact, the last doesn't exist without the first. It is key to learn to say no in this fast society of ours. To find what fits you best, what suits your abilities and needs, and, above all, your own desires. It is the only right thing to live for. As Jóska Soós, my apparent distant family member said it: we need to bring back the balance.

We have lived this fast-paced life for so long that we have forgotten what we, our bodies really need. It is time to go back to the basics and find our own equilibrium.

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Thank you.

"The only thing better than singing is more singing."

Ella Fitzgerald

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