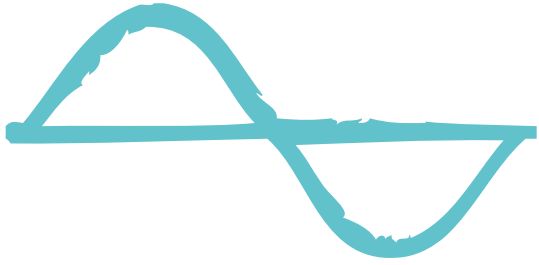
FOLLOW THE SINE



A Simple, Science-Backed
Breathing Rhythm That Unlocks:
Inner Harmony, Mental Clarity,
Optimal Health, and Peak Performance

GREG SAWERS

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Internal **Synchronisation**

In the 1990s a series of scientific studies were carried out on advanced masters of the Eastern spiritual traditions of Yoga, QiGong and Buddhism. The masters included yogis, swamis, Zen monks and Tibetan monks.

Only masters with a high degree of experience were selected. For example, the advanced Zen monks had been practising meditation over 6 hours a day for over 20 years[1].

The researchers would ask the masters to do something that got them centred, calm, alert and more resilient. [2]

To achieve that state of mind, each of the masters did basically the same thing. They would all breathe from low in their abdomen at a slow and steady rate between 4.5 - 7.5 breaths per minute. For comparison, most people breathe at around 12-20 breaths per minute.

Each master would use their own specific pace to re-enter the state at will but overall the result was the same.

The data readings showed their heart rate and breathing rhythms were synchronising together. Creating a larger and clearer sine wave of heart rate rhythm. Something now scientifically understood to have many health benefits.

Yet the masters were unaware of the science happening within their bodies. After years of meditation, their bodies had intuitively developed this internal harmony.

This was the biological effect of entering a state of deep calm and non-attachment. Often described as mindfulness. A state that they could seemingly re-enter at any time of their choosing.

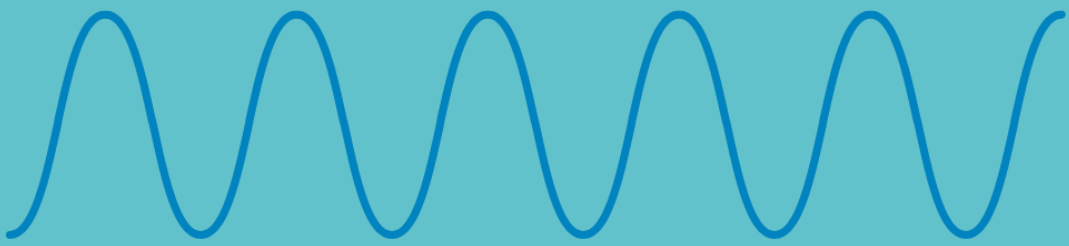
Scientists now also understand the dramatic effect of this breathing rhythm on the brain. It generates the ideal brainwaves for a calm, alert and focused state of mind.

Yet even though breathing and meditation practices are thousands of years old the scientific understanding is relatively recent.

Some of the first research into the effects of slow, rhythmic breathing comes from around 40 years ago.

In 1983 Russian scientist Evgeny Vaschillo was studying the heart rate data of Russian cosmonauts during their time up in space to help them perform better.

He noticed that at a certain time of the day the heart rate patterns would show a smooth and obvious sine wave pattern for around 20 minutes every day then return to normal.



At first Vaschillo was concerned and thought they might be suffering from space sickness. He asked them what they were doing and they told him to stop interrupting their meditation. A meditation practice that used a slow and steady breathing rhythm.

Their breathing rhythm was amplifying their heart rate rhythm.

The studies with masters of Eastern spiritual disciplines followed on from Vaschillo's early work. Dr Richard Gevirtz, a Professor of Psychology in the USA was one of the scientists involved.

He and his colleagues observed that the various swamis and gurus displayed very good levels of blood pressure regulation, emotional regulation and anxiety regulation. They began to query whether this was from mindfulness or if the calm mindfulness was driven from the breathing technique. And if so, could other people enter into a similar state through the same breathing.

Gevirtz set up clinical trials back in the USA to try to replicate these effects using biofeedback.

Biofeedback uses electrical instruments to monitor various body functions that we normally have no control over. By viewing these functions in real time it's possible to take conscious control over them. To achieve the state the masters entered into without needing twenty years of meditation practice.

The subjects would slow their breathing to a point where they could see their heart rate and breathing rates on a screen forming large and smooth sine waves.

According to Gevirtz, the research generated dramatic results. Some subjects showed lower blood pressure during the breathing exercise but also showed an increased ability to regulate their blood pressure in general. In other words an improvement in their default ability to maintain a healthy body.

Before the trials, cardiologists told Gevirtz that this ability couldn't be changed. Yet in some subjects their ability was improved by almost 30% after doing the breathing exercises for 2-3 weeks. [3]

Gevirtz knew they had found an incredibly powerful way of affecting the body's ability to relax. A new way using biofeedback to enter an optimal state of internal harmony. Or as Gevirtz puts it, a form of high tech meditation or yoga.

But it is widely known that monks and yogis have been using various breathing techniques to achieve similar states for millenia without the assistance of biofeedback.

As such Gevirtz would call this " a brand new idea that is 2500 years old."

The new scientific approach helped to clarify the underlying physiological harmony taking place and the various health benefits that followed on from this.

As we saw earlier, the common denominator of the practices of the masters was slow, smooth and rhythmic breathing - at their own unique speed.

Then they entered into a state of emotional calm and alert mindfulness.

In the next segment we'll take a look at the science to get a better understanding of the physiological magic happening.

When driving a car we don't really need to understand how a car's engine works to drive it. So in this sense, the next section is optional. Like the yogis and other masters you may simply wish to practice the technique and intuitively experience the benefits.

A Beginners Guide to the Science of Slow and Rhythmic Breathing.

Our nervous system or autonomic nervous system (ANS) is a control system in our body that manages all the unconscious processes in our body like heart rate, breathing, blood pressure and our digestion. We don't need to consciously think about these processes to make them happen. Like the name suggests, they happen automatically.

Yet breathing is the one aspect of our autonomic nervous system that we can take conscious control of. And the early biofeedback scientists discovered that slow breathing created a powerful effect on the part of the autonomic nervous system that is responsible for making us relax.

It was stimulating the parasympathetic nervous system (PNS) - one of the main branches of our autonomic nervous system. Normally known as the part of our nervous system responsible for 'rest and digest' whereas the sympathetic nervous system (SNS) is associated with fight or flight.

Triggering the sympathetic nervous system is like pressing the gas pedal in a car so that the body has more energy and is more alert to any danger. The parasympathetic nervous system is like pressing the brakes which tells the body to slow down and relax.

Each time the masters and subjects in the clinical trials were breathing at a slow frequency rate they were giving the body repeated training in pressing the brakes and relaxing.

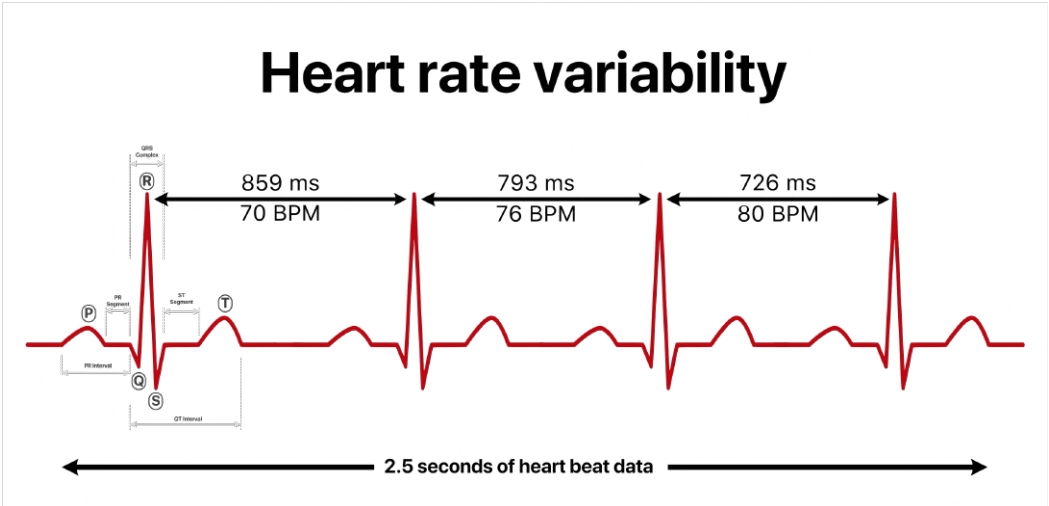
It's possible to activate the parasympathetic nervous system simply by taking an extended exhale. Yet something additional was happening as heart and breathing rhythms were matching up.

This synchronicity effect was responsible for generating a much higher range or oscillation of heart rate. The changing speed of heart rate is known as heart rate variability (HRV).

HRV

The heart rate was once misunderstood as following a constant rate like a metronome. A typical heart rate reading (BPM - beats per minute) is one number and that number can be the counted beats in one minute or an average of the speed over a shorter sample time. The number of heart beats at rest ranges from around 60-100 beats per minute in a normal healthy person.

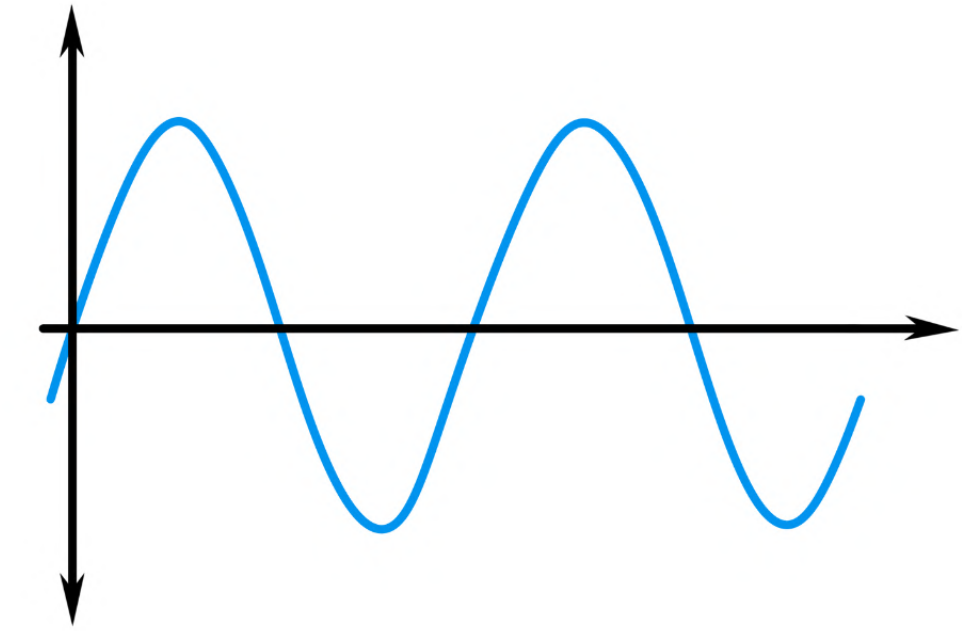
In actual fact the heart is always making slight changes in speed from beat to beat. Speeding up and slowing down in between beats. Varying the speed. Note the changing BPM (beats per minute) numbers in the image below.



Heart rate variability (HRV) tracks the variance in these speeds. The variance in the BPM.

So if BPM goes up and down a lot that would be high variability - high HRV - and if that movement and range is lower then it's lower variability - lower HRV. What Vaschillo saw in the cosmonauts was a higher range of HRV. The act of meditation was generating bigger peaks and valleys in the reading.

The Masters of Eastern Disciplines Also Generated Higher HRV. Larger, Clearer Sine Waves.



Scientists and physicians consider HRV to be an important indicator of health and fitness. It reflects our ability to adapt to changes in stress or environmental conditions.

Good HRV is very common in young healthy people and athletes. As we age our HRV range reduces. As a result, HRV is used as a marker for biological ageing. If people have an abnormally low HRV for their age group it can indicate increased risks of future health problems.

Higher HRV trains the body to speed up and slow down better. Like the accelerator and the brakes of a car.

The more variability the better the heart is at speeding up or slowing down, giving us more resilience.

Dr Alan Watkins is a neuroscientist and a renowned expert on HRV. He uses tall buildings to describe the benefits of variability. The world's tallest skyscrapers like the Burj Khalifa or Taipei 101 are designed to sway and it is this swaying that gives them more resilience to strong winds.[4]

People who are stressed will show poorer signs of HRV and thus less variance. People with good HRV are generally less stressed and happier.[5]

Respiratory Sinus Arrhythmia (RSA)

There are many things that affect HRV but a major one is breathing. Breathing naturally affects the speed of our heart rate.

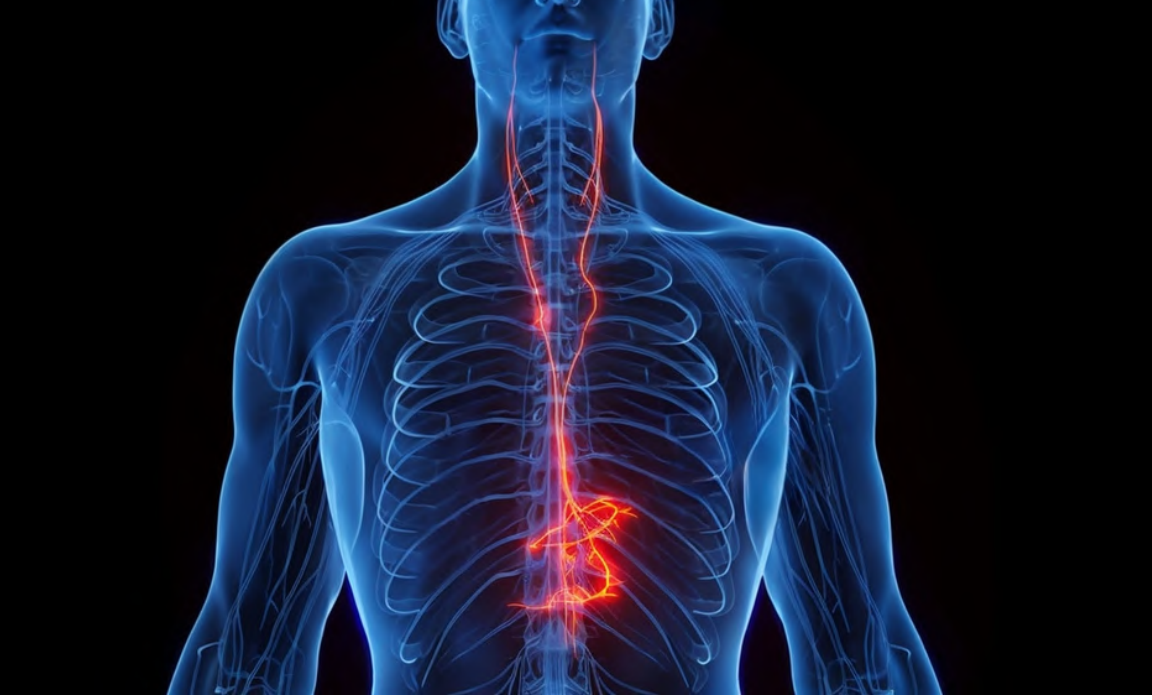
This is a phenomenon called respiratory sinus arrhythmia (RSA). Like HRV, this is a normal function of a healthy person.

As we breathe in, the heart rate increases to send as much blood as possible to the lungs to take full advantage of a new intake of oxygen (and release carbon dioxide). As we exhale the heart rate slows down when there is less oxygen in the lungs to be used.

This is easy to feel with a simple test. Hold your fingers where you can feel a pulse like a wrist or artery. As you breathe in, notice the speed of the pulse. As you breathe out, notice any change in speed.

The reason the change in speed is happening is to do with the vagus nerve. The vagus nerve is one of the major nerves running into our body from our brain. It acts as a superhighway, sending information between the body and the brain.

The vagus nerve is a key part of the parasympathetic nervous system (PNS) which we already know affects rest and digest or relaxation response in the body.



The vagus nerve has a relationship with the 'sinus node', which is the heart's natural pacemaker sitting on top of the heart. It receives signals and then tells the heart to speed up or slow down.
Without a pacemaker the heart's rhythms could beat dangerously fast. So the sinus node sits on top of the heart making sure the heart beats at an appropriate rhythm.

When the vagus nerve tells the heart to slow down, the effect is called the 'vagal brake'.

When we breathe out the vagal brake is applied and the heart rate slows down. When we breathe in the brake is lifted the heart rate speeds up.

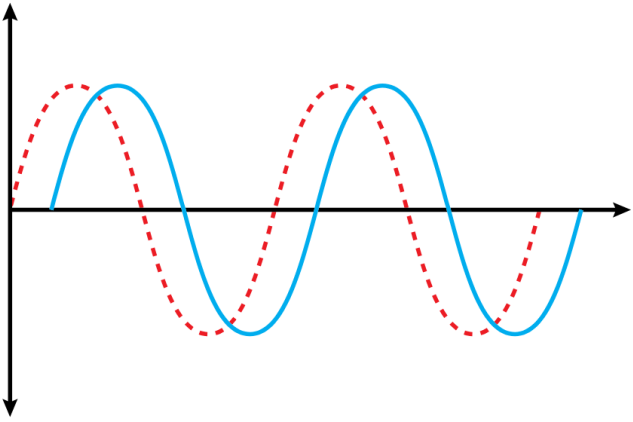
Like riding on a bicycle going downhill. To go faster we release the brakes and to slow down we apply the brakes.

This creates a changing speed and an irregular rhythm - referred to as an arrhythmia. Taken together we have respiratory (breathing) sinus (heart's pacemaker) arrhythmia (irregular speed) or RSA for short.

This term refers to the cyclic rise and fall of the heart rate in rhythm with breathing. Laymen tend to consider a steady, unvarying heartbeat a good sign, perhaps because skipped beats, palpitations, extra beats, and a racing heart all seem to involve deviations from clock-like steadiness. The truth is actually the opposite: a heartbeat that is steady like a metronome is not generally a sign of health, and if chronic, usually indicates high stress and/or cardiac damage. ***ScienceDirect.com***

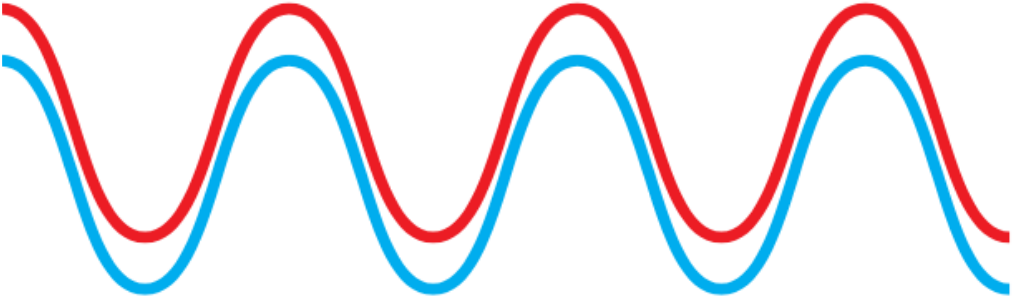
So this wave of heart rate is a naturally occurring phenomenon but when we breathe slowly and rhythmically at a certain speed we create an even bigger wave.

At a normal resting rate our breathing doesn't fully sync with our heart rate changes. When breathing in or out the heart rate change will lag slightly behind the breath. The oscillations of breathing and heart rate are slightly out of phase.



However at a slower speed of somewhere between 4.5 - 7.5 breaths per minute the wave of HRV movement syncs with our breathing rhythm. (A rate of 6 breaths per minute equals a 5 second in breath and 5 second out breath.)

Heart rate and breathing oscillate in phase.



A landmark study in Japan in the late 1990s discovered that the most effective time for the lungs to exchange gas takes place when heart rate increases at exactly the start of inhalation and decreases at the exact start of each exhalation .[6] In other words, in phase.

We also know this phased relationship generates the largest amplitude - or variability - in heart rate.

So we have optimal gas exchange and optimal HRV.

The optimal HRV is created because the heart and breathing rhythms intersect with another of the underlying rhythms of the body - the baroreflex.

The Baroreflex

'Baro' comes from the Greek word for pressure and reflex is an automatic reaction against something - that something being a change in blood pressure.

The baroreflex is another control mechanism in the body that affects our heart rate. It causes the heart rate to change to keep blood pressure under control.

If blood pressure is too high then tiny sensors above the heart - called baroreceptors - will send signals to the brainstem which then tells the heart to slow down.

And if the blood pressure is too low the baroreceptors will send information to the brain stem to speed up the heart rate. So the job of the baroreflex is to maintain balance or homeostasis - a healthy condition.

After sitting down and standing up the effect of gravity will decrease blood supply to the brain which might cause some light headedness or dizziness or at worst fainting.

To prevent this the baroreflex instantly reacts and alerts the brain stem to increase the heart rate to supply more blood to the brain.

This form of control is known as a 'negative feedback loop' and the body uses many of them to maintain internal balance.

When the body becomes too warm, sweating is activated to cool down and when the body is too cold, shivering is activated to warm up.

The baroreflex maintains balance by adjusting heart rate.

And from earlier we know that RSA adjusts heart rate.

During our normal resting breathing rates these rhythms don't normally sync up and operate more randomly to one another.

Yet during slow breathing within the range of 4.5 - 7.5 breaths per minute, the baroreflex and RSA start to work together to boost the effect of each other. The baroreflex amplifies the effect of RSA and thus heart rate variability.

This happens due to a resonance effect.

Resonance

In physics, resonance is an amplification effect. An effect that adds more energy to the energy already there.

All vibrating or oscillating objects have a natural frequency. If an external force is applied that matches that same natural frequency the object will vibrate at a greater amplitude.

This is known as the 'resonant frequency'.

When a child is swinging on a swing, someone standing beside them can time their push to match the speed or frequency of the swing. This will generate the maximum height. The maximum amplitude.

Even stationary looking objects are still vibrating at a molecular level. When a sound matches the resonant frequency of a glass it will create maximum vibrations which cause it to smash. Often demonstrated by opera singers.

Similarly soldiers are trained to break step when marching in step across a bridge in case their combined cadence matches the resonant frequency of the bridge and weakens it.

In 1831 in Broughton, England soldiers marching in unison across a suspension bridge matched the resonant frequency which caused it to collapse.

More recently In 2011, a group of people doing aerobics in Seoul accidentally caused a 39 story building to shake for ten minutes. They were stomping in sync with music and inadvertently matched the building's resonant frequency.

Another common example is two people bouncing on a trampoline. If the first jumper times their jump to combine with the bounce of the second person they will maximise or amplify the bounce of the second jumper.

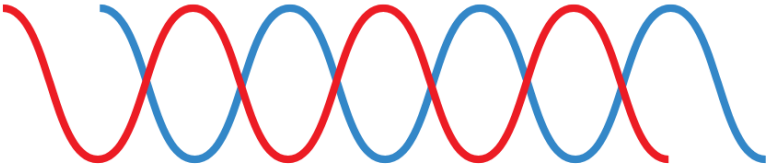
When we breathe slowly the breath acts as this external stimulus. It creates a resonance effect by combining with the natural frequency of the baroreflex.

This is what amplifies HRV.

Contra **Phase**

We know how when we breathe at a slow frequency our breathing matches up with our heart rate. A phased relationship.

The up and down oscillation of blood pressure (affected by the baroreflex) is in contra phase or 180 degree in phase.



The reason for this is a small delay in blood pressure change after the heart rate changes speed.

On average this delay is around 5 seconds.

This fixed delay creates another rhythm in the body called the Mayer Wave, which is around a 10 second cycle in blood pressure. A frequency of 0.1 Hz. [7]

We know that through the effect of RSA, when we take an in breath our heart rate increases. This also causes our blood pressure to increase. Around 5 seconds afterwards.

When we breathe out we make our heart rate go down again. As we breathe out the lag effect of the baroreflex sensing high blood pressure 5 seconds earlier kicks in and tells the heart rate to slow down. Creating a combined effect that is more than the sum of two parts. A resonance effect.

The RSA pattern becomes amplified. Generating a bigger, clearer sine wave of heart rate variability.

The effect is like the right timing of a push on a swing or the second jumper in the trampoline combining to generate extra height in the bounce.

The frequency of this breathing is around 0.1 hz.

0.1 hz = 10 second cycles or 5 second breaths in and out. 6 breaths per minute.

(between the 4.5 - 7.5 breaths per minute rate we saw above.)

The stimulus of slow rhythmic breathing intersects with the natural rhythm of the baroreflex to create resonance. Hence 'resonant breathing'.

Hidden Resonance in 'Rhythm Formulas'

Similar resonance effects have been found in studies of people practising prayers and chants.

In 2001 Dr. Luciano Bernardi and his colleagues from the University of Pavia, Italy studied people practising different types of prayer or chants that followed a regular cadence. The scientists referred to these practices as 'rhythm formulas'.[8]

These included prayers like Ave Maria in the Rosary and yoga mantras like 'om-mani-padme-om'. The scientists found they shared one common denominator.

The average number of breaths in each cycle of the prayer or chant would be around 6 breaths per minute.

The same frequency as resonant breathing.

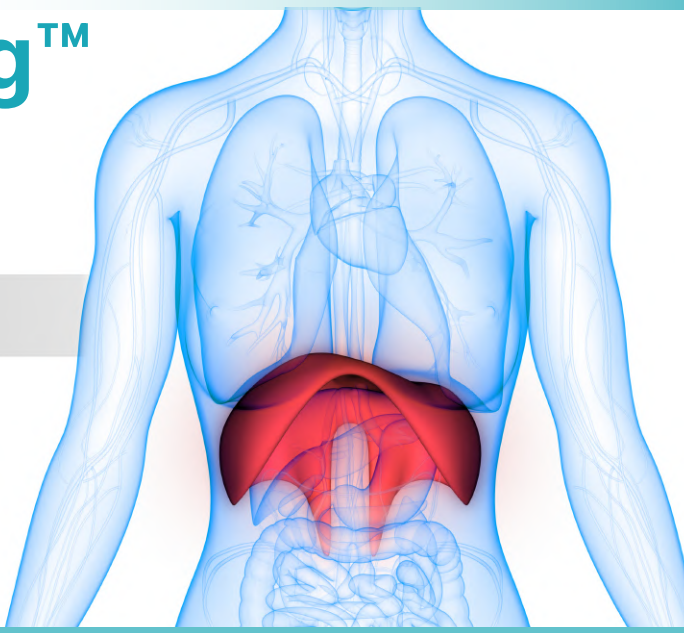
During the practice of the rhythm formulas, the scientists noted that blood flow to the brain increased and heart rate and blood pressure data showed the same coherence as resonant breathing.

As soon as the chanting or praying stopped the coherence was temporarily lost until the recital resumed.

The scientists suggested the Ave Maria prayer may have evolved at that specific rhythm as, in part, it intuitively felt good. Implying also that people from thousands of years ago also intuitively felt this internal state of harmony.

Whether through prayer, recital, meditation or resonant breathing the underlying effect of breathing slowly and rhythmically is a calm and centred state of mind and body which generates optimal health benefits.

Coherent Breathing™



Diaphragm

Separate from the research into resonant breathing, American inventor Stephen Elliott was studying this breathing induced coherence effect in the 2000s, and pioneered the term "Coherent Breathing™" as a specific form of resonant breathing with a different focus.[9]

A focus on the optimal circulation generated in the body during slow and rhythmic breathing.

Elliott's research found that circulation in the body became optimised when breathing was slowed down to around 5 breaths per minute / 6 second breaths. (Again within the average pace of 4.5 - 7.5 breaths per minute we noted earlier.)

At this pace the diaphragm - the dome shaped muscle below our lungs that helps us breathe - is used to a greater degree, which helps to fully optimise circulation around the body.

For the average breather the diaphragm will only move a few inches up and down. By breathing slowly and rhythmically from the belly area it's possible to move the diaphragm much further.

When we breathe in the diaphragm contracts and creates a negative pressure or vacuum which helps draw in air.

As we breathe in we also draw blood from our extremities back towards our heart. Known as 'venous return'. The blood is then sent to the heart to receive a fresh supply of oxygen.

On the outbreath that blood is sent back to the extremities.

The diaphragm assists circulation around the body and helps relieve the heart from the burden of work it would otherwise have to do to achieve the same effect.

Without deep, diaphragmatic based breathing the heart has to do more work, which increases blood pressure.

A slow and steady breathing rate - like a pendulum swinging back and forth - using the lower abdomen will cause the diaphragm to move in and out rhythmically.

This generates an optimum wave of blood circulation in the body.

Breathing is known for its role in gas exchange but has an important yet less well known function for optimising circulation. For Elliott, it is this additional role that has a crucial impact on health and well being.

When breathing is slow, rhythmic and from the belly area a graph showing blood circulation will show another clear and smooth sine wave. But this time the sine wave is the effect of breathing out which sends blood to the far extremities of the body (the peak of the circulation wave) and then returns to the heart to collect more oxygen (the trough of the wave).

As soon as the optimal pendulum-like breathing stops the blood circulation wave disappears and returns to its normal pattern, which shows less circulation around the body.

Elliott believes developing this state of optimal circulation is vital for health.

In its various forms of heart disease, circulatory health is the number one disease facing the human population.

In America the number one cause of death is heart disease and it is estimated that over 40% of the population suffer from high blood pressure (hypertension). [10]

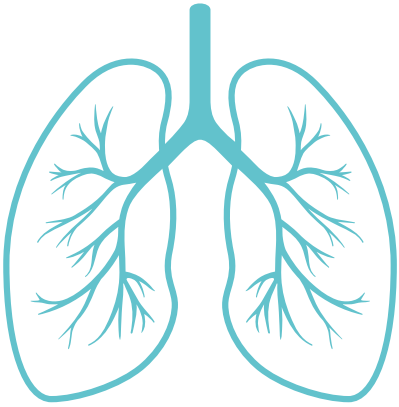
High blood pressure is the main cause of heart disease and is often referred to as 'the silent killer' due to a common lack of symptoms.

Elliott argues high blood pressure is a symptom of inadequate blood flow, which can be improved through slow and rhythmic breathing.

In the average human there are around 5 litres of blood. This is only a smaller proportion of the overall 42 litres of body fluids in the average human.

Slow and rhythmic breathing helps to circulate the remaining 37 litres of bodily fluid. This includes cerebrospinal fluid which provides nutrients to the brain and removes waste. Helping to replenish and improve overall brain function.

For Elliott these are the circulatory health benefits achieved through 'sinusoidal breathing' - breathing in a sine wave pattern.



The **Brain**

The heart and the brain are the two most important organs in the body and as we learned earlier resonant breathing affects the brain in a dramatic way.

Dr Stephen Larsen, a neurofeedback specialist, conducted studies into brainwave activity and found people accessed more regions of the brain during slow and rhythmic breathing. He also observed more connectivity between different regions of the brain. [11]

Stephen Elliott's research also observed this coherence in brain waves and found they increased in amplitude by approximately 10 times compared to normal readings.

At rest, brain waves are chaotic but within a short time after rhythmic breathing the brain waves from different regions of the brain form into clear and coherent sine waves with matching peaks and troughs. An effect that lasts for hours after the breathing stops.

Similarly Elliott's colleague Dee Edmonson worked alongside psychologist Dr Elsa Baehr to study brain waves during Coherent Breathing. They also found a certain symmetry in the frequencies and bands of functional brain waves. In brain wave research this is known as 'the meditative mind'.[12]

Dr Baehr remarked that her clients emerged from sessions of Coherent Breathing with a "strange sense of internal calm and quiet".

In other words, the breathing technique allowed people to quickly enter a state normally associated with meditation without knowing anything about meditation. To quickly enter a state in the brain normally associated with intuition and mental clarity.

This may sound familiar to what many people refer to as the flow state.

For neuroscientist Alan Watkins, coherence is the biological basis of the flow state.

When coherence emerges in a complex system it will cause that system to perform better.[13]

When synchronisation takes place between the heart and the brain our human system enters into a state of coherence. Helping us perform at a higher level.

Through various studies we know that this state gives us more access to the prefrontal brain region and specifically the amygdala - a key region of the brain involved in processing emotions and helping to boost emotional regulation and wellbeing.[14]

Therapy Work

Dr Richard Brown and Patricia Gerbarg are pioneers in the use of resonant coherent breathing as a healing modality for use in therapy and recovery.

They carried out numerous clinical studies that show how slow and rhythmic breathing helps reduce symptoms of anxiety, depression, attention deficit disorder and post-traumatic stress disorder.

In their book, "The Healing Power of the Breath", they detail how instrumental this breathing is in their therapy and breathing workshops.

According to Brown, it's one of the most rapidly effective yet safe and easy techniques to teach people new to breathwork with little or no side effects. It can be practised by anyone regardless of age, religion or culture. In crisis situations, it can be taught in groups to provide help to more people quickly. As Gerbarg explains,

"We wanted to identify a short program that could be quickly given to people, that they would have immediate relief within five or ten minutes, and that over time would produce long-term changes,"[15]

Typically they see good results in patients within 6 weeks but note for some patients with more severe medical conditions it can take as long as 6 months.

They have used the breathing technique to help treat survivors with severe trauma from many crises including earthquakes, tsunamis, the 9/11 attack, and survivors of the civil war in South Sudan.

Brown recalls how in Germany they taught the technique to a refugee boy from Afghanistan who had difficulty sleeping. The mother was concerned he hadn't been sleeping properly for weeks. After a short time of doing coherent breathing he was more relaxed and finally slept well for the first time in weeks.[16]

Through their work they noticed that stressed and traumatised people typically show chaotic, irregular and staccato breathing patterns. And even more so in children.

Brown and Gerbarg worked with children by getting them to lie down and place a favourite soft toy on their belly which acts as a 'breathing buddy' to help them activate deep, diaphragmatic breathing.

According to Brown, the kids loved the relaxation from the exercise so much they found the kids trying to sneak into extra workshops to do it again.

Meta **Analysis**

Sufficient studies have now been done on this slow, rhythmic pace of breathing to allow for studies of the various studies - otherwise known as meta analysis.

Looking at the aggregate results one meta analysis concluded

"The results suggest that HRV biofeedback is a highly promising intervention for reducing anxiety and stress." [17]

Another meta analysis found

"The results of this review provide evidence that heart rate variability breathing and paced breathing at approximately six breaths per minute have positive effects on a variety of physical, behavioral, and cognitive conditions." [18]

Concluding,

"These results suggest that heart rate variability breathing might be a useful addition to the skill sets of clinicians working in a variety of settings, including mental health, behavioral medicine, sports psychology, and education. The method is easy to learn and can easily be used along with other forms of intervention, with rare side effects."

Peak Performance

Peak performance is one of the variety of settings this slow, rhythmic breathing pattern can be a useful addition. In sporting performance a moment of stress can make the difference to winning or losing.

Dr David Shearer is a professor of elite performance psychology at the University of South Wales. He got results from athletes with as little as 5 minutes of resonant breathing every day.

In a pressure situation the sympathetic nervous system response can lead to poor decision making and impede overall performance. As he puts it "Breathing at resonant frequency is a bit like hitting the reset button".[19]

Studies have also been carried out with mountain climbers using resonant breathing.

Earlier we looked at Dr. Luciano Bernadi's research into 'rhythm formulas'.

In 2004 Dr. Bernardi carried out research on elite mountain climbers on an Italian expedition to climb the world's two tallest peaks, Mount Everest and K2. As part of the preparatory training the climbers practised slow breathing at a rate of 6 breaths per minute.

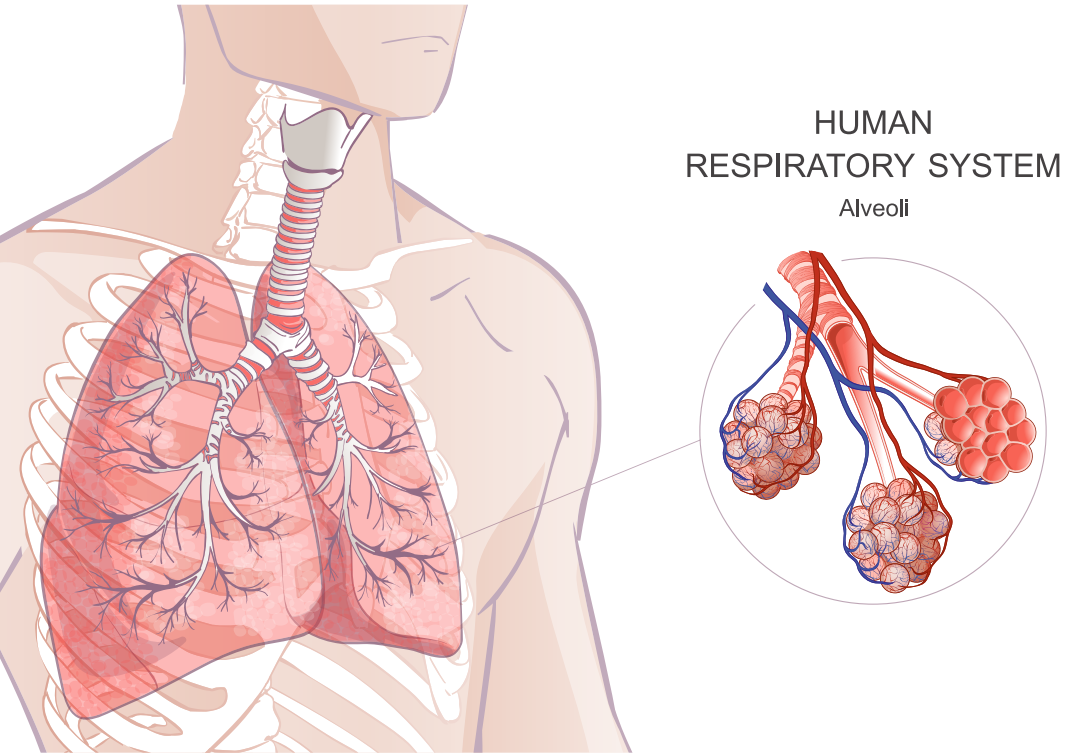
Breathing at this slower rate helped some of the climbers to summit the peaks without the use of oxygen. [20]

At high altitude the climbers without oxygen were able to maintain enough oxygen levels due to efficient gas exchange in the lungs. As we have seen earlier, when breathing is done at around 6 breaths per minute heart rate and respiration work in phase which maximises breathing efficiency.

The climbers that practised slow breathing at sea level had conditioned their default breathing to become slower and more efficient. Less is more.

In 2012 another group of Italian researchers conducted similar research. Finding that slow deep breathing at the rate of 0.1 Hz / 6 breaths per minute lowered blood pressure and increased oxygen levels in the blood when at high altitude.[21]

At 6 breaths per minute, more of the alveoli - the tiny air sacs on the surface of the lungs - open up to receive more oxygen.



This also reduces what is known as 'dead space ventilation'. Which is all the air in our body not being actively processed by the lungs. Air in the lungs not being actively processed by alveoli is dead space ventilation. Greater activation of alveoli leads to greater use of the air in the lungs.

For this reason the slow breathing at 0.1 hz proved to be very efficient at high altitude and a maximum effect was achieved in as little as 5 minutes. The scientists noting that 'this intervention is easy and cheap'.

Other Promising Areas of Research

Asthma

The boost in breathing efficiency has many benefits with respiratory disorders such as asthma. Paul Lehrer, one of the pioneers of resonant breathing research, conducted multiple studies with asthma sufferers over two decades.

Although not a cure for asthma attacks when they happen, the studies found that resonant breathing can help in the prevention of attacks. Resonant breathing lowers asthma symptoms, decreases inflammation and reduces the need for steroid medication.[22]

Substance Cravings

Studies have shown that resonance breathing can help reduce cravings in drugs, alcohol and food. In one study subjects practised resonant breathing and were then shown pictures of alcoholic drinks. After doing the breathing they reported less feelings of cravings.[23]

Another study into women with substance use disorder concluded "We found that brief, self-administered episodes of resonance breathing inhibited craving." [24]

Similarly resonance breathing "as a just-in-time, body-focused, anti-craving intervention has been shown effective in dampening craving."[25]

Long Covid

A recent study examining if resonant breathing could help mitigate effects of Long Covid concluded:

"Self-reported symptoms and wellbeing improved in people with Long COVID completing resonant breathing. Resonant breathing can be considered as an option within the broader treatment plan of people with Long COVID"[26]

Diabetes

In 2024 a groundbreaking study was published in the Lancet medical journal estimated that around 800 million people worldwide have diabetes.[27] This figure represents an alarming doubling of the figures from 30 years ago. Yet resonant breathing has already been found to have good effects on people with diabetes.

In 2017, Dr Luciano Bernardi and his colleagues conducted a study with type 1 diabetes sufferers using slow breathing at 6 breaths per minute.[28]

Before the breathing exercises the diabetes subjects were found to have higher blood pressure than normal healthy people due to having a lower baroreflex sensitivity. Their baroreflex was less adaptive to changes in blood pressure compared to normal people.

The subjects also showed a lower blood oxygen level compared to the control group.

After only 2 minutes of slow breathing at 6 breaths per minute they displayed a baroreflex ability similar to the normal people in the control group. Additionally their blood oxygen level increased.

The report suggested this was due to 'improved ventilation perfusion' - an increase in breathing and circulation efficiency where maximum blood is in the lungs during inhalation.

The scientists concluded " Slow breathing could be a simple beneficial intervention in diabetes."

Alzheimer's Disease

In 2023 a team of scientists including Professor Mara Mather from the University of South California found a significant link between the effect of resonant breathing and a reduction in the biomarkers associated with Alzheimer's Disease.

In other words, the data suggested resonant breathing can reduce the factors that lead to higher risk of Alzheimer's.

A hypothesis that came out of the study was that resonant breathing may create a similar state to deep sleep, which helps clean the brain. The build up of neurological waste is considered a contributory factor to Alzheimer's.

> **"Slow-paced breathing might have benefits not only for emotional well-being – but also for improving biomarkers associated with Alzheimer's disease.[29]"**
>
> **Professor Mara Mather**

Putting it into Practice

We have seen this similar slow pace showing up during various ancient practices of meditation, breath control and prayer. There are many different labels for the technique in different cultures and languages around the world but the key shared effect is the underlying harmony and health benefits to mind & body.

The slow rhythmic pace creates coherence in the brain and the heart. Generating optimal rates of circulation, heart rate variability, nervous system balance & blood pressure control.

For people who don't have the time or privacy to meditate or recite prayer, then resonant breathing will provide a simple, secular and very discreet way to access the state.

It can be practised anywhere and anytime without attracting attention as it doesn't require closed eyes, a meditative posture or recital. Possibly the only way for someone working in a public office to discreetly achieve this state whilst sitting down.

And the simplicity of the practice means it can be easily taught to others who might benefit.

Even though there are many forms and names of this style of breathing there are several key common components which have their own specific benefits.

To create good foundations for the technique it's important to examine them in detail.

Slowly

Earlier, we saw the average breathing rate is around 12-20 breaths per minute. Resonant breathing slows our breathing down to around 5-6 breaths per minute. This massive slowing down of our breathing pace already has huge benefits before we add in resonant breathing.

In general slow breathing is accepted as good for relaxation and health. It promotes calmness and clarity.

By breathing slowly we access more of the oxygen in our blood. And by accessing this extra oxygen we get more energy and feel better.

According to Patrick McKeown, a leading expert in breathing science, most people are breathing in too much air and too fast. This result is overbreathing. When we breathe too fast we purge out too much carbon dioxide (CO2) gas, which we rely on to access the oxygen within our blood.

CO2 acts as a catalyst for oxygen to transfer from our blood into our tissues and organs including the brain.

The longer we let CO2 build up in our system the greater the oxygen uptake. This helps us feel better.

Our red blood cells typically have a 95%- 99% saturation of oxygen, easily verified by a pulse oximeter. By overbreathing we purge too much of this CO2 which means we reduce our ability to access the oxygen already in our bloodstream.

Another leading expert in breathing is Anders Olsen who focuses on the benefits of CO2 for enhanced health and performance. He notes how oxygen is perceived as the good guy and CO2 as the bad guy.

For Olsen, the relationship of oxygen and CO2 should be perceived like a car engine and fuel. Adding too much fuel to the car engine doesn't improve the car's performance. What we need is the right amount, the right balance. And this is the counterbalance CO2 plays with oxygen in our body.

In biochemistry this process is known as the Bohr effect, where higher concentrations of carbon dioxide allow easier oxygen transfer from haemoglobin - a protein found in red blood cells that carries oxygen- to tissues.

There are many additional benefits of CO2, it acts as a vasodilator, helping to open up blood vessels and allowing for greater blood circulation. This is particularly beneficial during exercise and recovery. Taken together, more oxygen uptake and greater circulation around the body provides more energy and vitality.

But as most people overbreathe they purge out too much CO2 and prevent the body from accessing the oxygen within the bloodstream. This results in more lethargy and low energy levels as the additional oxygen is not being fully used.

Just by simply slowing down our breathing we allow more buildup of CO2 which can make a huge difference to our everyday health and energy levels.

This is the goal but not everyone can easily achieve this to begin with. People develop lots of bad breathing habits throughout their lives so the training can be done in increments.

McKeown stresses that people should slow down their breathing relative to how they breathe normally. They should understand what their normal breathing rate is and try to achieve lighter and softer breathing from that starting point.

Lightly

The next key component is light breathing. It is actually still possible to take a slow gasp for air and overbreathe in the process. We can breathe too vigorously or strongly even at a slow pace.

During their trials of heart rate variability biofeedback breathing, Richard Gevirtz and his colleague Paul Lehrer found some adults were hyperventilating and feeling dizzy during the breathing exercise. They were basically overbreathing and expelling too much CO2 causing them to feel light headed.[30]

Many people believe a deep breath is good for relaxation and health. This is partly true if we breathe 'deep' from our lower abdomen using a slow and light breath.

If we breathe deep in the commonly understood sense we inevitably take a big gasp and volume of air and overbreathe / hyperventilate.

Gevirtz and Lehrer found it would take a few attempts with clinical subjects before they stopped hyperventilating.

So when doing resonant breathing the breath should be light and soft. To the point there is hardly any sound. Breathing too vigorously whether slow or fast will generate noise.

There is a popular story about young samurai warriors being trained to breathe properly before going into battle. They would place a feather in front of their nose and continue to breathe in and out from the nose. If the feather moved they were breathing too strongly. By conditioning themselves to breath light and slow in this way they would be calm going into battle.

The easier modern way to replicate this test is to place a finger in front of your nose and then breathe in and out. If done correctly there should be very minimal air sensation on the finger.

With enough practice the breath can become so light it's imperceptible to anyone else. Silent, soft and gentle. There may be a feeling of slight 'air hunger', a term for the feeling of wanting to breathe more. But as we have already seen, the oxygen levels in the body are normally at approximately 98%. So we already have the oxygen in our system.

However through poor breathing habits many people are less conditioned to CO2 build up in the body.

So the light, slow and deep breathing help us recondition our bodies to be comfortable with greater CO2 levels in our bodies, which we know is beneficial to our health.

Rhythmicity

Slow and light breathing by itself will not necessarily achieve a resonance effect. To achieve resonance we need a static rhythm of breathing. A fixed ratio of in breath to out breath. Like a pendulum swinging back and forth. Or a wave moving up and down in sinusoidal breathing.

But the exact speed for resonant breathing is not a fixed number. It will vary slightly for each person depending on unique attributes like height and the amount of blood in the body.

The science shows the sweet spot for resonant breathing is somewhere in the range of 4.5 - 7.5 breaths per minute. 5.5 breaths per minute is referenced in many places as the overall 'perfect rate'. These precise figures are just from numbers being averaged over multiple studies.

In practical terms, for most people the correct speed will be somewhere around 5 - 6 breaths a minute which works out to 5 or 6 second inhales followed by 5 or 6 second exhales.

To begin with, 5 seconds in and 5 seconds out is a good starting point for most people. If that feels comfortable then you can try 6 seconds in and 6 seconds out.

But if this is too challenging at first then you can fall back to easier targets like 3 seconds in and 3 seconds out to slowly build up more tolerance to CO2 and the feeling of 'air hunger'.

Taller people might need to breathe at around 3-4 breaths per minute due to the extra blood volume in their body taking longer to complete one cycle of circulation. That works out at slightly longer breaths of around 7 seconds in and out.

The key point is that everyone will need to experiment a little bit within the resonant frequency range to find what feels best. As we saw earlier with the masters of Eastern traditions, it's possible to intuitively find the best pace.

Nasal Breathing or Mouth Breathing

An easy way to slow down our breathing rate is to use nasal breathing. This naturally creates some resistance to the air going in and out.

Nasal breathing has many other health benefits as well. It generates the gas nitric oxide (NO) which further helps to open up blood vessels and airways. The nose also acts as a filter and humidifier for air ensuring that incoming air is optimised.

Plus it's the most discreet way to breathe allowing practice of the technique anywhere and anytime. So for these reasons nasal breathing is the priority choice for practicing slow, deep and rhythmic breathing.

But as we already know, many people cannot fully utilise nasal breathing. Fortunately resonant breathing can be done using mouth breathing.

Yet with mouth breathing there is an easier tendency to over breathe so to overcome this we need to add some kind of air resistance to keep the breathing soft and light.

There are a variety of simple techniques like pursing the lips as if about to whistle as this will reduce the size of the mouth and create resistance.

This might be too conspicuous to do somewhere public so an alternative technique is simply to close the lips but leaving a small gap to allow some air flow and some resistance.

Another way to create air resistance is by voicing a silent 'ah' or 'ha" sound during the breathing.

Making this sound constricts the throat at the glottis slightly, which creates the resistance.

Forms of resistance breathing are found in many cultures and countries around the world.

In the yogic tradition, Ujjayi breathing, also known as victorious breath or ocean breath, is a technique that slightly restricts the back of the throat to generate an ocean-like noise.

Dr Gerbarg used this technique in a clinical trial to enhance the use of coherent breathing to treat people with major depression.[31]

Resistance during breathing helps to further stimulate the vagus nerve and the parasympathetic nervous system (PNS) and increase HRV.[32]

Resistance also increases the pressure in the lungs which open up more alveoli, meaning more of the surface area of the lungs is used which allows more oxygen into the bloodstream.

Using resistance has an added benefit of strengthening the breathing muscles. Like a little gym session for breathing.

Other forms of resistance breathing include 'ki breathing' from the Japanese martial art of Aikido which is another form of slow, rhythmic breathing regarded as 'an elixir of life'.[33] It involves breathing slowly in through the nose and then breathing out through the mouth while making a soft 'ah' or 'ha' noise. 'Ki' in Japanese refers to life spirit similar to the terms prana, mana or qi.

This practice derives from an older purification practice from the Shinto religion known as 'misogi'.

As we saw earlier, slow breathing in a pendulum like manner helps fully circulate blood and the other 37 litres of body fluids around the body including cerebrospinal fluids. This provides nutrients to the brain and removes waste. So the practice is actually a literal purification from optimal circulation.

In Hawaii there is a similar practice called 'ha breathing'. In the Hawaiian language one of the meanings of 'ha' is breath or the breath of life. Breath is integral to Hawaiian culture and the word ha can be seen in the word Hawaii and aloha.

Ha breathing also involves slowly breathing in through the nose and then out through the mouth whilst making a soft 'ha' sound.

Using resistance breathing may help to augment the effect of resonance breathing or help people achieve the correct pace.

Adding resistance breathing may also generate a good feeling through extra oxygen delivery.

Yet for most people nasal breathing is simple, discreet and perhaps the simplest of all methods.

Again it will come down to what feels best after some experimentation.

Habit

The sheer simplicity and convenience of this technique makes building a habit a realistic goal for most people.

We know that athletes achieved results with resonance breathing with as little as 5 minutes a day. Yet the consensus seems to be that 10 - 20 minutes daily practice is best for good results.

Richard Gevirtz suggested his subjects continued to practise for twenty minutes a day but found they would only manage ten minutes. Yet even ten minutes proved to be effective.[34]

The clinical trials subjects showed powerful changes in their bodies after practising for ten minutes a day over the course of six weeks.

This repetition is necessary to strengthen the relaxation response.

Then, according to Gevirtz, after repeated training his subjects could reenter the state of coherence after just a few minutes of resonant breathing without biofeedback equipment. They had trained their bodies to reenter the state within a matter of minutes.

Paul Lehrer and his colleagues also note

An interesting implication of our findings is that length of treatment and home practice does not influence the effect size. *It is possible that very short training periods may suffice.* Perhaps learning how to breathe at resonance frequency provides a sufficient method for most of the beneficial effects, such that it is mostly used when needed. (my emphasis) [35]

In her recent study on Alzheimer's and resonant breathing, Professor Mather noted:

"We don't yet know what dose is optimal. But it probably doesn't have to be every day – my guess at this point is that doing 20 minutes 4-5 times per week would have benefits," she says. [36]

So whilst there are slightly different guidelines for good practice the one common denominator is regular practice. Daily ideally and if not daily, several times a week.

Like the kids in the workshops of Dr Brown and Dr. Gerbarg, if something feels good you naturally want to do it again or do it for longer.

5 minutes is good for an introduction to the technique and 10 or 20 mins is ideal for regular practice.

Health Tech and Biofeedback Equipment vs Stripped Down Approach

Despite a boom in recent years of wearable health tech devices, biofeedback equipment is still not easily accessible to the general public. While the technology has a huge advantage for pinpointing your resonant frequency it is debatable if this is really necessary.

In one of their papers on resonant breathing, Evgeny Vaschillo and Paul Lehrer concluded:

It is possible that, despite the findings described in this paper, even standardised paced breathing at 5.5 or 6 times/minute for all people may produce clinical effects that are just as strong, *without the need for biofeedback equipment, or that a estimate of resonant frequency in a single session is sufficient, followed by assignments to breathe at that frequency at home, without biofeedback instrumentation.* (my emphasis)[37]

The stripped down approach is the most accessible. Whilst the technology has benefits we certainly don't need it to try out the technique or feel the benefits.

Clearly the technique requires practice. Then with sufficient practice we can re-enter the state quicker in the future.

What is helpful to begin with is some kind of timer to help pace the correct speed. And there are many free apps, music and timers that do just this.

With these resources it's easy to experiment with different breathing rates to find the most comfortable pace and eventually the rate with the best feeling.

But resonant breathing can be done by simply counting and following your own rhythm.

Gevirtz recalls a personal story when he was going for an MRI scan. He breathed at his own resonant breathing pace without any additional guidance and was quickly able to enter a calm state during the scan.[38]

So after a while the resources become quite optional. Like the stabilisers we use when learning to ride a bike. After a while we don't need them anymore.

Then it's easy to do the exercise anywhere. In the dentist's chair, in an exam, in a stressful meeting, lying in bed, in a waiting room etc. As Dr Gerbarg comments

"If you find yourself anxious, depressed, or stressed at any time during the day, you can sit at your desk or in a meeting and do a few rounds. "It's totally private. Nobody knows you're doing it"[39]

In this simplicity lies the beauty.

In his best selling book Breath, The New Science of a Lost Art, James Nestor refers to the technique as Resonant (Coherent) breathing and describes it as

"A calming practice that places the heart, lungs, and circulation into a state of coherence, where the systems of the body are working at peak efficiency. *There is no more essential technique, and none more basic."* (my emphasis) [40]

Resonance breathing pioneer Paul Lehrer further notes,

"It's a nondrug treatment with very powerful effects. It's easy to learn. Why isn't everybody doing it?"[41]

So what's stopping you?

Resonant (Coherent) Breathing - A Summary

Fixed Rhythm

For most people. **5 seconds in / 5 seconds out OR 6 seconds in / 6 seconds out.**

For low CO2 tolerance or breathing difficulty, try **3 seconds in, 3 seconds out** to begin with

For people over 6 feet tall: try longer breaths like **7 seconds in / 7 seconds out.**

Experiment and discover what feels best.

Slowly

Let carbon dioxide increase and release more oxygen. Energise yourself.

Smoothly & Gently

Do not force the breath. Let the diaphragm do the work. Breathing is from 'deep' in the lower abdomen.

Recommended Resources

Breathing Zone - A fantastic, simple and easy to use app that offers different speeds of breathing to experiment with. Open the app and select 'equal speeds' and then set the pace to 5.5, 5 or 6 breaths per minute etc.

Available for free on Android or App Store

Google, search for 'breathing exercise' and a 5.5 breaths per minute timer will appear at the top of the page. Great for recommending to other people.

2 Bells (60 mins) - Coherence by Stephen Elliott is an excellent simple and calming guide set at 5.1 breaths per minute. Available on most streaming platforms.

About The Author

Greg Sawers is a writer with an interest in mind and body wellness. He has over 20 years experience in martial arts, breath work, NLP and hypnosis.

After studying Aikido and Hawaiian breathing practices he noticed some underlying similarities that led him to research further into the science of slow, deep & rhythmic breathing. He created this guide to make the science more accessible to a wider audience.

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