Scientific background whitepaper

moonbird

More calm, better nights. Just by breathing

“Studies have shown that breathing exercises can effectively reduce stress, combat anxiety, improve sleep and even boost focus, attention and decision-making. Biofeedback devices such as moonbird may help in guiding the breathing rhythm and stimulate this relaxation response.”

Prof Steven Laureys, neurologist

Preface

We have been breathing our entire lives. You would think we've become experts at it. Yet the opposite is true. Today, our breath is still one of the most underexplored and underused tools we all possess.

Breathing draws in vital oxygen, the energy for our system. If we breathe inconsistently, rapidly or superficially, our emotional, physical and mental well-being is impacted. You may feel restless, and experience anxiety, sleeping problems and stress due to the activation of the stress response in your body. Research shows the vital importance of learning to breathe slowly. Slow-paced breathing positively impacts our autonomous nervous system: the interaction between the cardiac and respiratory mechanisms activates the body's relaxation response.

At moonbird, we want to give you the tools to discover the power of slow breathing.
Moonbird is the first handheld device that guides your breathing intuitively while providing biofeedback. The device expands and contracts in your hand giving you a pace to match with your breathing. Biofeedback is the insight users receive about their bio signals. This way you are more aware and get a better understanding of the impact breathing has on your body. Guiding breathing via touch is a powerful sense to activate relaxation, especially when combined with biofeedback.

Moonbird helps you to connect mind and body, reduce stress, and fall asleep faster.
Just by breathing.

All the best,
The moonbird team

"At moonbird, we want to improve the overall happiness and health of every person, both children and adults, by making breathwork accessible, cool and convenient."

Stefanie Broes, CEO and co-founder of moonbird

Mental health issues on the rise

The overall number of people reporting mental problems is increasing worldwide, with a 13% rise in the last decade and even a 30% increase during the Covid-19 pandemic.[1–4]. Even 20% of children and adolescents in the world suffer from a mental health problem.[5] Today, 40% of the global population is suffering from stress,[6] up to approximately 5% suffers from anxiety[7] and nearly 20% of the population suffers from sleep problems.[8] These problems have a significant effect on quality of life, in terms of work, relationships or social activities.

"Chronic stress may place us at risk for various diseases."

When stressed, our bodies produce adrenaline, elevating our heart rate, blood pressure and energy level. This automatic response developed in our ancient ancestors protected them from predators like wild animals, or other threats. In these situations stress can be positive, shielding us from harm. Stress also enhances our performance and problem-solving skills. For example, when giving an important presentation, it keeps us sharp and focused. But stress can have negative consequences. Our bodies are unable to differentiate between a *real* threat (like a wild animal) or *perceived* threats (like a full email inbox). Both positive and negative stress triggers the same biological processes. And when we feel stressed more frequently and it turns into a constant feeling of being overwhelmed or pressured, it becomes chronic and may place us at risk for various diseases.

Whereas stress is a reaction to a specific trigger, anxiety is an emotional state that can occur with or without an identifiable trigger.[9] Yet, both are expressed physiologically and psychologically, resulting in emotional, physical, cognitive, or behavioral responses. Anxiety creates an unpleasant feeling often associated with fear, worry and discomfort. Feeling anxious is normal to a certain extent, for example, when we find ourselves in an unsafe situation (e.g. walking in a dark alley). Although this anxiety is unpleasant, it is temporary and even useful e.g., increasing alertness. In the case of persistent anxiety, the feeling of fear is constant, intense and disruptive. It might even worsen, which can prevent us from living a normal life.

Sleeping difficulties involve an inadequate quality, timing, or amount of sleep. The most common sleeping problem is psychological insomnia, which involves trouble falling or staying asleep.[8] Most insomniacs have an underlying problem, such as anxiety or stress.[10]

"When dealing with anxiety, we feel less healthy and vital and daily activities can become challenging."

Such stress, anxiety and sleep problems can interfere with a normal lifestyle. They slowly drain our resources for both mind and body. Chronic stress can manifest as anxiety and sleeping problems, but also as pain, low energy, lack of focus, social withdrawal, or change in appetite. It is even linked to medical conditions such as cardiovascular diseases or addiction, and mental health disorders.[11–13] Second, when dealing with anxiety we feel less healthy and vital and are less able to carry out daily activities. We tend to avoid anxiety-provoking situations and activities leading to a lower quality of life.[14,15] Finally, sleep problems often result in daytime distress and impaired functioning and are associated with major health risks, including compromised quality of life, lower productivity and illnesses such as depression, hypertension and diabetes mellitus.[16–20]

The rise of mental health awareness

Fortunately, in recent years there has been more awareness around stress. The mental health action plan for 2013–2020, recently published by the WHO, demonstrated the need for a collective evidence-based effort to improve mental health[21]. However, in practice this appears easier said than done.

While medication is traditionally considered a potential way to address stress, anxiety and insomnia, it is associated with several side-effects significantly affecting quality of life such as daytime drowsiness, dizziness, constipation, diarrhea, and difficulty keeping balance.[22] Furthermore, certain medications can be physically and psychologically addictive. Long-term treatment of stress, anxiety and sleeping problems with these medicines often results in dependency and increasing tolerance. This can lead to even more side-effects associated with the need to take larger dosages to obtain the desired effect, and to physical and mental withdrawal effects including difficulty sleeping, restlessness, anxiety, shivering, and circulation problems.[22]

"Mindfulness, meditation, and breathing practices are gaining popularity as effective ways to relieve stress."

Today, an overconsumption of prescription medication is reported. People suffering from stress and sleeping problems as well as physicians and psychologists plead for more non-pharmacological alternatives.[23–25] This has translated into a strong shift in consumers' mindset towards non-pharmacological mental health solutions. We become more and more encouraged to become a more active player in gaining control over symptoms. We have learned that sleep, healthy food, time management and regular exercise can help us recover from stress and stress-related problems. During the last years, mindfulness, meditation and breathing practices are gaining popularity to relieve stress.

Breathing as the remote control of our body

With breathing techniques, we *consciously and voluntarily* change one or more respiration parameters like the breathing pace and depth, or the inspiration versus expiration ratio. This is different from other relaxation techniques, such as mindfulness or meditation, where a person merely directs his attention to the act of breathing *without* actually changing it (i.e. breath awareness).[26]

Breathing techniques have been around for thousands of years. Nowadays, widely known techniques are the Buteyko method (i.e. primarily used for treatment of asthma) and the Wim Hof method (i.e. a combination of fast-paced breathing exercises, mindset training and gradual exposure to cold).[27,28] In addition, various forms of breathing exercises exist like alternate nostril breathing (i.e. alternating between two nostrils), abdominal or diaphragmatic breathing (i.e. breathing through your belly), vocalized breathing (i.e. speaking on exhaled air), forceful breathing (i.e. breathing which utilizes additional muscles to rapidly expand and contract the thoracic cavity volume), nasal or oral breathing or biofeedback breathing (i.e. learning to control bio signals like heart rate via breathing exercises).

"Slow-paced breathing techniques seem to be closely linked to relaxation and wellbeing."

A resting breathing rate of healthy adults is around 10-20 breaths per minute (0.15-0.30 Hz).When breathing at a frequency lower than the resting, spontaneous breathing pace, it concerns *slow-paced breathing*.[29] This is a breathing technique with controlled inha-

lations and exhalations, within the *range of 4-10 breaths per minute*, or 0.05 - 0.15 Hz.[30] In contrast to uncontrolled fast breathing, generally linked to anxiety and stress, slow-paced breathing techniques have been associated with relaxation and wellbeing.[30,31]

The gas and brake pedal of our body

The autonomic nervous system represents the actions of our nervous system that are generally not under direct voluntary control. It consists of two systems: the sympathetic nervous system and the parasympathetic nervous system.[32] They exert opposing control over the heart and other organs, keeping them in homeostasis.

Activation of the sympathetic nervous system produces a set of reactions that activate an alarm response in organisms, the so-called *'fight or flight' response*.[33] Important visceral phenomena of this activation are pupil dilatation, increase in visual field, sweating, and increased respiration rate, heart rate and blood pressure to provide greater blood flow to the muscles. (Figure 1)

It stimulates immediate availability of energy so that we are prepared to handle a possible threat. This system is referred to as the *gas pedal*. At rest, healthy humans only have minimal sympathetic activity, which increases during exercise and physical

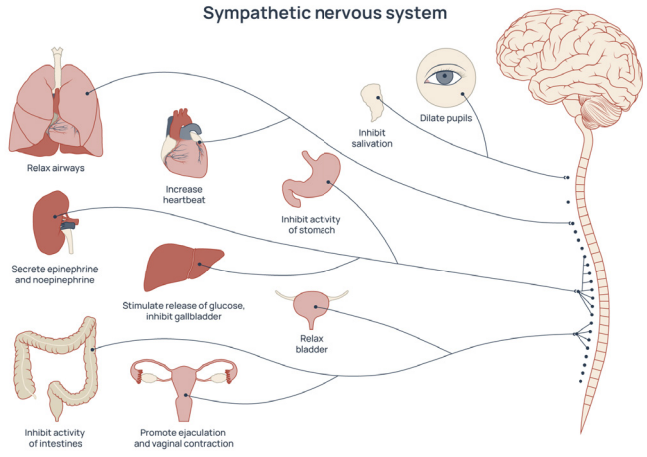


Figure 1. The sympathetic nervous system.

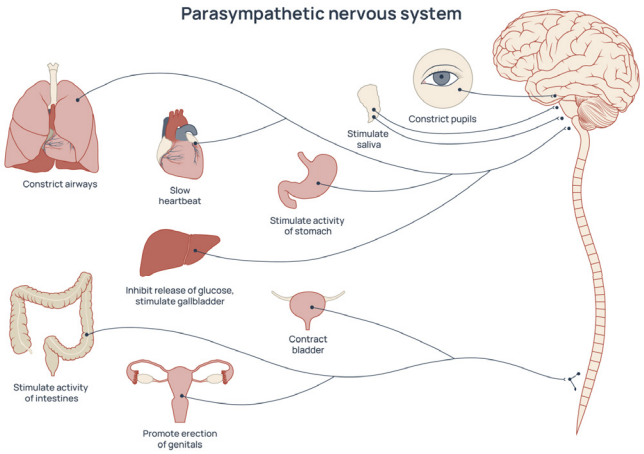


Figure 2. The parasympathetic nervous system.

or mental stress, and in various disease states.[34] In contrast, activation of the parasympathetic nervous system promotes bodily reactions such as pupillary constriction, decreased heart rate, blood pressure and respiration rate, digestion and sexual arousal.[34,35] (Figure 2) It stimulates the so-called *rest-and-digest response* that occurs when the body is at rest.

This system is also known as the *brake pedal* of the body. Parasympathetic activity presumably is the dominant arm of the autonomic nervous system as it provides a homeostatic background in resting conditions.[36]

Stress is considered a state of threatened homeostasis following exposure to extrinsic (e.g., a lion or a full email inbox) or intrinsic adverse forces (e.g., personality traits). In stressful situations, the sympathetic nervous system goes into overdrive (i.e. hyperarousal). The balance is shifted to the sympathetic nervous system without the normal counteraction of the parasympathetic nervous system, thus constantly pushing the gas pedal of our body.[37]

Heart rate variability, a marker for stress

A healthy heart is not a metronome. In fact, our heart rate is highly irregular, even during resting conditions. These fluctuations in heart rate result from complex interactions between different physiological systems such as age, temperature and circadian rhythm.[38] The nervous system also plays a role in this: the sympathetic nervous system increases heart rate, the parasympathetic nervous system decreases heart rate. The time intervals between heart beats are thus highly variable (Figure 3). This variation between successive heart beats is referred to as *heart rate variability (HRV)*.

Heart rate variability provides critical information about the functioning of the nervous system and the adaptability of the cardiovascular system.

When both nervous systems are active and in balance, they constantly increase and decrease our heart rate. This leads to a high variation in time between consecutive heartbeats. High heart rate variability is related to physiologic resilience and high physical and cognitive performance. It is therefore considered a sign of good health and reflects the ability to cope with stressful situations. In contrast, in stressed situations, when our sympathetic nervous system is overactive, the variations between consecutive heart beats - and thus heart rate variability - are low. Low heart rate variability has been associated with hypertension, depressive symptoms, anxiety, panic, post-traumatic stress disorder and cardiac mortality [39–43].

"High heart rate variability is considered a sign of good health and reflects the ability to cope with stressful situations."

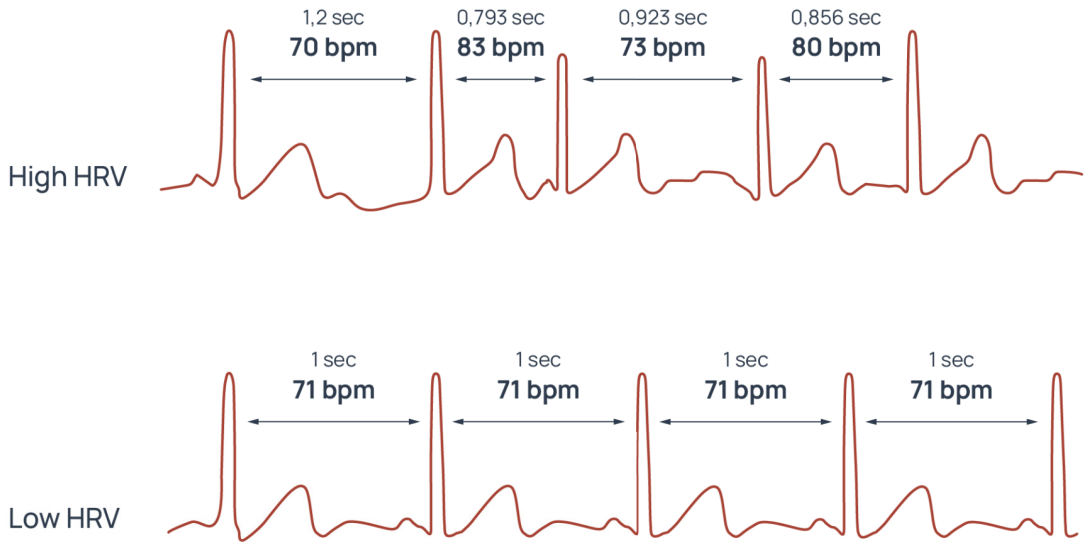


Figure 3. Heart rate variability (HRV): The time interval between heart beats is variable.

The science behind slow-paced breathing

Our cardio-respiratory system is coupled to ensure maximum gas exchange in the lungs when we breathe in.[44–48] This coupling is mainly modulated by the *vagus nerve*, an important nerve of the parasympathetic nervous system.[49,50]

"Several studies show that practicing slow-paced breathing has an activating effect on the parasympathetic nervous system, increasing heart rate variability."

When we inhale, the activity of the vagus nerve is reduced (i.e. low vagal tone), thereby alleviating its decelerating effect on heart rate, eventually accelerating heart rate. When we exhale, the vagus nerve activity is increased (i.e. high vagal tone), thereby slowing down the heart rate (Figure 4). [49,51] This form of irregularity, called *respiratory sinus arrhythmia*, is completely normal and healthy.[49,52,53] Respiratory sinus arrhythmia is a specific form of heart rate variability. It represents the rising and falling of heart rate synchronous with breathing. The degree of synchronization between the heart rate and breathing rate is expressed as *heart coherence*.

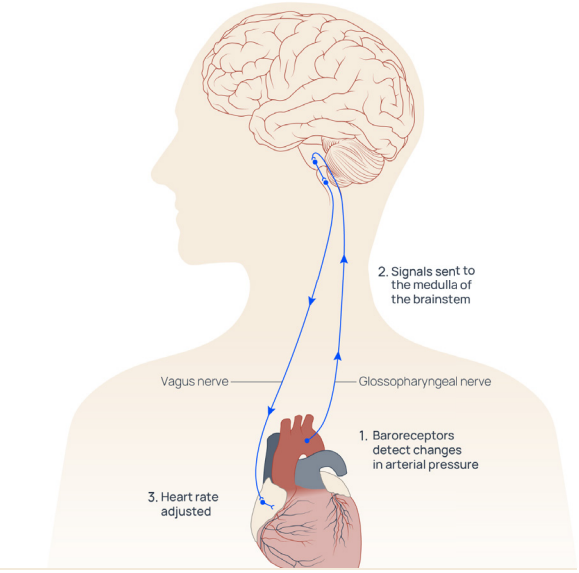


Figure 5. The baroreceptor reflex.

On the other hand, heart rate is also stimulated via the *baroreceptor reflex*. An increase in blood pressure activates specific neural stretch receptors in the cardiac arteries, the so-called *baroreceptors*. When these baroreceptors signal to the vagus nerve that blood pressure is becoming too high, they lower heart rate and blood pressure. This type of respiratory biofeedback ensures homeostasis in the body.[54–56]

Several studies show that *practicing slow-paced breathing* has an activating effect on the parasympathetic nervous system and a decelerating effect on the sympathetic nervous system, *increasing heart rate variability*.[45,57–63] This enhances autonomic reactivity to physical and mental stress both short and long-term.[34–36]

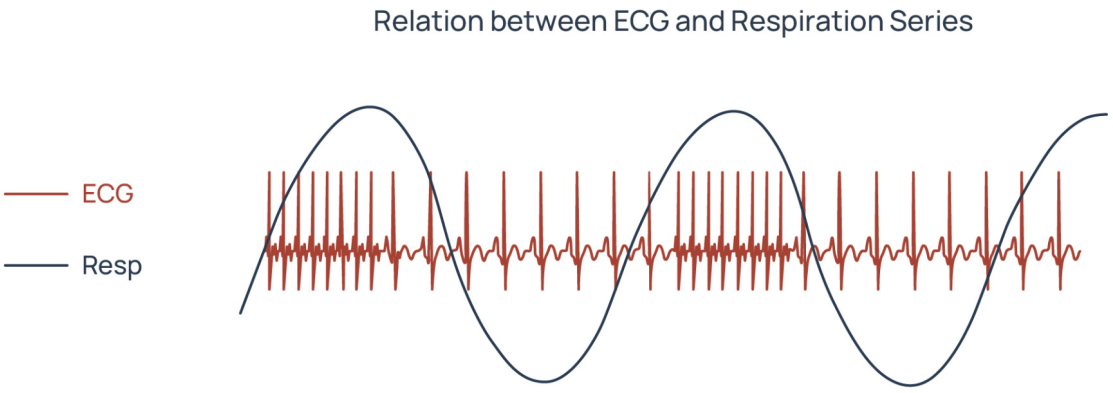


Figure 4. Relation between heart rate (measured by electrocardiogram) and respiration.

In one study 100 healthy volunteers were asked to breathe in respiration cycles of four, five, six, seven and eight breaths per minute for two minutes each.[62] Heart rate variability was measured with an electrocardiogram. Results indicated that a breathing frequency of 5 to 7 breaths per minute led to highest heart rate variability values. This puts 5 to 7 breaths per minute forward as the breathing frequency that results in the highest relaxation.

In another experiment participants were divided into three groups: after a 5-min baseline, participants engaged in (1) six breath per minute breathing using a pacer, (2) soothing rhythm breathing, or (3) watching a 10-minute nature video.[61] To induce a stressful state, participants then wrote for 5 min about a time they felt intensely self-critical. Afterwards, participants wrote about a time they felt self-compassionate for 5 min. The experiment ended with a 10-min recovery period. Participants that attempted to breathe at six breaths per minute as well as those in the soothing rhythm breathing condition effectively increased heart rate variability. The six breaths per minute group had the highest heart rate variability measures. This indicates that slow breathing leads to relaxation, with the best results at a frequency of six breaths per minute.

The physiological effects of slow-paced breathing on cardiac activity are explained by a combination of the two mechanisms: respiratory sinus arrhythmia and the sensitivity of the baroreceptor reflex. At a breathing frequency of around 6 breaths/min (or 1Hz, Figure 6: upper graph), both mechanisms generate steady heart rate oscillations. At this pace the oscillations of both mechanisms are aligned (in sync), making them resonant, which increases the total heart rate oscillation or variability (Figure 6: lower graph).

“5 to 7 breaths per minute results in the highest relaxation response.”

The exact breathing rate at which heart rate variability is maximal depends on the person - i.e. the **individual resonant frequency** - however **always lies between 5 and 7 breaths per minute**.[62]

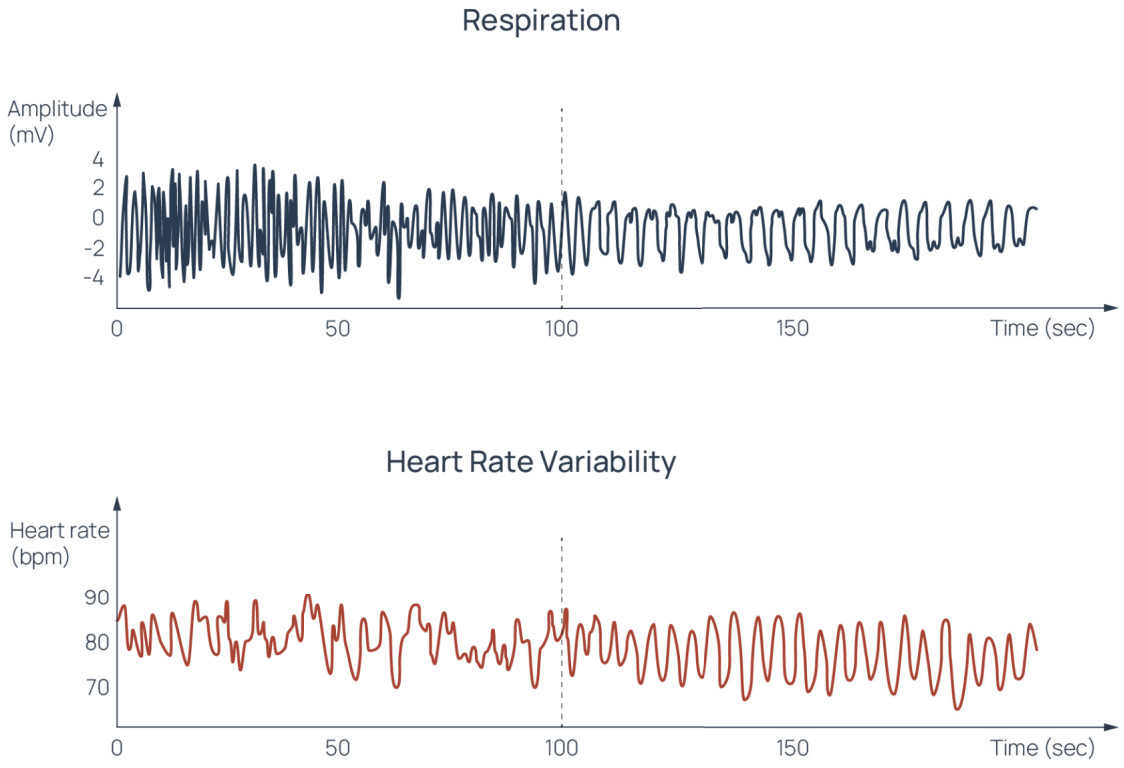


Figure 6. Oscillations in heart rate (HRV) can be maximized by slow-paced breathing (1Hz or 6 breaths/min). Amplitude (mV: minute ventilation): the amount of air entering the lungs per minute.

In other words, *heart rate variability can be maximized* by breathing *at a frequency of around 6 breaths/min*, which may be *individually optimized as slightly higher* (6,5 or 7 breaths/min) *or lower* (5,5 of 5 breaths/min).

"Research showed positive effects of slow breathing on sleeping problems, anxiety and stress."

The positive effects of slow breathing have been studied in-depth. Researchers found that practicing breathing exercises via heart rate variability biofeedback for only 10 minutes led to a significant 15%-increase in reported relaxation.[64] Another study with insomniacs showed that a slow breathing session of 20 min before bedtime decreased sleep onset latency by 15 minutes, nearly halved the number of awakenings, and reduced time awake during sleep with 30%.[65] Finally, breathing exercises have been recommended as a beneficial treatment for anxiety as well. In one study with 60 pregnant women, performing abdominal breathing exercises 3 times a day for a 3-day period decreased state anxiety with approximately 20%.[66] Consequently, slow-paced breathing has been identified as an effective management tool for stress-related problems.

"A slow breathing session of 20 minutes before bedtime, significantly improved sleep among insomniacs."

Moonbird: relaxation in the palm of your hand

To help you relax, calm down or fall asleep faster, moonbird developed and commercialized an intuitive, tactile and handheld breath pacer that incorporates a heart rate sensor, combined with a mobile app. The device expands and contracts in the palm of your hand, providing the user with a slow pace to match their breathing rhythm. Heart rate data are acquired from a photoplethysmogram (PPG) sensor. The software derives, from the sensors, real-time pulse rate and rest/activity data. The accompanying app presents real-time biofeedback on heart rate, heart rate variability and heart coherence.

HOW DOES MOONBIRD WORK?

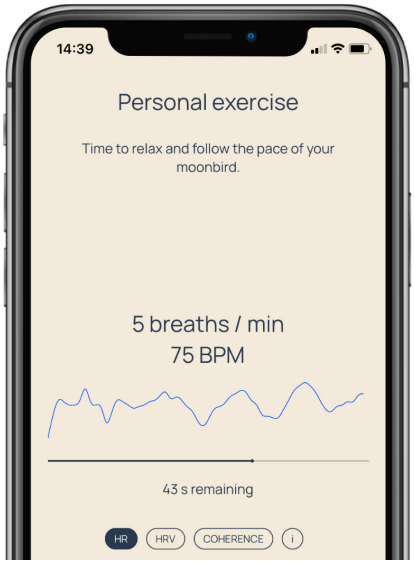
1. **Hold moonbird in your hand.** Select your type of breathing exercise and let moonbird set the pace.

2. **Follow the rhythm.** Match your breath with your moonbird's rhythm and relax. Meanwhile, the PPG sensor and motion sensor collect raw data on heart rate and movement. This data is converted into different parameters (heart rate, heart rate variability and heart coherence) via software and is presented in the app as biofeedback.

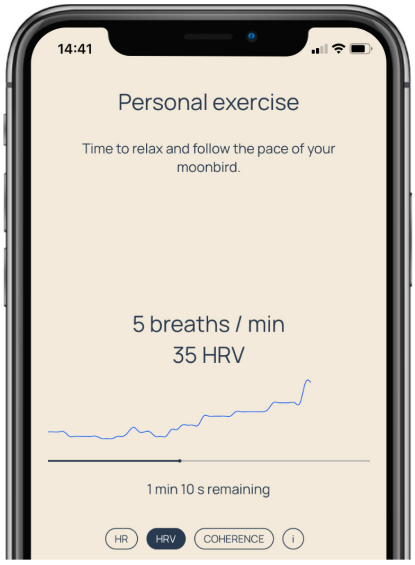
3. **Slow down.** Guided slow breathing with moonbird increases vagal parasympathetic activity, as measured by decreased heart rate, higher heart rate variability and heart coherence.

4. **See and feel the effect.** The biofeedback in the moonbird app shows you how your body responds to a slow breathing exercise by means of graphs and numbers.

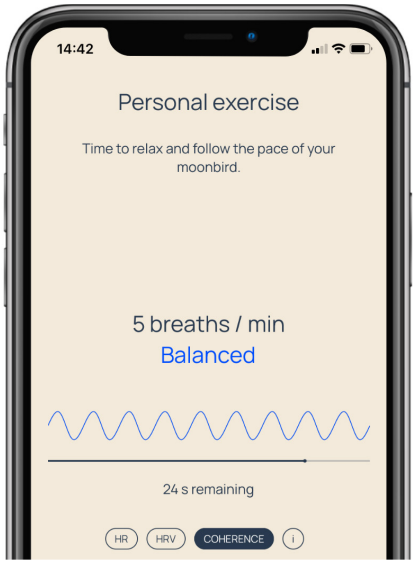
Watch your heart rate go up when you breathe in, down when you breathe out



See whether your heart rate variability increases



Check if your heart rate and breathing are in sync so you can learn and adapt in real time



Why biofeedback?

Biofeedback gives insights to users about their bio signals. This way we are more aware and get a better understanding of the impact breathing has on our body. Breathing biofeedback provides an opportunity to learn and adapt breathing in real time.[67] It allows us to increase heart rate variability and to reinforce heart coherence, slowing and steadying breathing which slows down our heartbeat. The moonbird app provides biofeedback to monitor progress regarding heart rate and heart rate variability and indicates whether or not the breathing happens coherently (i.e. whether heart rate and breathing rate are in sync).

Several studies indicate that heart rate variability biofeedback helps to relieve stress. In one study, volunteers exposed to work-related stress reported alert relaxation and improved cognitive performance after a heart rate variability biofeedback intervention compared to those in the non-biofeedback group.[65] In another study, researchers aimed to examine the effect of resonant breathing biofeedback training for reducing stress among manufacturing operators. The intervention group received five sessions of heart rate variability biofeedback training, once a week. Physiological and self-perceived stress was measured before and after the intervention. The biofeedback group showed a significant decrease in subjective stress after the training.[68]

Heart rate variability biofeedback training can also be an effective tool to reduce anxiety. In a study with anxious patients, participants indicated that a tangible relaxation guide was more helpful than unassisted breathing or yoga, which was also shown by a significant reduction in anxiety.[67] A meta-analysis, collecting data from 24 studies about 484 participants that received heart rate variability biofeedback training, focused on self-reported stress and anxiety. Authors reported that heart rate variability biofeedback training was associated with large reductions in stress and anxiety and was a promising treatment component.[69]

Finally, research showed that heart rate variability biofeedback ameliorates sleep disturbances and improves restorative function of sleep. Using a handheld heart rate variability biofeedback device for approximately 20 minutes before habitual bedtime improved cardiorespiratory resting (high heart rate variability levels) compared to listening to an audiotaped instruction before bedtime.[70] Similar to breathing exercises, heart rate variability biofeedback exercises appear effective to restore sleep and are recommended for treating insomnia patients.[71]

"Heart rate variability biofeedback training helps to relieve stress and can be an effective tool to reduce anxiety as well."

Tactile guidance

Research indicates that externally-paced (or guided) breathing is more effective in improving heart rate variability than self-paced breathing.[63] This is probably why nowadays many breath guidance tools have been developed during recent years. In most applications, breathing guidance is usually expressed in graphics or numbers, which tends to be rather technical[72], or via audiovisual cues, which can be quite cognitively demanding to follow. Some devices or apps are performance-oriented which can even lead to increased stress or anxiety. In addition, breath pacers via smartphone apps are not always welcomed in an already overly digital world.

Moonbird offers breathing guidance via the sense of touch, the eldest and most intuitive sense. In everyday life, it appears to be a powerful method of communicating safety. Studies show that interaction with tangible objects is important for those who have lost connection to their body and environment.[73] In the treatment of anxiety for example, attention is focused on the tactile component. People with anxiety often seek comfort in holding or touching a blanket, clothing, or rubbing a piece of furniture. Research shows that touch even regulates our response to threat.[74] More specifically, studies illustrate that various forms of touch e.g. changes in temperature, vibrations or movements, can affect how we feel. One review on the research of touch discussed its positive physiological effects, including reduced stress levels indicated by lower heart rate, blood pressure and cortisol and increased oxytocin.[75]

> "Interaction with a tangible object is important for those who have lost connection to their body and environment."

A study on people with dental phobia (n=50), measured anxiety levels after a breathing exercise of five minutes with a tactile rhythm device. They found that slow-paced breathing induced by tactile stimulation of the hand decreased state anxiety significantly.[76] In another study, researchers evaluated the effectiveness of tactile interface by simulating participants' breathing movements through the shape changes of an inflatable airbag.[72] Participants were asked to put their hand on the device, while breathing guidance was provided through shape changes. Inflation of the bag represented inhalation and deflation implied exhalation. During the exercise, biofeedback on heart rate and heart rate variability was offered. For all participants, overall heart rate variability improved after training. When asked to rate user experience participants indicated they were very pleased with the tactile interface.

Another study investigated the effects of a tactile breathing guide - a breathing teddy bear - for premature infants. Compared to a non-breathing bear, sleeping with the breathing teddy resulted in slower, more regular respiration and more quiet, less active sleep after two and twelve weeks respectively.[77] Furthermore, research suggests that touch enhances motor learning and somatic experience. The use of tactile feedback reinforces the feeling of presence and could reduce the perceived workload in learning tasks, which makes breathing exercises less cognitively demanding.[72,78]

Research findings

Though the scientific rationale behind moonbird is nothing new, we strongly believe that new technology needs to be validated. Hereto, we partner with clinicians and healthcare institutions and aim to publish the outcomes in peer reviewed scientific papers over time.

USER DATA AND TESTS

Over a 6-month period we collected anonymised data from 1435 moonbird app users who completed mood and energy check-ins. These check-ins ask users to rate their mood and energy level before and after each breathing exercise on a 5-point scale. In total, users completed 4807 valid (before and after) mood check-ins. Of those, 36% improved in mood and 59% remained stable. For 4396 valid energy check-ins, 33% showed improvement, 63% stayed the same.

A third round of user tests was performed in 2020. Insomniacs (n=21)- diagnosed and selected by their GP - were asked to use a moonbird prototype for 20 minutes before going to bed, over a four-week period. Participants rated their subjective sleep quality (using the Pittsburgh Sleep Quality Index, PSQI) before and after the intervention. Results indicated greater use of the moonbird correlated with better (lower) post-intervention PSQI-scores.

In a recent moonbird sleep study we involved 40 individuals with sleeping problems (age: 42.5 ±13.3 years▒gender 65% female▒72.5% highly educated). We measured the impact of moonbird on sleep quality and feeling fresh in the morning via the Pittsburgh Sleep Quality Index (PSQI▒N=37) and the Non-Restorative Sleep Scale (NRSS▒N=39). PSQI score (lower scores indicate higher quality)

"User tests show improvement in emotional and physical wellbeing, sleepiness, sleep quality, restorative sleep, drowsiness and relaxation."

Furthermore, we set up two rounds of user tests with physicians and pharmacists. In our first hardware validation test (CrossCare project phase I), eight self-reported chronic insomniacs took part (of which seven women). After an eight-minute in-lab breathing exercise with moonbird, participants reported feelings of sleepiness, drowsiness and relaxation. User feedback was implemented into the following product development processes.

decreased and NRSS scores (higher scores indicate more restorative sleep) increased in 29 and 32 participants, respectively. The change in the overall PSQI score was significant ($t(35)=5.692$, $p=0.000$). For NRSS the change was also significant ($t(38)=-5,401$, $p=0,000$). Since participants used the moonbird in a home context, it was not possible to establish a causal relationship between an improved sleep score and moonbird. However, the significant results provided a strong suspicion.

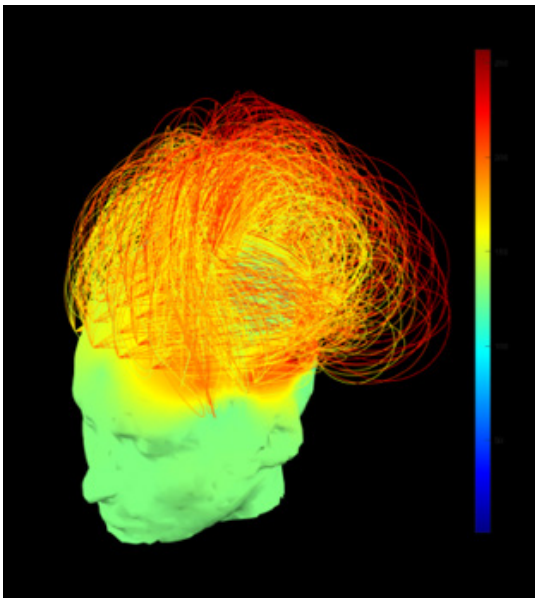
EEG case study

Breathing is closely linked to brain activity and can enhance cerebral flexibility. One systematic review showed that slow breathing led to increased EEG alpha power (i.e. indicating a resting state)[60]. A recent study measuring changes of stress stimulation through EEG in 26 healthy individuals found slow breathing to result in higher values of alpha/high-béta ratio compared to a control group[79]. At moonbird, we analyzed the impact of moonbird guided breathing sessions on the functioning of the brain via a preliminary case study (n=1). We measured the electrical activity of the brain using high density EEG consisting of 256 electrodes. Afterwards we mapped brain connectivity both at rest and during a moonbird slow-paced breathing, moonbird-guided session (Figure 8).

Our findings are in line with existing research findings. The measurements at rest (Figure 8, left panel: moonbird off), show intense and widespread béta brain connectivity (red). Left to its musings, our minds are uncontrolled and constantly wandering from one thought or feeling to the other. This so-called *monkey mind* deprives us of tranquility, which leads to negative effects such as stress, anxiety and sleeping problems. Breathing with moonbird (right panel), led to reduced béta connectivity with more brain connectivity around the midline. These findings indicate that with moonbird the *monkey mind* is calmed down by entering a wakeful but relaxed state of mind.

"Breathing with moonbird allows you to enter a relaxed state of mind."

MOONBIRD OFF



MOONBIRD ON

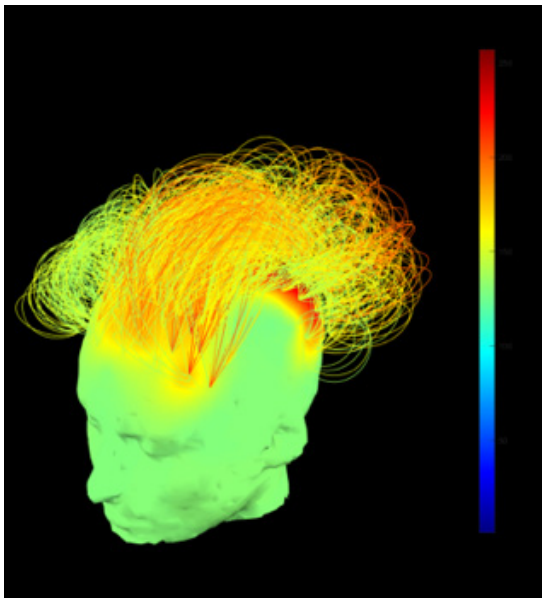


Figure 8. Béta Band Brain Connectivity. Results from our high density EEG recording without the moonbird (moonbird off) compared to moonbird focused attention on breathing. The findings illustrate unstructured and widespread béta connectivity during the control baseline condition and decreased more focal beta activity during moonbird guided breathing.

Conclusion

Available research shows that slow-paced breathing exercises have beneficial effects on overall health and on mental health problems such as stress relief, reduced anxiety and sleep problems. Slow-paced breathing has a positive effect on our autonomous nervous system, indicated by lower heart rate levels and higher heart rate variability levels. Via slow breathing the interaction between the cardiac and respiratory mechanisms enhances the activation of the parasympathetic nervous system, the body's brake pedal, inducing relaxation. In addition, studies indicate that guiding breathing via touch is a powerful sense to activate relaxation, especially when combined with heart rate variability biofeedback.

The first user tests (N=90) with moonbird were already promising. Results indicated improvement in emotional and physical wellbeing and increase in sleepiness, sleep quality, restorative sleep, drowsiness and relaxation. At moonbird, we aim to make intuitive breathing exercises more accessible for everyone. We aspire to bring you into a desired state of mind by inducing a relaxation response and lowering stress and anxiety levels. Our device represents a useful tool that supports the needs of people suffering from stress and stress-related disorders.

"At moonbird, we aim to make inuitive breathing exercises more accessible for everyone."

Final word

Moonbird was founded by Stefanie and Michael, brother and sister, with a mission: helping people relax, calm down and focus in a fast-paced world, simply by using their breath. Not only did they develop moonbird as a solution for stress-related (mental) health challenges but also found an innovative way to address them.

With moonbird, relaxed breathing became easy, effortless and even fun. Our device can impact the daily well-being of millions of people worldwide. We receive multiple stories from our users who feel calmer, more relaxed and have less trouble falling asleep, thanks to breathing with their moonbird.

The moonbird team continues to focus on improving the effectiveness and user experience of the device. We plan to conduct more clinical trials to validate the effect of moonbird and its use for different user groups.

This will help us on our mission to make people discover how much power they hold.
Just by breathing.

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