Science Behind our App

Our autonomic nervous system (ANS) regulates the functions of the organs and is responsible for maintaining a functional balance (equilibrium), which is the basis for maintaining health, adapting appropriately to challenges and maintaining high performance. It is also very important to a well-working natural immunity, preventing lack of or excess of action on the part of the immune system.

ANS function is strongly affected by a number of factors, such as conscious and subconscious emotions, life rhythms (e.g. sleeping and waking, breathing, activity and rest), medication, diet etc.

There are two parts of the autonomic nervous system, which are opposite in their effect but need to be in a fine rhythmic balance to maintain health and performance.

The Sympathetic Nervous System

THE SNS is responsible for mobilising energy in challenging situations. It gives the physiological foundation for the 'fight or flight' response, as it raises the heart rate and blood pressure, pushes the blood away from the skin and inner organs towards the muscles, and can move us away from lengthy consideration towards fast reflex responses. When sympathetic activity is in overdrive for a long time, this 'stress' can manifest in a number of health problems, such as hypertension, cardio-vascular disease, diabetes etc.

The sympathetic nervous system is particularly active during the light phases of sleep, such as sleep phases 1 and 2 and REM sleep. During REM sleep, we process our daytime experiences through dreaming. This happens even though we may not be aware of it.

When all is going well, the overall activity of the sympathetic nervous system markedly decreases during sleep and increases during the day, allowing for good performance during the day and undisturbed recovery during sleep.

The Parasympathetic Nervous System

The PNS is responsible for the ability to regenerate and recover during times of rest, relaxation, when digesting and whilst asleep. During the day, it also creates the physiological foundation for the 'tending and befriending' response, a parasympathetic stress relief response that is accompanied by increasing levels of oxytocin in the blood and brain. Oxytocin reduces anxiety and increases feeling of trust and bonding.[1]

Physiologically, parasympathetic activity lowers the heart rate and blood pressure, speeds up digestion, centralises the blood and helps us to access the creative forces of our subconscious mind. Driven to the extreme, however, by high levels of sustained pressure (stress), the parasympathetic nervous system may lead to a 'freeze response' (pretend-to-be-dead reflex) during waking, a state of disconnection from life, a sense of numbness and paralysis of will. This is the case when the situation becomes so hopeless there is no way out except to pretend to be dead. This state can result from burnout, trauma and/or chronic poor sleep.

During sleep, parasympathetic activity facilitates recovery; it is especially active during the deep sleep phases 3 and 4, particularly during the first part of the night.

When all is going well, there is strong parasympathetic activity during sleep, but also some parasympathetic activity during the day, as all activities that involve our full engagement and creativity, for example problem solving, are best supported by balanced and rhythmic sympathetic and parasympathetic activity (autonomic balance).

In Summary

The Autonomic Nervous System (ANS) comprises two parts with opposite and complementary functions.

- **Sympathetic system**
  - Activation response
  - Mobilises and alerts
  - 'Fight or flight' response
  - Speeds up the heart

- **Parasympathetic system**
  - 'Freeze or flop' response
  - Relaxes and regenerates
  - 'Tending and befriending' response
  - Slows the heart down

Predominance of the sympathetic nervous system is experienced as negative stress and tension and can lead, when not counterbalanced and when it goes on too long, to chronic conditions such as premature ageing, arteriosclerosis, hypertension, diabetes and cancer. Underlying all these conditions is a chronic inflammatory process that is enhanced when we experience negative emotions, such as stress, anger and anxiety over a long period of time.

The parasympathetic nervous system (vagal nerve) is engaged during relaxation, sleep and when we digest. It is responsible for recovery after strain and operates in a functional polarity with the sympathetic nervous system. Predominance of the parasympathetic nervous system, as is often found after trauma or with burnout, may be experienced as ongoing fatigue, daytime sleepiness, emotional withdrawal, lack of drive and even depression. It can also manifest in the form of a 'premature inner retirement', which happens when we move our body into work, but our mind is somewhere else. This is a state of 'freeze or flop', or a simple withdrawal into boredom ('bore out').

The sympathetic and parasympathetic nervous systems need to be in dynamic balance and constant flux. Any permanent fixation of this relationship or age-inappropriate dominance of one system over the other will lead to illness, reduced wellbeing and reduced performance.

Stress & Resilience	Physiological	Emotional	Behavioural	Mental
Sympathetic Dominance	High heart rate High blood pressure High inflammation Irregular heart rate High arousal Insomnia Arrhythmia	Tension Anxiety Fear Anger Shame	Fight or flight Impulsiveness Risk taking Rigidity Competitiveness	Poor judgments Poor decisions
Engagement (Balance)	Normal heart rate Normal blood pressure Balanced ANS High stamina High resilience	Appreciation Enthusiasm Empathy Courage	Sustainable peak performance	Good judgments Good decisions Imagination Inspiration
Parasympathetic Dominance	Low heart rate Low blood pressure Low inflammation Low arousal Sleepiness Fatigue	Numbness Disconnection Disassociation Depression	Freeze or flop Avoidance Inhibition Procrastination	Indecisiveness Hesitation

The Physiology of Engagement and Flow

We all know what it feels like to be put on the spot unexpectedly; we may experience our heart pounding, sensations of butterflies in the stomach area, get a dry mouth, breathe shallowly and quickly and may even lose our voice.

Even the most experienced actors describe a feeling of stage fright before they go out on stage. They will also tell you they need this stage fright in order to perform well in challenging circumstances, i.e. during a performance. Stage fright is correlated to an increased physiological stress 'fight or flight' response that is alerting and mobilising; it keeps actors awake and literally on their toes.

But the surprising thing is what happens when the experienced performing artist is out on stage: all stress symptoms are replaced by an excellent performance based on complete identification with the role, the act of performing and the strong rapport created with the audience. This is a state of *engagement,* a third state between strain and recovery.

When measuring the functioning of the autonomic nervous system with heart rate variability assessments (see below), **activities of engagement are characterised by a simultaneous and rhythmic interaction of both the sympathetic and parasympathetic nervous systems**. The resulting *physiological state of engagement* has the following characteristics:

Science Behind our App

1. Sustainable Peak Performance

People who are in a state of 'engagement' can problem-solve well in challenging circumstances, are creative, make good judgments and decisions under duress and are highly productive. Despite excellent performance and productivity, people do not tire as quickly when they are in a state of engagement as when they are in a state of tension. This is because during engagement both parts of the ANS are simultaneously activated, with the sympathetic nervous system contributing towards alertness and mobility, while the parasympathetic nervous system supports playfulness, artistry and recovery. Negative aspects of a fixed, one-sided nervous system dynamic—such as 'fight or flight' or 'freeze or flop', as well as social isolation with rigid behaviour patterns—are transformed through the positive aspects of alertness and mobility (sympathetic) and tend and befriend response (parasympathetic).

2. Flow

Positive psychologist Mihály Csíkszentmihályi describes flow as the mental state in which a person performing an activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity. In essence, flow is characterized by complete absorption in what one does. Achieving flow is often referred to as being *in the zone*.

According to Csíkszentmihályi, flow is completely focused motivation. It is a single-minded immersion and represents perhaps the ultimate experience in harnessing the emotions in the service of sustainable peak performing and learning. In flow, the emotions are not just contained and channeled, but positive, energized, and aligned with the task at hand. Feelings experienced whilst performing a task in flow are spontaneous joy, passion, enthusiasm and love. Nevertheless, the individual is exclusively focused on the activity, rather than himself or his feelings and emotions.

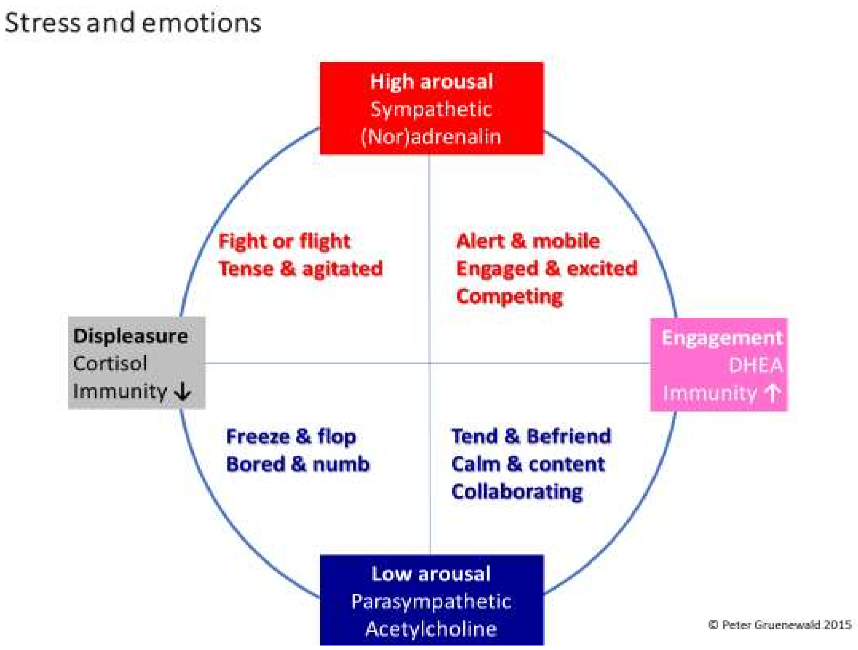
Csíkszentmihályi identified the following six factors as encompassing an experience of flow: [4]

- Intense and focused concentration on the present moment
- Merging of action and awareness
- A loss of reflective self-consciousness
- A sense of personal control or agency over the situation or activity
- The individual's subjective experience of time is altered
- The activity is experienced as intrinsically rewarding and strongly connected with a sense of purpose.

We recognise in Csíkszentmihályi's description of flow the *state of engagement* and have identified the physiological correlate of this flow state in the simultaneous, rhythmic and balanced interaction of sympathetic and parasympathetic activity.

3. Positive Emotional Attitude and Empathetic Interaction

The same physiological effect of simultaneous, rhythmic and balanced interaction of sympathetic and parasympathetic activity is found when focusing on a positive feeling, such as gratitude or self-confidence. We have also found the physiological state of simultaneous, rhythmic and balanced interaction of sympathetic and parasympathetic activity occurs when two people interact with empathy.



Positive emotions are active and critical elements of resilience.

Research into resilience[2] has shown a close link between the capacity to shift from negative to positive emotions and the capacity to stay well and healthy and perform well under pressure.[3] [4] [5] [6] [7] [8] [9] [10]

Positive emotions were found to help resilient people:

- Disrupt the experience of stress and recover efficiently from daily stress.
- Construct psychological resources that are necessary for coping successfully with adversity and significant catastrophes.
- Notice positive meanings within the problems they faced (e.g. feel grateful to be alive after a terrorist attack).

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Positive emotions can cause a number of health benefits related to:

- the autonomic nervous system
- heart rate variability
- the immune system
- our capacity to recover from physical and emotional trauma, heart attacks and infections
- our emotional and mental health

It is important to understand we are not talking about ‘positivity’, but about positive emotions. You may have a positive mindset, but the emotions triggered by your memories may still be negative. The emotions that we are the least aware of, so-called subconscious emotions, affect our physiology, health and performance profoundly.

To overcome this split between thoughts and (subconscious) emotions and to bring thinking (brain) and feeling (heart) into alignment, we can use a number of techniques that allow us to create an effective partnership between the conscious and subconscious mind.

Balcony View (Relaxation) and Ballroom Dancing (Engagement):
Mindful Detachment and Connecting at Will

Imagine:

Imagine you are dancing on the ballroom floor of an old ballroom with balconies, and after having enjoyed yourself for a while, you ask your partner to go with you up onto the balcony. You climb up the stairs to the next floor and step right onto the balcony overlooking the dance floor. Standing there and looking down gives you a different perspective: you have gained overview, you see your friends dancing, for example, see what clothes they are wearing, where the musicians are playing, where the drinks are being served etc. Now imagine you are able to do something very unusual: although you have stepped onto the balcony, look back in your imagination to the time when you were dancing on the ballroom floor and see yourself dancing with your partner, but from the balcony perspective—looking down onto yourself, becoming your own observer.

This witness or onlooker consciousness is far from being alien to us, quite the opposite; as we look back and remember, we may experience these past events in two opposite manners: we either experience ourselves right inside our body, or we see ourselves in our memory like a picture from outside.

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Depending upon our perspective, we relate quite differently to the past event.

1. ***If we experience ourselves inside our body and see the event through our own eyes during the act of remembering, we relive and re-experience the event*** with all its feelings and emotions attached. This experience of reliving the event makes it even more tangible for us and heightens our emotional response to it—even though it is in the past. This is one of the reasons why we should avoid remembering traumatic events without therapeutic support, as the reliving of the event may make the impact of the trauma worse.

2. ***In the other case of seeing ourselves from the outside in our memory, we are disconnected and removed: we review the event rather than relive it.*** As we review the event and ask ourselves what we experienced at the time, we create something like a third-person account; we become our own observer. This helps to process the event and neutralises any negative emotions, as we will see.

Experiencing that we do not always have to be one with events and our emotions, but rather that we have the capacity to become the observer of our own mind and consciousness and describe events and emotions objectively allows us to develop calm detachment in the most challenging of circumstances. ***Remembering with inner detachment, which is part of our natural, day-to-day experience, can be deliberately practiced and turned into a powerful technique*** that gives us a stronger sense of identity, even in very demanding situations. This allows us to reduce personal bias, strengthens the quality of our judgment and decision making, protects us against developing resentments and can even prevent trauma, when experiencing catastrophe.

A similar challenge can be perceived in different ways by different people, and also be perceived differently by the same individual under different life circumstances. The perception of the challenge depends upon our angle of view and our perspective. The perspective we take impacts our emotions, which in turn influence our judgment and decision making.

We experience the phenomenon of shifting perspective best when we look at a challenging situation again after having had a good night sleep. You may have experienced that in a state of strong emotional involvement you prepared an email you wanted to write to a colleague or friend, stating your unease about a situation, only to decide you don't want to send it right away, but would rather sit on it for a little while. The next day, after a good night's sleep, you read the email again, and suddenly the situation described doesn't feel so overwhelming any more, and you feel ultimately relieved that you didn't send the email after all.

Our two training elements in the Engagement Training, Resonant Frequency Training and Bilateral Stimulation, help develop the physiological support required for detaching and connecting at will, as a foundation for emotional and physical health and performance.

Adaptive Resilience

Science Behind our App

Heart Rate Variability: A Highly Correlative Health Predictor

Heart rate variability reflects the changing speed of the heartbeat, as the heart constantly speeds up and slows down in a regular fashion. HRV is a scientifically validated and highly correlative measure for health potential and the risk of falling ill, having an accident or even dying.[11] [12] [13] [14] [15] [16] [17]

- The speed of your heart beat changes constantly.
- High HRV is a sign of good health and youthfulness of the organism (good flexibility and adaptability), although it can sometimes also be the expression of abnormally high and fixed parasympathetic activity.
- HRV declines with age, poor mental, emotional and physical health, and when one experiences tension, agitation, anxiety, anger and low mood.
- HRV worsens as a result of sleep deprivation, smoking, sedentary lifestyle and alcohol abuse.
- HRV improves with moderate and preferably rhythmic exercise, emotional management, rhythmic life style and HRV training.
- HRV is a highly correlative predictor of ill health prognosis, accidents and death.

The Value of Heart Rate Variability Analysis is that it allows us to:

- Assess health risks and health potential
- Detect early signs of development of pathological processes or the presence of a functional disorder
- Assess the level of our physical fitness
- Assess our stress-coping ability
- Evaluate the effectiveness of training and lifestyle changes
- Monitor the effect of our Resonant Frequency Training
- Measure the physiology of emotion regulation and emotional balance
- Measure the physiology of sustainable peak performance and flow states
- Assess the quality of our sleep
- Assess the impact of certain activities on the autonomic nervous system (Expert View)

The Rhythm of the Heart

Heart rate variability reflects and summarises a number of other biological rhythms, too, such as breathing rhythm, blood pressure rhythm, circulation rhythm, basic rest and activity cycle and sleeping/waking rhythm. These rhythms are regulated by the sympathetic and parasympathetic nervous systems. HRV also measures the rhythm and balance of the autonomic nervous system itself.

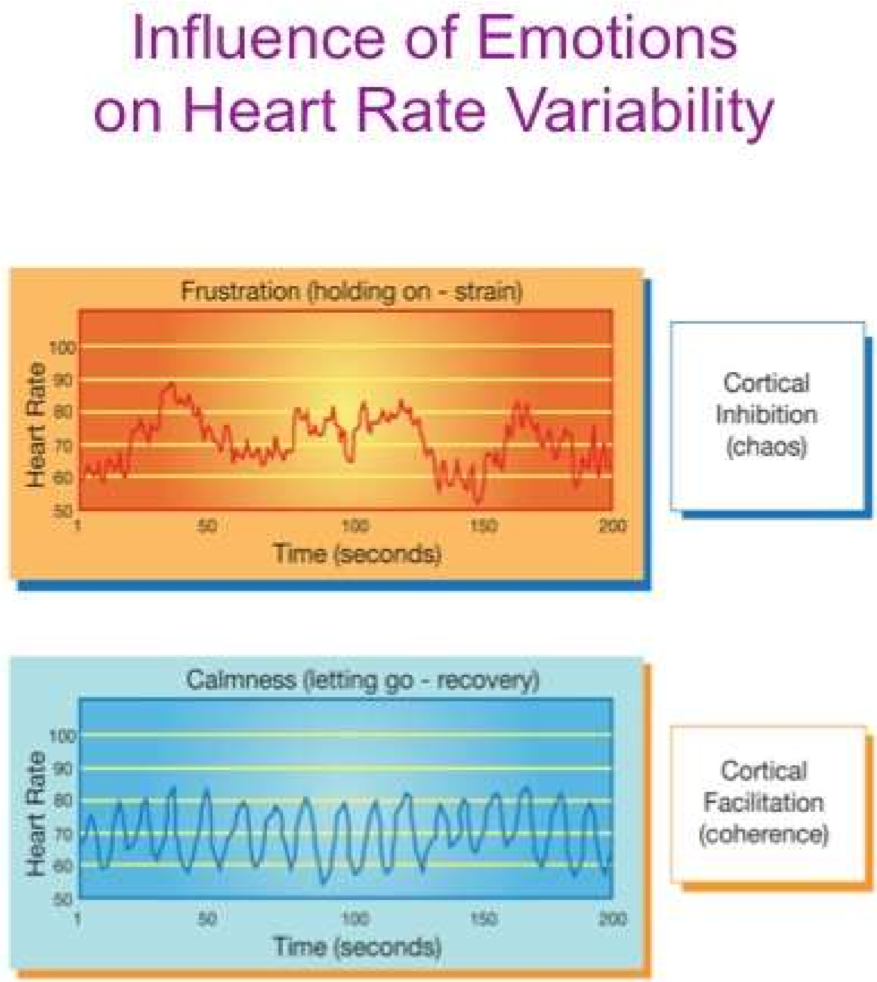
Heart Rate Variability in Stress and Sleep

Heart rate variability assessments allow us to measure the impact of stress and assess the quality of our sleep. There is a close relationship between sleep quality and conscious activity during waking.[18]

'Changes in heart rate variability associated with acute stress may represent one pathway to disturbed sleep. Stress-related changes in heart rate variability during sleep may also be important in association with chronic stressors, which are associated with significant morbidity and increased risk for mortality.' [19]

Emotions have a strong, immediate and long-term influence on HRV and cognitive functioning.

Positive and negative emotions influence heart rate variability.[20] [21] [22] [23] [24] Low heart rate variability, in turn, seems to have an impact on cognitive functioning.[25]



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Heart Rate Variability is a highly predictive measure for health risk and health potential, youthfulness and mortality.

Scientific research has shown that lower HRV reliably predicts ill health, making it not only useful in assessing health risks and health potential, but also an excellent tool to assess the efficacy of any prevention or curative intervention. The good news is that HRV can be improved at any time of life, and its improvement reduces the risk of falling ill, dying, suffering accidents or ageing prematurely. 'Healthy living' and relaxation increase heart rate variability—even as we get older. Advances in the understanding of HRV have given us valuable new methods of assessing risks, preventing and treating the consequences of long-term stress, anxiety, depression and insomnia.

The Framingham Study: Why Heart Rate Variability?

'In 1948, the Framingham Heart Study embarked on an ambitious project in health research to identify the common factors that contribute to cardiovascular disease by following its development over a long period of time in a large group of participants. After 65 years, our participants [of 3 generations; the author] continue to help scientists throughout the world unlock answers to many of medicine's most important and timely questions.' National Heart Lung and Blood Institute and Boston University

The Framingham Study found:

- Low HRV is a strong indicator for mortality
- HRV is strongly cardio-protective
- HRV is a good prognostic indicator for coronary heart disease and heart attack
- Depression and anxiety in adolescence and young adulthood significantly increase the risk of developing heart disease before the age of 65.

How to Train and Improve Heart Rate Variability

HRV can be improved through training, such as Engagement Training (Resonant Frequency Training), biofeedback and self-management programmes, which may therefore improve health and reduce your risk of falling ill.[26] [27] [28] [29] [30] [31] [32] [33] [34] HRV training can also reduce the intensity of symptoms of post-traumatic stress disorder.[35]

HRV can be trained and improved when you:

- Practise slow and deep breathing regularly at your resonant frequency (see below)
- Manage extreme emotions, by shifting away from negative to positive emotions
- Improve your quality and duration of sleep
- Establish rhythm throughout the day
- Eat a healthy diet (e.g. omega-3 fatty acids)
- Exercise regularly (rhythmic physical exercises)
- Reduce the impact of stress

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Improve Heart Rate Variability by training the rhythmic balance of the autonomic nervous system.

1. Create a physiological state of rhythmic balance of the autonomic nervous system (sympathetic and parasympathetic) by:
    a. Practising Engagement Training
    b. Focusing on a positive feeling, such as gratitude
    c. Practising focused relaxation
    d. Acting in a flow state
    e. Engaging in empathetic connectedness
2. Reduce sympathetic and increase parasympathetic activity of the autonomic nervous system to improve regeneration and recuperation by:
    a. Practising Relaxation Training
    b. Practising Engagement Training
    c. Getting quality sleep

Anxiety and fear make our breathing shallow and fast; embarrassment can make it diaphragmatically deep and slow. Breathing is the one activity that is half unconscious (you are rarely aware that you are doing it) and half conscious (you are aware of it now). Purposely regulating our breathing can have a powerful effect on the way we manage and change our emotions; when we take a deep breath after a distressing experience, we can feel the immediate relief from the oppressing emotion.

Whenever we extend our inhalation (breathing in longer than breathing out), we reduce the slowing activity of the parasympathetic nervous system and change the balance of our autonomic nervous system towards sympathetic activity, experiencing stimulation. Whenever we prolong our exhalation, we activate the parasympathetic nervous system and experience a sense of calmness, relaxation and detachment.

HRV and Engagement Training (Resonant Frequency Training)

Engagement Training is a specific variation of heart rate variability training. ***Every individual has a 'resonant frequency' at which heart rate variability is the greatest.*** This resonant frequency is achieved when breathing rhythm, blood pressure rhythm and heart rate variability rhythm are aligned.

*When travelling through England, you may come to a bridge with instructions written for soldiers on a signpost: '*Break your step*'. This is because when soldiers march over a bridge in the same step, it can cause a solid bridge to collapse. The collective energy created by the marching step of all the soldiers can make the bridge swing so extremely that it falls apart. We call this swinging phenomenon 'resonance'.*

Resonance also happens within the human body when we align our breathing rhythm with our blood pressure rhythm. Our blood pressure goes up approximately every five seconds and down every five seconds. When we train our breathing to the same rhythm as our blood pressure—approximately 4.5 to 6 seconds in and equally long out—then breathing rhythm and blood pressure rhythm are aligned and our heart rate variability rhythm follows suit. It is as if these three soldiers are marching in the same step. The result is a substantial increase in amplitude of heart rate variability and a rhythmic and balanced engagement of both the sympathetic and parasympathetic nervous systems' activities.

Relaxed breathing at about six breaths per minute produces a spike in the power spectrum of heart rate variability at about 0.1 Hz (6 cycles per minute, each cycle lasting 10 seconds) and tends to maximize most other measures of heart rate variability in most people.

The resonant frequency is most often produced by a person in a physically relaxed and mentally focused state, with positive emotional tone, breathing diaphragmatically and smoothly at a rate of 5 – 6.5 breathing cycles per minute (4.5 - 6 seconds in and 4.5 – 6 seconds out)—mostly around 6 cycles per minute.

The 0.1 Hz peak in heart rate variability indicates the activation and rhythmic balance of the sympathetic and parasympathetic nervous systems. The 0.1 Hz peak in heart rate variability is also achieved when we experience and focus on a positive feeling such as gratitude, when we are acting in a flow state or when we are engaged in an empathetic conversation.

The part of the power spectrum of heart rate variability that increases due to resonant frequency training and is also increased during engagement and when experiencing positive emotional states, is the Mid Frequency fraction (0.085-0.125Hz), which appears as golden on the spectrogram in the application. When Mid Frequency activity rises, the two arms of the autonomic nervous system (sympathetic – strain & parasympathetic – recovery).

This physiological state of balance tends to:

- Facilitate 'high sustainable performance' (cognitive function, motivation, productivity etc.)
- Optimise social connectedness with other people (emotion regulation)
- Support problem solving in challenging circumstances
- Improve stress tolerance

This physiological state can be learned by our bodies and reproduced when required. It serves as a transferable skill in demanding situations.

Small clinical trials have shown that Resonant Frequency Training techniques can help control problems like stress; anxiety; anger; depression; panic attacks; attention deficit disorder; asthma; high blood pressure; irritable bowel syndrome; and chronic fatigue syndrome.

As we have seen, heart rate variability is a measure of the continuous interplay between sympathetic and parasympathetic influences on heart rate that yields information about autonomic flexibility. ***HRV therefore represents the capacity for regulated emotional responding. Effective emotion regulation depends on being able to flexibly adjust your physiological response to a changing environment.*** HRV reflects the degree to which our physiology can be modulated to meet changing situational demands.

Breathing air into the lungs temporarily gates off the parasympathetic influence on heart rate, producing a heart rate increase. Breathing air out of the lungs reinstates parasympathetic influence on heart rate, resulting in a heart rate decrease. This rhythmic oscillation in heart rate produced by respiration is called respiratory sinus arrhythmia (RSA).

The central autonomic network (CAN) assists emotion regulation by adjusting physiological arousal to appropriately match the external and internal environments. The CAN consists of cortical, limbic and brainstem components. Its output is transmitted to the sinoatrial node of the heart, among other organs. HRV reflects by proxy an individual's capacity to generate regulated physiological responses in the context of emotional expression.

Empirical research has shown that:

- Higher levels of resting HRV are associated with effective stress-coping strategies and increased resilience under stress.
- Attention control is associated with higher HRV.
- Reduced HRV is seen in many disorders with autonomic dysregulation, including anxiety, depression, tension (negative stress), irritable bowel syndrome and asthma.
- Reduced HRV is also associated with increased vulnerability to physical and psychological stressors and disease.

Slowing down and deepening your breathing to approximately six breathing cycles per minute has a powerful rhythm-enhancing and balancing effect on your autonomic nervous system, stimulating your energy when exhausted, but also calming you when over-stimulated. This is why our breathing technique is so effective in improving fatigue and exhaustion. It stimulates the balance between strain (sympathetic activity) and recovery (parasympathetic activity). The physiological effect of the breathing technique is much enhanced when you simultaneously focus on gratitude, joy or confidence (stimulation).

Bilateral Brain Stimulation

Bilateral stimulation is stimuli (visual, auditory or tactile) which occur in a rhythmic left-right pattern. Auditory bilateral stimulation involves listening to tones that alternate between the left and right sides of the head. Bilateral stimulation is a treatment element of EMDR, trauma therapy. It was discovered by Francine Shapiro Phd.

Adaptive Resilience

Science Behind our App

Bilateral stimulation produces the following main effects:

1. A relaxation effect including decreased physiological arousal.
   This is also shows in the EEG in increased brainwaves activity in the range of ***Delta 1.5Hz***.[36]
2. Increased attentional flexibility (meaning that your thoughts become less 'stuck' on whatever was bothering you). This may also be reflected in the stimulation and rhythmic activation of both hemispheres.[37]
3. Distancing effect (meaning that the problem seems smaller and further away).
4. Decreased worry.
5. Relief from physical pain
6. Stress reduction
7. Sleep improvement

These effects are experienced as a 'bottom-up' cascade of changes meaning that they are experienced in the lower areas of the brain first, as a physiological response (i.e.: decreased tension) then travel 'up' the brain leading to mental changes (e.g.: decreased worry).
Because this order works with how the brain normally processes information, the effects are often experienced more quickly and easily than with say top-down strategies such as insight and conscious introspection.

Training Your Heart Rate Variability with Engagement Training can help to:

- Improve coherence and balance of HRV
- Train your autonomic nervous system dynamic towards flexibility, rhythm and balance
- Reduce the negative impacts of stress and anxiety
- Build resilience and improve stress tolerance
- Enhance your capacity to perform well under pressure
- Enhance your capacity to recover[38] [39]
- Increase mental performance (focus, concentration, memory)
- Improve judgment and decision making under duress
- Improve problem solving in challenging situations
- Reduce impulsivity
- Decrease frequency of low mood
- Improve anger management
- Improve social integration
- Reduce fatigue
- Reduce systemic inflammation (an underlying cause of most 'civilization' diseases)

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Engagement Training can be helpful in the following situations:

- Before, during and after challenging situations
- When you feel anxious, angry, stressed or low in mood
- Upon waking to help set the tone for the day
- Before going to sleep (to help wind down and let go)
- Before an athletic performance (to reduce performance anxiety)

We encourage you to do the training once a day or more, if possible. And, after a while, resonance training can be done without the breath trainer: focus on slow, deep breathing and on feeling a positive emotion to replace the sounds.

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[1] Taylor, Shelley E.; Klein, Laura Cousino; Lewis, Brian P.; Gruenewald, Tara L.; Gurung, Regan A. R.; Updegraff, John A., Biobehavioral responses to stress in females: Tend-and-befriend, not fight-or-flight. *From the Abstract: "The human stress response has been characterized, both physiologically and behaviorally, as "fight-or-flight." Although fight-or-flight may characterize the primary physiological responses to stress for both males and females, we propose that, behaviorally, females' responses are more marked by a pattern of "tend-and-befriend." Tending involves nurturant activities designed to protect the self and offspring that promote safety and reduce distress; befriending is the creation and maintenance of social networks that may aid in this process. The biobehavioral mechanism that underlies the tend-and-befriend pattern appears to draw on the attachment-caregiving system, and neuroendocrine evidence from animal and human studies suggests that oxytocin, in conjunction with female reproductive hormones and endogenous opioid peptide mechanisms, may be at its core. This previously unexplored stress regulatory system has manifold implications for the study of stress."*

[2] Studies by Fredrickson et al., 2003; Tugade et al., 2004; Ong et al., 2006; Bonanno et al., 2007

[3] Soc Sci Med. 1997 Oct;45(8):1207-21. Folkman S. Positive psychological states and coping with severe stress. Center for AIDS Prevention Studies, University of California at San Francisco, USA. *From the Abstract: "Providing care to a spouse or partner who is dying and then losing that person are among the most stressful of human experiences. A longitudinal study of the caregiving partners of men with AIDS showed that in addition to intense negative psychological states, these men also experienced positive psychological states throughout caregiving and bereavement. The co-occurrence of positive and negative psychological states in the midst of enduring and profoundly stressful circumstances has important implications for our understanding of the coping process. Coping theory had traditionally focused on the management of distress. This article describes coping processes that are associated with positive psychological states in the context of intense distress and discusses the theoretical implications of positive psychological states in the coping process."*

[4] Am Psychol. 2000 Jun;55(6):647-54. Folkman S, Moskowitz JT. Center for AIDS Prevention Studies, University of California, San Francisco, USA. Positive affect and the other side of coping. *From the Abstract: "Although research on coping over the past 30 years has produced convergent evidence about the functions of coping and the factors that influence it, psychologists still have a great deal to learn about how coping mechanisms affect diverse outcomes. One of the reasons more progress has not been made is the almost exclusive focus on negative outcomes in the stress process. Coping theory and research need to consider positive outcomes as well. The authors focus on one such outcome, positive affect, and review findings about the co-occurrence of positive affect with negative affect during chronic stress, the adaptive functions of positive affect during chronic stress, and a special class of meaning-based coping processes that support positive affect during chronic stress."*

[5] Rev Gen Psychol. 1998 Sep;2(3):300-319. Fredrickson BL. University of Michigan. What Good Are Positive Emotions? *From the Abstract: "This article opens by noting that positive emotions do not fit existing models of emotions. Consequently, a new model is advanced to describe the form and function of a subset of positive emotions, including joy, interest, contentment, and love. This new model posits that these positive emotions serve to broaden an individual's momentary thought-action repertoire, which in turn has the effect of building that individual's physical, intellectual, and social resources. Empirical evidence to support this broaden-and-build model of positive emotions is reviewed, and implications for emotion regulation and health promotion are discussed."*

[6] J Am Geriatr Soc. 2000 May;48(5):473-8. Ostir GV, Markides KS, Black SA, Goodwin JS. Department of Preventive Medicine and Community Health, University of Texas Medical Branch, Galveston 77555-0460, USA.
Emotional well-being predicts subsequent functional independence and survival. From the Abstract: "Our results support the concept that positive affect, or emotional well-being, is different from the absence of depression or negative affect. Positive affect seems to protect individuals against physical declines in old age."

[7] J Pers Soc Psychol. 2004 February; 86(2): 320–333. Michele M. Tugade and Barbara L. Fredrickson
Resilient Individuals Use Positive Emotions to Bounce Back From Negative Emotional Experiences. *From the Abstract: "The broaden-and-build theory (Fredrickson, 1998, 2001) predicts that positive emotions are useful in several ways. The present research expanded this theory into the realm of coping, suggesting that positive emotions guide present coping behavior. By examining psychological resilience from subjective, cognitive, and physiological angles, the present investigation provides greater insight into the reasons why resilient individuals are able to effectively cope with stressful experiences, whereas others facing similar conditions do not fare as well. Resilient individuals may recognize the benefits that positive emotions have on negative emotion regulation. As proposed by the broaden-and-build theory (Fredrickson, 1998, 2001) experiences of positive emotions during times of stress prompt individuals to pursue novel and creative thoughts and actions. Thus, through exploration and experimentation, in time they may be able to build an arsenal of effective coping resources that help buffer (psychologically and physiologically) against negative emotional life experiences."*

[8] Journal of Happiness Studies; September 2007, Volume 8, Issue 3, pp 311-333. Michele M. Tugade, Barbara L. Fredrickson. Regulation of Positive Emotions: Emotion Regulation Strategies that Promote Resilience. *From the Abstract: "The regulation of emotions is essential in everyday life. In this paper, we discuss the regulation of positive emotional experiences. Our discussion focuses on strategies aimed at maintaining and increasing experiences of positive emotions. We discuss the importance of these strategies for well-being, and suggest that cultivating positive emotions may be particularly useful for building resilience to stressful events. Then, we explore possible mechanisms that link positive emotions to coping for resilient people, with a focus on the automatic activation of positive emotions while coping. We conclude by discussing alternative models and proposing future directions in the work on positive emotion regulation and resilience."*

[9] J Pers. 2004 December; 72(6): 1161–1190. Michele M. Tugade, Barbara L. Fredrickson, and Lisa Feldman Barrett. Psychological Resilience and Positive Emotional Granularity: Examining the Benefits of Positive Emotions on Coping and Health. *From the Abstract: In conclusion, "positive emotions can be an important factor that buffers individuals against maladaptive health outcomes. Emerging research indicates that finding ways to cultivate meaningful positive emotions is a critical necessity for optimal physical and psychological functioning. Indeed, positive emotions are good for your health. With increasing research, we continue to substantiate empirically age-old folk theories about positive emotions and health that have persisted through time."*

[10] Personality and Individual Differences; Volume 41, Issue 7, November 2006, Pages 1263–1273. Anthony D. Ong, Lisa M. Edwards, C.S. Bergeman, Department of Psychology, University of Notre Dame, Notre Dame, IN, United States, Department of Counseling and Educational Psychology, Marquette University, Milwaukee, WI, United States. Hope as a source of resilience in later adulthood. *From the Abstract: "This research provided a preliminary investigation of how variations in trait and state hope are associated with positive adaptation to stress in later adulthood. Trait hope and neuroticism were measured by questionnaires and state hope, stress, and negative emotions were assessed daily for 45 days. Results from multilevel random coefficient modeling analyses suggested that daily hope provides protective benefits by keeping negative emotions low, while also contributing to adaptive recovery from stress. The dynamic linkages between daily hope, stress, and emotion were further moderated by individual differences in trait hope. Compared with those low in trait hope, high-hope individuals showed diminished stress reactivity and more effective emotional recovery."*

[11] European Heart Journal (1996) 17, 354-381. Guidelines, Heart rate variability Standards of measurement, physiological interpretation, and clinical use, Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology. *From the Abstract: "Heart rate variability has considerable potential to assess the role of autonomic nervous system fluctuations in normal healthy individuals and in patients with various cardiovascular and non-cardiovascular disorders. HRV studies should enhance our understanding of physiological phenomena, the actions of medications, and disease mechanisms. Large prospective longitudinal studies are needed to determine the sensitivity, specificity, and predictive value of HRV in the identification of individuals at risk for subsequent morbid and mortal events."*

[12] Circulation 1993; 88: 180-5. Algra A, Tijssen JG, Roelandt JR, Pool J, Lubsen J., Department of Cardiology, Erasmus University, Rotterdam, The Netherlands. Heart rate variability from 24-hour electrocardiography and the 2-year risk for sudden death. *From the Abstract: "These findings support the theory that patients with low parasympathetic activity (low short-term RR interval variability) have an increased risk for sudden death independent of other risk factors."*

[13] Circulation 1994; 90: 878-83. Tsuji H, Venditti FJ, Manders ES et al. Lahey Clinic Medical Center, Burlington, Mass. Reduced heart rate variability and mortality risk in an elderly cohort: The Framingham Study.
From the Abstract: "The estimation of heart rate variability by ambulatory monitoring offers prognostic information beyond that provided by the evaluation of traditional risk factors."

[14] Am J Epidemiol; 145:899-908. Dekker JM, Schouten EG, Klootwijk P et al. 1997, Department of Epidemiology and Public Health, Agricultural University, Wageningen, Netherlands. Heart rate variability from short electrocardiographic recordings predicts mortality from all causes in middle aged and elderly men: the Zutphen study. *From the Abstract: "In conclusion, in middle-aged men and probably in elderly men, low heart rate variability is predictive of mortality from all causes. This suggests that low heart rate variability is an indicator of compromised health in the general population."*
Circulation. 1998 May 26;97(20):2031-6.

[15] Heikki V. Huikuri, MD; Timo H. Mäkikallio, MD; K. E. Juhani Airaksinen, MD; Tapio Seppänen, PhD; Pauli Puukka, MA; Ismo J. Räihä, MD; Leif B. Sourander, MD, Division of Cardiology, Department of Medicine, University of Oulu, Finland. Power-Law Relationship of Heart Rate Variability as a Predictor of Mortality in the Elderly
From the Abstract: "Power-law relationship of 24-hour HR variability is a more powerful predictor of death than the traditional risk markers in elderly subjects. Altered long-term behavior of HR implies an increased risk of vascular causes of death rather than being a marker of any disease or frailty leading to death."

[16] Acta Diabetol. 2011 Mar;48(1):55-9. Epub 2010 Sep 16. May O, Arildsen H., Department of Medicine, Region Hospital Herning, 7400 Herning, Denmark. Long-term predictive power of heart rate variability on all-cause mortality in the diabetic population. *From the Abstract: "During the period following the first 5 years, the baseline LF continued to be a significant predictor of mortality. This long-term follow-up study indicates that the LF power is the strongest HRV predictor with regard to mortality. A reduced HRV at baseline still holds prognostic information after 5 years."*

[17] BMC Cardiovasc Disord. 2005 Nov 11;5:33. Greiser KH, Kluttig A, Schumann B, Kors J, Swenne CA, Kuss O, Werdan K, Haerting J., Institute of Medical Epidemiology, Biostatistics. Cardiovascular disease, risk factors and heart rate variability in the elderly general population: design and objectives of the cardiovascular disease, Living and Ageing in Halle (CARLA) Study. *From the Abstract: "Heart rate variability parameters offer prognostic information beyond that of traditional risk factors. In the elderly, increased HRV measured on a 10-second ECG is an even stronger indicator of cardiac death than decreased HRV."*

[18] J Clin Neuropsychol. 1982 Sep; 4(3):193-218. Broughton R. Human consciousness and sleep/waking rhythms: a review and some neuropsychological considerations. *From the Abstract: "The relevance of sleep/waking rhythms to issues of human consciousness is reviewed from data in the literature and from personal studies. Consciousness is often considered to be markedly attenuated or absent in sleep. There is, however, much evidence for a rich subjective experience during sleep, much of which is not recalled later. This implies that William James' "stream of consciousness" persists continuously throughout sleep as well as wakefulness, but that problems of memory recall interfere with its being reported as such. Sleeping subjects show selective awareness of external stimuli, with significant stimuli generally leading to awakening and relatively non-significant stimuli, at least at times, being incorporated into the on-going mental activity of REM or NREM sleep.*

Mentation throughout sleep is characterized by a high degree of autonomy and little willful control. Creative insight and problem solving of a very high order may occur in sleep and involve either dreaming or thought-like mentation. Parameters of waking consciousness show possibly sleep-related rhythmic fluctuations at both circadian (24 hr sleep/waking) and ultradian (90-120) min, NREM/REM sleep) rates. Moreover, waking consciousness is markedly influenced by the quality of temporal stability of preceding sleep. A substantial number of so-called "altered states of consciousness" is found to involve primarily or exclusively dysfunction of sleep/waking mechanisms. Cerebral lesions can produce selective impairment of aspects of sleep mentation. It is concluded that further analysis of subjective awareness in sleep or in partial sleep states is very relevant and indeed vital to a more comprehensive understanding of human consciousness."

[19] Psychosom Med. 2004 Jan-Feb;66(1):56-62. Hall M, Vasko R, Buysse D, Ombao H, Chen Q, Cashmere JD, Kupfer D, Thayer JF., University of Pittsburgh Department of Psychiatry, Pittsburgh, PA, USA. Acute Stress Affects Heart Rate Variability During Sleep. *From the Results: "Acute psychophysiological stress was associated with decreased levels of parasympathetic modulation during non-rapid eye movement (NREM) and rapid eye movement sleep and increased levels of sympatho-vagal balance during NREM sleep. Parasympathetic modulation increased across successive NREM cycles in the control group; these increases were blunted in the stress group and remained essentially unchanged across successive NREM periods. Higher levels of sympatho-vagal balance during NREM sleep were associated with poorer sleep maintenance and lower delta activity." From the Conclusion: "Changes in heart rate variability associated with acute stress may represent one pathway to disturbed sleep. Stress-related changes in heart rate variability during sleep may also be important in association with chronic stressors, which are associated with significant morbidity and increased risk for mortality."*

[20] Am Heart J. 2000 Oct; 140 (4 Suppl):77-83. Gorman JM, Sloan RP. Department of Psychiatry, College of Physicians and Surgeons, New York, NY, USA. Heart rate variability in depressive and anxiety disorders. *From the Abstract: "Individuals with high hostility scores and patients with anxiety or depressive disorders have low heart rate variability and may be at increased risk for cardiovascular death associated with coronary heart disease and arrhythmias. After myocardial infarction, depressed patients exhibit higher mortality rates compared with non-depressed patients. Men with "phobic anxiety," a construct that appears to overlap substantially with panic disorder, also have higher rates of sudden cardiac death and coronary artery disease than control populations. The reduction in autonomic nervous system control to the heart may be one link between psychopathology and heart disease. Although tricyclic antidepressants reduce heart rate variability, at least one study has suggested that, in patients with panic disorder, treatment with the selective serotonin reuptake inhibitor paroxetine normalizes heart rate variability. Hence there is potential for the treatment of psychiatric disorders to affect positively the development and course of cardiovascular disease."*

[21] Psychosom Med. 2009 Jun;71(5):508-18. Licht CM, de Geus EJ, van Dyck R, Penninx BW., Department of Psychiatry, EMGO Institute, VU University Medical Center, AJ Ernststraat 887, 1081 HL, Amsterdam, The Netherlands. Association between anxiety disorders and heart rate variability in The Netherlands Study of Depression and Anxiety (NESDA). *From the Abstract: "This study shows that anxiety disorders are associated with significantly lower HR variability, but the association seems to be driven by the effects of antidepressants."*

[22] Arch Gen Psychiatry. 2008;65(12):1358-1367. Carmilla M. M. Licht, MSc; Eco J. C. de Geus, PhD; Frans G. Zitman, MD, PhD; Witte J. G. Hoogendijk, MD, PhD; Richard van Dyck, MD, PhD; Brenda W. J. H. Penninx, PhD
Association Between Major Depressive Disorder and Heart Rate Variability in the Netherlands Study of Depression and Anxiety (NESDA) FREE. *From the Abstract: "This study shows that depression is associated with significantly lowered heart rate variability. However, this association appears to be mainly driven by the effect of antidepressants. Depression results in unfavorable health outcomes, such as cardiovascular morbidity and mortality. Alterations in the autonomic nervous system have been hypothesized to be an underlying physiological mechanism that may partly explain these unfavorable health outcomes among depressed persons. Such alterations are believed to reduce heart rate variability, a well-known prognostic risk factor for cardiovascular disease (e.g., myocardial infarct and arrhythmias), and mortality. In research on autonomic nervous system correlates of depression, most attention has been focused on low cardiac vagal control, which may impair social engagement and flexible adjustment to environmental demands and may be a major determinant of a reduction in heart rate variability. Cardiac vagal control can be assessed by examining heart rate variability, particularly that in the respiratory frequency range. This part of heart rate variability is also known as respiratory sinus arrhythmia (RSA).In a recent meta-analysis, Rottenberg examined the association between depression and RSA. The meta-analysis summarized 13 studies that reported on RSA measures, with a total of 312 depressed subjects and 374 controls.*

Depressed persons were found to have a significantly shorter RSA, though the summarized effect size was small to medium according to Cohen conventions (d = 0.332). As pointed out by Rottenberg, data collection and analysis differed considerably among the studies and only a few of them had the required sample size to address confounding by lifestyle (smoking, use of alcohol, high body mass index, and low physical activity) and comorbid anxiety. However, many of these factors—substance use, low physical activity, and comorbid anxiety—occur frequently in depression and have been associated with decreased cardiac vagal control.

Finally, antidepressants are a particularly relevant source of potential confounding when examining the association between depression and cardiac vagal control. The suppressive effects of tricyclic antidepressants (TCAs) on autonomic function are already well established. The effect of other antidepressants on autonomic function, however, are not as well studied and inconsistent results have been reported.
The present study reports cross-sectional analyses from a large depression cohort study (Netherlands Study of Depression and Anxiety [NESDA], N = 2981). We examined whether heart rate variability, as indexed by the standard deviation of normal-to-normal beats (SDNN), and cardiac vagal control, as indexed by RSA derived from peak-valley estimation, differed between depressed individuals and healthy controls. The study was sufficiently powered to examine the extent to which these associations are confounded by lifestyle, comorbid anxiety, and effect of antidepressants."

[23] International Journal for Psychophysiology 37 (2000) 121-133. Rod K. Dishman, Yoshio Nakamura, Melissa E. Garcia, Ray W. Thompson, Andrea L. Dunn, Steven N. Blair, Department of Exercise Science, Ramsey Center, The University of Georgia, 300 River Road, Athens, GA, USA. Division of Epidemiology and Clinical Applications, The Cooper Institute, 12330 Preston Road, Dallas, TX, USA. Heart rate variability, trait anxiety, and perceived stress among physically fit men and women. *From the Abstract: "There was an inverse relationship between perceived emotional stress during the past week and the normalized HF component of HRV (P=0.038). This indicates a lower cardiac vagal component of HRV among men and women who perceived more stress. That relationship was independent of age, gender, trait anxiety, and cardiorespiratory fitness. It was also independent of heart rate; mean arterial blood pressure; and respiration rate, factors which can influence HRV and might be elevated among people reporting anxiety and perceived stress. We conclude that vagal modulation of heart period appears to be sensitive to the recent experience of persistent emotional stress, regardless of a person's level of physical fitness and disposition toward experiencing anxiety."*

[24] International Journal of Psychophysiology 63 (2007) 39–47. Jos F. Brosschot, Eduard Van Dijk a, Julian F. Thayer
Division of Clinical and Health Psychology, Department of Psychology, Leiden University, Leiden, The Netherlands, Department of Psychology, The Ohio State University Columbus, OH, USA. Daily worry is related to low heart rate variability during waking and the subsequent nocturnal sleep period. *From the Abstract: "The finding of a link between worry and low waking and sleeping HRV extends previous findings with HRV (Brosschot et al., 2006). As mentioned, low HRV is a risk factor for CV disease and overall somatic morbidity and mortality, but it also has specific significance for psychopathology (Friedman and Thayer, 1998; Musselman et al., 1998; O'Connor et al., 2005; Thayer et al., 1998; Yeragani et al., 2002). Low HRV is an index of low parasympathetic activity, and as such also an index of disinhibition of sympathoexcitatory neural circuits that are normally under tonic inhibitory control via the prefrontal cortex.*

During worry and other states characterized by vigilance and arousal, priority is given to pre-potent cognitive and behavioral programs, and the prefrontal cortex is taken temporarily "offline." Parasympathetic inhibitory action is withdrawn (i.e. low HRV) and a relative sympathetic dominance associated with disinhibited defensive circuits is released. The result is a pattern of perseverations in cognitive, affective, and autonomic behavior that when sustained for long periods, can be pathogenic, somatically as well as psychologically. Psychopathological conditions such as anxiety, depression, post-traumatic stress disorder, and schizophrenia are all associated with prefrontal hypo-activity and a lack of inhibitory neural processes.

This is reflected in poor habituation to novel neutral stimuli, a pre-attentive bias for threat information, deficits in working memory and executive function, and poor affective information processing and regulation (Thayer and Friedman, 2004), all of which have been linked to low HRV (Thayer and Brosschot, 2005). Together, low HRV may be the final common pathway linking psychopathology with psychosomatics, including cardiovascular disease."

[25] Hansen, A., Johnsen, B., & Thayer, J. (2008). Relationship between heart rate variability and cognitive function during threat of shock. Anxiety, Stress & Coping, 9, 1-12. *From the Abstract:" The aim of the study was to investigate the relationship between resting heart rate variability (HRV) and cognitive functions during threat of shock. A Continuous Performance Task and a Working Memory Task were used to measure cognitive functions. Sixty-five male participants from the Royal Norwegian Navy participated. HRV was measured during baseline, test conditions and recovery. Participants were randomly assigned into non-threat and threat groups. Based on the median split of the high frequency (HF) spectral power, groups were divided into two additional groups. Overall, the high HRV participants showed superior performance on cognitive tasks independent of non-threat or threat conditions. During threat condition the low HRV group showed improved performance. Thus, individuals with high HRV were more stress tolerant and resilient in the face of environmental changes. The results from the study might have implications with regard to performance in operational settings, but also for other fields of psychological research such as individual differences, anxiety and coping."*

[26] Integrative Physiological and Behavioral Science; April–June 1997, Volume 33, Issue 2, pp 151-170. Rollin McCraty M.A., Bob Barrios-Choplin Ph.D., Deborah Rozman Ph.D., Mike Atkinson, Alan D. Watkins M.D. The impact of a new emotional self-management program on stress, emotions, heart rate variability, DHEA and cortisol. *From the Abstract: "This study examined the effects on healthy adults of a new emotional self-management program, consisting of two key techniques, "Cut-Thru" and the "Heart Lock-In." These techniques are designed to eliminate negative thought loops and promote sustained positive emotional states. The hypotheses were that training and practice in these techniques would yield lowered levels of stress and negative emotion and cortisol, while resulting in increased positive emotion and DHEA levels over a one-month period. In addition, we hypothesized that increased coherence in heart rate variability patterns would be observed during the practice of the techniques.*

Forty-five healthy adults participated in the study, fifteen of whom acted as a comparison group for the psychological measures. Salivary DHEA/DHEAS and cortisol levels were measured, autonomic nervous system function was assessed by heart rate variability analysis, and emotions were measured using a psychological questionnaire. Individuals in the experimental group were assessed before and four weeks after receiving training in the self-management techniques.

The experimental group experienced significant increases in the positive affect scales of Caring and Vigor and significant decreases in the negative affect scales of Guilt, Hostility, Burnout, Anxiety and Stress Effects, while no significant changes were seen in the comparison group. There was a mean 23 percent reduction in cortisol and a 100 percent increase in DHEA/DHEAS in the experimental group. DHEA was significantly and positively related to the affective state Warmheartedness, whereas cortisol was significantly and positively related to Stress Effects. Increased coherence in heart rate variability patterns was measured in 80 percent of the experimental group during the use of the techniques.

The results suggest that techniques designed to eliminate negative thought loops can have important positive effects on stress, emotions and key physiological systems. The implications are that relatively inexpensive interventions may dramatically and positively impact individuals' health and well-being. Thus, individuals may have greater control over their minds, bodies and health than previously suspected."

[27] Psychosomatic Medicine, 65, 796–805. Lehrer, P. M., Vaschillo, E., Vaschillo, B., Lu, S.-E., Eckberg, D. L., Edelberg, R., et al. (2003). Department of Psychiatry, Robert Wood Johnson Medical School, 671 Hoes Lane, Piscataway, NJ, USA. Heart rate variability biofeedback increases baroreflex gain and peak expiratory flow.
From the Abstract: "Heart rate variability biofeedback had strong long-term influences on resting baroreflex gain and pulmonary function. It should be examined as a method for treating cardiovascular and pulmonary diseases. Also, this study demonstrates neuroplasticity of the baroreflex."

[28] Journal of Electrocardiology, Volume 23, Supplement, 1990, Pages 85–94. Marie J. Cowan, RN, PhD, Helen Kogan, RN, PhD, FAAN, Robert Burr, MSEE, PhD, Sue Hendershot, RN, PhC, Lynne Buchanan, RN, PhD
School of Nursing, University of Washington, Seattle, Washington, USA. Power spectral analysis of heart rate variability after biofeedback training. *From the Abstract: "These data indicate that subjects who have had sudden cardiac arrest can, through biofeedback/self-management, cognitively increase their HRV over a 5-week period, consequently increasing parasympathetic activity."*

[29] Psychosom Med. 2003 Sep-Oct; 65 (5):796-805. Paul M. Lehrer, PhD, Evgeny Vaschillo, PhD, Bronya Vaschillo, MD, Shou-En Lu, PhD, Dwain L. Eckberg, MD, Robert Edelberg, PhD, Weichung Joe Shih, PhD, Yong Lin, PhD, Tom A. Kuusela, PhD, Kari U. O. Tahvanainen, MD and Robert M. Hamer, PhD, Department of Psychiatry Robert Wood Johnson Medical School, Piscataway, New Jersey, USA. Heart Rate Variability Biofeedback Increases Baroreflex Gain and Peak Expiratory Flow. *From*

the Abstract: "Heart rate variability biofeedback had strong long-term influences on resting baroreflex gain and pulmonary function. It should be examined as a method for treating cardiovascular and pulmonary diseases. Also, this study demonstrates neuroplasticity of the baroreflex."

[30] The American Journal of Cardiology, Volume 76, Issue 14, 15 November 1995, Pages 1089–1093. Rollin McCraty, MA[1], Mike Atkinson, William A. Tiller, PhD, Glen Rein, PhD, Alan D. Watkins, MBBS. From the Institute of HeartMath, Boulder Creek, California, USA. The effects of emotions on short-term power spectrum analysis of heart rate variability. *From the Abstract: "In summary, this work extends previous findings by demonstrating that anger produces a sympathetically dominated power spectrum, whereas appreciation produces a power spectral shift toward MF and HF activity. Results suggest that positive emotions lead to alterations in HRV, which may be beneficial in the treatment of hypertension and in reducing the likelihood of sudden death in patients with congestive heart failure and coronary artery disease."*

[31] Applied Psychophysiology and Biofeedback, September 2000, Volume 25, Issue 3, pp 177-191. Paul M. Lehrer, Evgeny Vaschillo, Bronya Vaschillo. Resonant Frequency Biofeedback Training to Increase Cardiac Variability: Rationale and Manual for Training. *From the Abstract: "Heart rate and blood pressure, as well as other physiological systems, among healthy people, show a complex pattern of variability, characterized by multi-frequency oscillations. There is evidence that these oscillations reflect the activity of homeostatic reflexes. Biofeedback training to increase the amplitude of respiratory sinus arrhythmia (RSA) maximally increases the amplitude of heart rate oscillations only at approximately 0.1 Hz. To perform this task, people slow their breathing to this rate to a point where resonance occurs between respiratory-induced oscillations (RSA) and oscillations that naturally occur at this rate, probably triggered in part by baroreflex activity. We hypothesize that this type of biofeedback exercises the baroreflexes, and renders them more efficient. A manual is presented for carrying out this method. Supporting data are provided in Lehrer, Smetankin, and Potapova (2000) in this issue."*

[32] Applied Psychophysiology and Biofeedback, June 2006, Volume 31, Issue 2, pp 129-142. Evgeny G. Vaschillo, Bronya Vaschillo, Paul M. Lehrer. Characteristics of Resonance in Heart Rate Variability Stimulated by Biofeedback. *From the Abstract: "As we previously reported, resonant frequency heart rate variability biofeedback increases baroreflex gain and peak expiratory flow in healthy individuals and has positive effects in treatment of asthma patients. Biofeedback readily produces large oscillations in heart rate, blood pressure, vascular tone, and pulse amplitude via paced breathing at the specific natural resonant frequency of the cardiovascular system for each individual. This paper describes how resonance properties of the cardiovascular system mediate the effects of heart rate variability biofeedback. There is evidence that resonant oscillations can train autonomic reflexes to provide therapeutic effect. The paper is based on studies described in previous papers. Here, we discuss the origin of the resonance phenomenon, describe our procedure for determining an individual's resonant frequency, and report data from 32 adult asthma patients and 24 healthy adult subjects, showing a negative relationship between resonant frequency and height, and a lower resonant frequency in men than women, but no relationship between resonant frequency and age, weight, or presence of asthma. Resonant frequency remains constant across 10 sessions of biofeedback training. It appears to be related to blood volume."*

[33] Applied Psychophysiology and Biofeedback; September 2010, Volume 35, Issue 3, pp 229-242. Amanda L. Wheat, Kevin T. Larkin. Biofeedback of Heart Rate Variability and Related Physiology: A Critical Review. *From the Abstract: "Low heart rate variability (HRV) characterizes several medical and psychological diseases. HRV biofeedback is a newly developed approach that may have some use for treating the array of disorders in which HRV is relatively low. This review critically appraises evidence for the effectiveness of HRV and related biofeedback across 14 studies in improving (1) HRV and baroreflex outcomes and (2) clinical outcomes. Results revealed that HRV biofeedback consistently effectuates acute improvements during biofeedback practice, whereas the presence of short-term and long-term carry-over effects is less clear. Some evidence suggests HRV biofeedback may result in long-term carry-over effects on baroreflex gain, which is an area most promising for future investigations. On the other hand, concerning clinical outcomes, there is ample evidence attesting to efficacy of HRV biofeedback. However, because clinical and physiological outcomes do not improve concurrently in all cases, the mechanism by which HRV biofeedback results in salutary effects in unclear. Considerations for the field in addressing shortcomings of the reviewed studies and advancing understanding of the way in which HRV biofeedback may improve physiological and clinical outcomes are offered in light of the reviewed evidence."*

[34] The American Journal of Cardiology, Volume 76, Issue 14, 15 November 1995, Pages 1089–1093. Rollin McCraty, MA[1], Mike Atkinson, William A. Tiller, PhD, Glen Rein, PhD, Alan D. Watkins, MBBS. From the Institute of HeartMath, Boulder Creek, California, USA. The effects of emotions on short-term power spectrum analysis of heart rate variability. *From the Abstract: "In summary, this work extends previous findings by demonstrating that anger produces a sympathetically dominated power spectrum, whereas appreciation produces a power spectral shift toward MF and HF activity. Results suggest that positive emotions lead to alterations in HRV, which may be beneficial in the treatment of hypertension and in reducing the likelihood of sudden death in patients with congestive heart failure and coronary artery disease."*

[35] Applied Psychophysiology and Biofeedback, June 2009, Volume 34, Issue 2, pp 135-143. Terri L. Zucker, Kristin W. Samuelson, Frederick Muench, Melanie A. Greenberg, Richard N. Gevirtz. The Effects of Respiratory Sinus Arrhythmia Biofeedback on Heart Rate Variability and Posttraumatic Stress Disorder Symptoms: A Pilot Study. *From the Abstract: "Recent studies have found a significant association between PTSD and low heart rate variability (HRV), a biomarker of autonomic dysregulation. Research indicates that respiratory sinus arrhythmia (RSA) biofeedback increases HRV while reducing related pathological symptoms. This controlled pilot study compared RSA biofeedback to progressive muscle relaxation (PMR) as adjunctive interventions for 38 persons with PTSD symptoms in a residential treatment facility for a substance use disorder. Both groups were assessed at pre-intervention and 4-week post-intervention. Group × time interactions revealed significantly greater reductions in depressive symptoms and increases in HRV indices for the RSA group. Both groups significantly reduced PTSD and insomnia symptoms and a statistical trend was observed for reduced substance craving for the RSA group. Increases in HRV were significantly associated with PTSD symptom reduction. Overall, these results provide preliminary support for the efficacy of RSA biofeedback in improving physiological and psychological health for individuals with PTSD."*

[36]Melvin L. Harper, PhD, private practice (A Center for Psychotherapy, LLC, Colorado Springs, Co. and Guadalajara, Mexico) Tasha Rasolkhani-Kalhorn, PsyD, Evans Army Community Hospital, Colorado Springs, Co., John F. Drozd, PhD, private practice (The NeuroAssessment Centre, LLC, Colorado Springs, CO.)
On the Neural Basis of EMDR Therapy: Insights from QEEG Studies
Presented at the EMDRI annual convention in Dallas (September, 2007) and the American Psychological Association annual meeting in Boston (August, 2008).
We present here evidence based primarily on qEEG studies that the
neural basis for the EMDR effect is depotentiation of fear memory synapses in the amygdala during an evoked brain state similar to that of slow wave sleep (SWS).
The evoked EEG response consists of ~1.5 Hz delta waves and 13.5 Hz beta spindles paced by the delta waves.
In our study, we found that BBS (bilateral brain stimulation) caused immediate slowing of the depolarization rate of neurons in the frontal lobes from the dominant waking state frequency of around 7 Hz to about 1.5 Hz.
The change to high power, low frequency waves of neuronal depolarizations is a change from conditions favorable for synaptic potentiation to one of depotentiation.
EEG records of EMDR sessions reported here show that low frequency brain stimulation invokes a large response from the memory areas of the brain; this response is at a frequency of about 1.5 Hz regardless of the input frequency over the range of 0.75 to 2.5 Hz.
The frequencies most often selected, as indicated by anecdotal evidence, range from 0.5 – 1.5 Hz. This falls within the range that has proven effective in depotentiation of synapses in laboratory investigations by Huerta and Lisman, 1996.

[37] Traumatology, Vol. 12, No. 1 (March, 2006). Tasha Rasolkhani-Kalhorn1 and Melvin L. Harper**.**
EMDR and Low Frequency Stimulation of the Brain
Bilateral brain stimulation (also referred to as dual attention stimulus) superimposed on this brain state may cause rapid attentional shifts from one brain hemisphere to the other (Stickgold, 2002). It seems likely that these shifts cause alternate activation and deactivation of neuronal networks throughout the brain.
Researchers have induced depotentiation by applying low frequency tetanic stimulation to previously potentiated synapses. The most effective stimulation frequency has been found to be in the range of 0.5 to 5 times per second (0.5 – 5 Hz) (Huerta & Lisman, 1996; Wagner & Alger; Xu, Hölscher, Anwyl, & Rowan, 1998).

[38] Biomedical Research 29 (5) 242-250, 2008. Shr-Da Wu, Pei-Chen Lo, Department of Electrical and Control Engineering, National Chiao Tung University. Inward-attention meditation increases parasympathetic activity: a study based on heart rate variability. *From the Abstract: "Phenomenon of the heart rate variability (HRV) during various meditation techniques has been reported. However, most of these techniques emphasized the skill of slow breathing (< 0.15 Hz). This paper reports our study on HRV during meditation, which emphasizes inward attention. Inward attention has been an important approach for the Zen-meditation practitioners to enter into transcendental consciousness. Two groups of subjects were investigated, 10 experimental subjects with Zen-meditation experience and 10 control subjects without any meditation experience. We analyzed HRV both in time and frequency domains. The results revealed both common and different effects on HRV between inward-attention meditation and normal rest. The major difference of effects between two groups were the decrease of LF/HF ratio and LF norm as well as the increase of HF norm, which suggested the benefit of a sympathovagal balance toward parasympathetic activity. Moreover, we observed regular oscillating rhythms of the heart rate when the LF/HF ratio was small under meditation. According to previous studies, regular oscillations of heart rate signal usually appeared in the low-frequency band of HRV under slow breathing. Our findings showed that such regular oscillations could also appear in the high-frequency band of HRV but with smaller amplitude."*

[39] International Journal of Cardiology, Volume 130, Issue 3, 28 Nov. 2008, Pages 481–484. Sukanya Phongsuphap, Yongyuth Pongsupap, Pakorn Chandanamattha, Chidchanok Lursinsap, Department of Computer Science, Faculty of Science, Mahidol University, Bangkok, Health Care Reform Project, National Health Security Office, Nonthaburi, Thailand, Department of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Department of Mathematics, Faculty of Science, Chulalongkorn University, Bangkok. Changes in heart rate variability during concentration meditation. *From the Abstract: "This study aims at investigating changes in heart rate variability (HRV) measured during meditation. The statistical and spectral measures of HRV from the RR intervals were analyzed. Results indicate that meditation may have different effects on health depending on frequency of the resonant peak that each meditator can achieve. The possible effects may concern resetting baroreflex sensitivity, increasing the parasympathetic tone, and improving efficiency of gas exchange in the lung."*

Peter Gruenewald
The Quiet Heart. Putting Stress in its Place. Floris Books, 2007.

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Various Authors: Binaural beat technology in humans: a pilot study to assess neuropsychologic, physiologic, and electroencephalographic effects. In: Journal of alternative and complementary medicine 13 (2), p.199-206, 2007.

Wahbeh, H., Calabrese, C., Zwickey, H.: Binaural beat technology in humans: a pilot study to assess psychologic and physiologic effects. In: Journal of alternative and complementary medicine 13 (1), p.25-32, 2007.

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Brady, B., Stevens, L.: Binaural-beat induced theta EEG activity and hypnotic susceptibility. In: The American journal of clinical hypnosis, 43 (1), p.53-69, 2000. Harris, B.: Thresholds of the mind. - USA: Centerpointe Research Institute, 2007.

Traumatology, Vol. 12, No. 1 (March, 2006) EMDR and Low Frequency Stimulation of the Brain. Tasha Rasolkhani-Kalhorn1 and Melvin L. Harper2.

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neuropsychologic, physiologic, and electroencephalographic effects. In: Journal of alternative and complementary medicine 13 (2), p.199-206, 2007.

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Various Authors: Use of binaural beat tapes for treatment of anxiety: a pilot study of tape preference and outcomes. In: Alternative therapies in health and medicine, 7 (1), p.58-63, 2001. Binaural beat induced theta EEG activity and hypnotic susceptibility: contradictory results and technical considerations. In: The American journal of clinical hypnosis, 45 (4), p.295-309, 2003. Brady, B., Stevens, L.: Binaural-beat induced theta EEG activity and hypnotic susceptibility. In: The American journal of clinical hypnosis, 43 (1), p.53-69, 2000. Harris, B.: Thresholds of the mind. - USA: Centerpointe Research Institute, 2007.

Biomedical Research 29 (5) 242-250, 2008. Shr-Da Wu, Pei-Chen Lo, Department of Electrical and Control Engineering, National Chiao Tung University. Inward-attention meditation increases parasympathetic activity: a study based on heart rate variability. From the Abstract: “Phenomenon of the heart rate variability (HRV) during various meditation techniques has been reported. However, most of these techniques emphasized the skill of slow breathing (< 0.15 Hz). This paper reports our study on HRV during meditation, which emphasizes inward attention. Inward attention has been an important approach for the Zen-meditation practitioners to enter into transcendental consciousness. Two groups of subjects were investigated, 10 experimental subjects with Zen-meditation experience and 10 control subjects without any meditation experience. We analyzed HRV both in time and frequency domains. The results revealed both common and different effects on HRV between inward-attention meditation and normal rest. The major difference of effects between two groups were the decrease of LF/HF ratio and LF norm as well as the increase of HF norm, which suggested the benefit of a sympathovagal balance toward parasympathetic activity. Moreover, we observed regular oscillating rhythms of the heart rate when the LF/HF ratio was small under meditation. According to previous studies, regular oscillations of heart rate signal usually appeared in the low-frequency band of HRV under slow breathing. Our findings showed that such regular oscillations could also appear in the high-frequency band of HRV but with smaller amplitude.”

International Journal of Cardiology, Volume 130, Issue 3, 28 Nov. 2008, Pages 481–484. Sukanya Phongsuphap, Yongyuth Pongsupap, Pakorn Chandanamattha, Chidchanok Lursinsap. Department of Computer Science, Faculty of Science, Mahidol University, Bangkok. Health Care Reform Project, National Health Security Office, Nonthaburi, Thailand. Department of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok
Department of Mathematics, Faculty of Science, Chulalongkorn University, Bangkok. Changes in heart rate variability during concentration meditation. From the Abstract: “This study aims at investigating changes in heart rate variability (HRV) measured during meditation. The statistical and spectral measures of HRV from the RR intervals were analyzed. Results indicate that meditation may have different effects on health depending on frequency of the resonant peak that each meditator can achieve. The possible effects may concern resetting baroreflex sensitivity, increasing the parasympathetic tone, and improving efficiency of gas exchange in the lung.”

Gian Mauro Manzoni, Francesco Pagnini, Gianluca Castelnuovo and Enrico Molinari. Relaxation training for anxiety: a ten-years systematic review with meta-analysis. BMC Psychiatry. 2008. 8:41. Conclusion: “The results show consistent and significant efficacy of relaxation training in reducing anxiety. This meta-analysis extends the existing literature through facilitation of a better understanding of the variability and clinical significance of anxiety improvement subsequent to relaxation training.”

Ruth Wells, Tim Outhred, James A. J. Heathers, Daniel S. Quintana, Andrew H. Kemp. Matter Over Mind: A Randomised-Controlled Trial of Single-Session Biofeedback Training on Performance Anxiety and Heart Rate Variability in Musicians. PLOS ONE 7(10): e46597. “These findings indicate that a single session of slow breathing, regardless of biofeedback, is sufficient for controlling physiological arousal in anticipation of psychosocial stress associated with music performance and that slow breathing is particularly helpful for musicians with high levels of anxiety. Future research is needed to further examine the effects of HRV BF as a low-cost, non-pharmacological treatment for music performance anxiety.”

Kevin Vaughan, Michael S. Armstrong, Ruth Gold, Nicholas O'Connor, William Jenneke, Nicholas Tarrier. A trial of eye movement desensitization compared to image habituation training and applied muscle relaxation in post-traumatic stress disorder. Journal of Behavior Therapy and Experimental Psychiatry, Volume 25, Issue 4, Pages 283-291.

Terri L. Zucker, Kristin W. Samuelson, Frederick Muench, Melanie A. Greenberg, Richard N. Gevirtz
The Effects of Respiratory Sinus Arrhythmia Biofeedback on Heart Rate Variability and Posttraumatic Stress Disorder Symptoms: A Pilot Study. ppl Psychophysiol Biofeedback (2009) 34: 135.

Reynolds, W. M., & Coats, K. I. (1986). A comparison of cognitive-behavioral therapy and relaxation training for the treatment of depression in adolescents. *Journal of Consulting and Clinical Psychology, 54*(5), 653-660.
The cognitive-behavioral and relaxation training groups were superior to the wait-list control group in the reduction of depressive symptoms at both posttest and 5-wk follow-up assessments. There was no significant difference between active treatments in their effectiveness for reducing depression. Ss in the cognitive-behavioral and relaxation training conditions

went from moderate levels of depression at pretest to nondepressed levels at posttest, and they maintained these levels at follow-up. Improvements in anxiety and academic self-concept were also demonstrated by the active treatments. Findings demonstrate that these short-term group-administered therapies are effective in significantly decreasing depression in adolescents.

George E. Murphy, Robert M. Carney, Mary Ann Knesevich, Richard D. Wetzel, Pamela Whitworth
Cognitive Behavior Therapy, Relaxation Training, and Tricyclic Antidepressant Medication in the Treatment of Depression. Psychological Reports. Volume: 77 issue: 2, page(s): 403-420 Issue published: October 1, 1995
"Outcomes of seven treatment trials comparing cognitive behavioral therapy to treatment with tricyclic antidepressant medication in major depressive disorder have been quite similar to one another. This led us to question whether treatment outcome in time-limited studies reflected a unique effect of cognitive behavioral therapy … For both cognitive behavioral therapy and relaxation training, outcome of depression was superior to that of tricyclic antidepressant medication by endpoint analysis."

P. Cuijpers, Ph.D., Professor of Clinical Psychology, Department of Clinical Psychology, VU University Amsterdam, Van der Boechorststraat 1, 1081 BT Amsterdam, The Netherlands. Is guided self-help as effective as face-to-face psychotherapy for depression and anxiety disorders? A systematic review and meta-analysis of comparative outcome studies. Psychological Medicine, Volume 40, Issue 12, December 2012, pp. 1943-1957
"It seems safe to conclude that guided self-help and face-to-face treatments can have comparable effects. It is time to start thinking about implementation in routine care."

Robert Freedman, James D. Papsdorf. Biofeedback and progressive relaxation treatment of sleep-onset insomnia. Biofeedback and Self-regulation (1976) 1: 253

Taylor, Shelley E.; Klein, Laura Cousino; Lewis, Brian P.; Gruenewald, Tara L.; Gurung, Regan A. R.; Updegraff, John A., Biobehavioral responses to stress in females: Tend-and-befriend, not fight-or-flight. *From the Abstract: "The human stress response has been characterized, both physiologically and behaviorally, as "fight-or-flight." Although fight-or-flight may characterize the primary physiological responses to stress for both males and females, we propose that, behaviorally, females' responses are more marked by a pattern of "tend-and-befriend." Tending involves nurturant activities designed to protect the self and offspring that promote safety and reduce distress; befriending is the creation and maintenance of social networks that may aid in this process. The biobehavioral mechanism that underlies the tend-and-befriend pattern appears to draw on the attachment-caregiving system, and neuroendocrine evidence from animal and human studies suggests that oxytocin, in conjunction with female reproductive hormones and endogenous opioid peptide mechanisms, may be at its core. This previously unexplored stress regulatory system has manifold implications for the study of stress."*

Studies by Fredrickson et al., 2003; Tugade et al., 2004; Ong et al., 2006; Bonanno et al., 2007

Soc Sci Med. 1997 Oct;45(8):1207-21. Folkman S. Positive psychological states and coping with severe stress.
Center for AIDS Prevention Studies, University of California at San Francisco, USA. *From the Abstract: "Providing care to a spouse or partner who is dying and then losing that person are among the most stressful of human experiences. A longitudinal study of the caregiving partners of men with AIDS showed that in addition to intense negative psychological states, these men also experienced positive psychological states throughout caregiving and bereavement. The co-occurrence of positive and negative psychological states in the midst of enduring and profoundly stressful circumstances has important implications for our understanding of the coping process. Coping theory had traditionally focused on the management of distress. This article describes coping processes that are associated with positive psychological states in the context of intense distress and discusses the theoretical implications of positive psychological states in the coping process."*

Am Psychol. 2000 Jun;55(6):647-54. Folkman S, Moskowitz JT. Center for AIDS Prevention Studies, University of California, San Francisco, USA. Positive affect and the other side of coping. *From the Abstract: "Although research on coping over the past 30 years has produced convergent evidence about the functions of coping and the factors that influence it, psychologists still have a great deal to learn about how coping mechanisms affect diverse outcomes. One of the reasons more progress has not been made is the almost exclusive focus on negative outcomes in the stress process. Coping theory and research need to consider positive outcomes as well. The authors focus on one such outcome, positive affect, and review findings about the co-occurrence of positive affect with negative affect during chronic stress, the adaptive functions of positive affect during chronic stress, and a special class of meaning-based coping processes that support positive affect during chronic stress."*

Rev Gen Psychol. 1998 Sep;2(3):300-319. Fredrickson BL. University of Michigan. What Good Are Positive Emotions? *From the Abstract: "This article opens by noting that positive emotions do not fit existing models of emotions. Consequently, a new model is advanced to describe the form and function of a subset of positive emotions, including joy, interest, contentment,* *and love. This new model posits that these positive emotions serve to broaden an individual's momentary thought-action repertoire, which in turn has the effect of building that individual's physical, intellectual, and social resources. Empirical evidence to support this broaden-and-build model of positive emotions is reviewed, and implications for emotion regulation and health promotion are discussed."*

J Am Geriatr Soc. 2000 May;48(5):473-8. Ostir GV, Markides KS, Black SA, Goodwin JS. Department of Preventive Medicine and Community Health, University of Texas Medical Branch, Galveston 77555-0460, USA.
Emotional well-being predicts subsequent functional independence and survival. From the Abstract: "Our results support the concept that positive affect, or emotional well-being, is different from the absence of depression or negative affect. Positive affect seems to protect individuals against physical declines in old age."

J Pers Soc Psychol. 2004 February; 86(2): 320–333. Michele M. Tugade and Barbara L. Fredrickson
Resilient Individuals Use Positive Emotions to Bounce Back From Negative Emotional Experiences. *From the Abstract: "The broaden-and-build theory (Fredrickson, 1998, 2001) predicts that positive emotions are useful in several ways. The present research expanded this theory into the realm of coping, suggesting that positive emotions guide present coping behavior. By examining psychological resilience from subjective, cognitive, and physiological angles, the present investigation provides greater insight into the reasons why resilient individuals are able to effectively cope with stressful experiences, whereas others facing similar conditions do not fare as well. Resilient individuals may recognize the benefits that positive emotions have on negative emotion regulation. As proposed by the broaden-and-build theory (Fredrickson, 1998, 2001) experiences of positive emotions during times of stress prompt individuals to pursue novel and creative thoughts and actions. Thus, through exploration and experimentation, in time they may be able to build an arsenal of effective coping resources that help buffer (psychologically and physiologically) against negative emotional life experiences."*

Journal of Happiness Studies; September 2007, Volume 8, Issue 3, pp 311-333. Michele M. Tugade, Barbara L. Fredrickson. Regulation of Positive Emotions: Emotion Regulation Strategies that Promote Resilience. *From the Abstract: "The regulation of emotions is essential in everyday life. In this paper, we discuss the regulation of positive emotional experiences. Our discussion focuses on strategies aimed at maintaining and increasing experiences of positive emotions. We discuss the importance of these strategies for well-being, and suggest that cultivating positive emotions may be particularly useful for building resilience to stressful events. Then, we explore possible mechanisms that link positive emotions to coping for resilient people, with a focus on the automatic activation of positive emotions while coping. We conclude by discussing alternative models and proposing future directions in the work on positive emotion regulation and resilience."*

J Pers. 2004 December; 72(6): 1161–1190. Michele M. Tugade, Barbara L. Fredrickson, and Lisa Feldman Barrett. Psychological Resilience and Positive Emotional Granularity: Examining the Benefits of Positive Emotions on Coping and Health. *From the Abstract: In conclusion, "positive emotions can be an important factor that buffers individuals against maladaptive health outcomes. Emerging research indicates that finding ways to cultivate meaningful positive emotions is a critical necessity for optimal physical and psychological functioning. Indeed, positive emotions are good for your health. With increasing research, we continue to substantiate empirically age-old folk theories about positive emotions and health that have persisted through time."*

Personality and Individual Differences; Volume 41, Issue 7, November 2006, Pages 1263–1273. Anthony D. Ong, Lisa M. Edwards, C.S. Bergeman, Department of Psychology, University of Notre Dame, Notre Dame, IN, United States, Department of Counseling and Educational Psychology, Marquette University, Milwaukee, WI, United States. Hope as a source of resilience in later adulthood. *From the Abstract: "This research provided a preliminary investigation of how variations in trait and state hope are associated with positive adaptation to stress in later adulthood. Trait hope and neuroticism were measured by questionnaires and state hope, stress, and negative emotions were assessed daily for 45 days. Results from multilevel random coefficient modeling analyses suggested that daily hope provides protective benefits by keeping negative emotions low, while also contributing to adaptive recovery from stress. The dynamic linkages between daily hope, stress, and emotion were further moderated by individual differences in trait hope. Compared with those low in trait hope, high-hope individuals showed diminished stress reactivity and more effective emotional recovery."*

European Heart Journal (1996) 17, 354-381. Guidelines, Heart rate variability Standards of measurement, physiological interpretation, and clinical use, Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology. *From the Abstract: "Heart rate variability has considerable potential to assess the role of autonomic nervous system fluctuations in normal healthy individuals and in patients with various cardiovascular and non-cardiovascular disorders. HRV studies should enhance our understanding of physiological phenomena, the actions of medications, and disease mechanisms. Large prospective longitudinal studies are needed to determine the sensitivity, specificity, and predictive value of HRV in the identification of individuals at risk for subsequent morbid and mortal events."*

Circulation 1993; 88: 180-5. Algra A, Tijssen JG, Roelandt JR, Pool J, Lubsen J., Department of Cardiology, Erasmus University, Rotterdam, The Netherlands. Heart rate variability from 24-hour electrocardiography and the 2-year risk for sudden death. *From the Abstract: "These findings support the theory that patients with low parasympathetic activity (low short-term RR interval variability) have an increased risk for sudden death independent of other risk factors."*

Circulation 1994; 90: 878-83. Tsuji H, Venditti FJ, Manders ES et al. Lahey Clinic Medical Center, Burlington, Mass. Reduced heart rate variability and mortality risk in an elderly cohort: The Framingham Study.
From the Abstract: "The estimation of heart rate variability by ambulatory monitoring offers prognostic information beyond that provided by the evaluation of traditional risk factors."

Am J Epidemiol; 145:899-908. Dekker JM, Schouten EG, Klootwijk P et al. 1997, Department of Epidemiology and Public Health, Agricultural University, Wageningen, Netherlands. Heart rate variability from short electrocardiographic recordings predicts mortality from all causes in middle aged and elderly men: the Zutphen study. *From the Abstract: "In conclusion, in middle-aged men and probably in elderly men, low heart rate variability is predictive of mortality from all causes. This suggests that low heart rate variability is an indicator of compromised health in the general population."*
Circulation. 1998 May 26;97(20):2031-6.

Heikki V. Huikuri, MD; Timo H. Mäkikallio, MD; K. E. Juhani Airaksinen, MD; Tapio Seppänen, PhD; Pauli Puukka, MA; Ismo J. Räihä, MD; Leif B. Sourander, MD, Division of Cardiology, Department of Medicine, University of Oulu, Finland. Power-Law Relationship of Heart Rate Variability as a Predictor of Mortality in the Elderly
From the Abstract: "Power-law relationship of 24-hour HR variability is a more powerful predictor of death than the traditional risk markers in elderly subjects. Altered long-term behavior of HR implies an increased risk of vascular causes of death rather than being a marker of any disease or frailty leading to death."

Acta Diabetol. 2011 Mar;48(1):55-9. Epub 2010 Sep 16. May O, Arildsen H., Department of Medicine, Region Hospital Herning, 7400 Herning, Denmark. Long-term predictive power of heart rate variability on all-cause mortality in the diabetic population. *From the Abstract: "During the period following the first 5 years, the baseline LF continued to be a significant predictor of mortality. This long-term follow-up study indicates that the LF power is the strongest HRV predictor with regard to mortality. A reduced HRV at baseline still holds prognostic information after 5 years."*

BMC Cardiovasc Disord. 2005 Nov 11;5:33. Greiser KH, Kluttig A, Schumann B, Kors J, Swenne CA, Kuss O, Werdan K, Haerting J., Institute of Medical Epidemiology, Biostatistics. Cardiovascular disease, risk factors and heart rate variability in the elderly general population: design and objectives of the cardiovascular disease, Living and Ageing in Halle (CARLA) Study. *From the Abstract: "Heart rate variability parameters offer prognostic information beyond that of traditional risk factors. In the elderly, increased HRV measured on a 10-second ECG is an even stronger indicator of cardiac death than decreased HRV."*

J Clin Neuropsychol. 1982 Sep; 4(3):193-218. Broughton R. Human consciousness and sleep/waking rhythms: a review and some neuropsychological considerations. *From the Abstract: "The relevance of sleep/waking rhythms to issues of human consciousness is reviewed from data in the literature and from personal studies. Consciousness is often considered to be markedly attenuated or absent in sleep. There is, however, much evidence for a rich subjective experience during sleep, much of which is not recalled later. This implies that William James' "stream of consciousness" persists continuously throughout sleep as well as wakefulness, but that problems of memory recall interfere with its being reported as such. Sleeping subjects show selective awareness of external stimuli, with significant stimuli generally leading to awakening and relatively non-significant stimuli, at least at times, being incorporated into the on-going mental activity of REM or NREM sleep.*

Mentation throughout sleep is characterized by a high degree of autonomy and little willful control. Creative insight and problem solving of a very high order may occur in sleep and involve either dreaming or thought-like mentation. Parameters of waking consciousness show possibly sleep-related rhythmic fluctuations at both circadian (24 hr sleep/waking) and ultradian (90-120) min, NREM/REM sleep) rates. Moreover, waking consciousness is markedly influenced by the quality of temporal stability of preceding sleep. A substantial number of so-called "altered states of consciousness" is found to involve primarily or exclusively dysfunction of sleep/waking mechanisms. Cerebral lesions can produce selective impairment of aspects of sleep mentation. It is concluded that further analysis of subjective awareness in sleep or in partial sleep states is very relevant and indeed vital to a more comprehensive understanding of human consciousness."

Psychosom Med. 2004 Jan-Feb;66(1):56-62. Hall M, Vasko R, Buysse D, Ombao H, Chen Q, Cashmere JD, Kupfer D, Thayer JF., University of Pittsburgh Department of Psychiatry, Pittsburgh, PA, USA. Acute Stress Affects Heart Rate Variability During Sleep. *From the Results: "Acute psychophysiological stress was associated with decreased levels of parasympathetic modulation during non-rapid eye movement (NREM) and rapid eye movement sleep and increased levels of sympatho-vagal balance during NREM sleep. Parasympathetic modulation increased across successive NREM cycles in the control group; these increases were blunted in the stress group and remained essentially unchanged across successive NREM periods. Higher levels* *of sympatho-vagal balance during NREM sleep were associated with poorer sleep maintenance and lower delta activity." From the Conclusion: "Changes in heart rate variability associated with acute stress may represent one pathway to disturbed sleep. Stress-related changes in heart rate variability during sleep may also be important in association with chronic stressors, which are associated with significant morbidity and increased risk for mortality."*

Am Heart J. 2000 Oct; 140 (4 Suppl):77-83. Gorman JM, Sloan RP. Department of Psychiatry, College of Physicians and Surgeons, New York, NY, USA. Heart rate variability in depressive and anxiety disorders. *From the Abstract: "Individuals with high hostility scores and patients with anxiety or depressive disorders have low heart rate variability and may be at increased risk for cardiovascular death associated with coronary heart disease and arrhythmias. After myocardial infarction, depressed patients exhibit higher mortality rates compared with non-depressed patients. Men with "phobic anxiety," a construct that appears to overlap substantially with panic disorder, also have higher rates of sudden cardiac death and coronary artery disease than control populations. The reduction in autonomic nervous system control to the heart may be one link between psychopathology and heart disease. Although tricyclic antidepressants reduce heart rate variability, at least one study has suggested that, in patients with panic disorder, treatment with the selective serotonin reuptake inhibitor paroxetine normalizes heart rate variability. Hence there is potential for the treatment of psychiatric disorders to affect positively the development and course of cardiovascular disease."*

Psychosom Med. 2009 Jun;71(5):508-18. Licht CM, de Geus EJ, van Dyck R, Penninx BW., Department of Psychiatry, EMGO Institute, VU University Medical Center, AJ Ernststraat 887, 1081 HL, Amsterdam, The Netherlands. Association between anxiety disorders and heart rate variability in The Netherlands Study of Depression and Anxiety (NESDA). *From the Abstract: "This study shows that anxiety disorders are associated with significantly lower HR variability, but the association seems to be driven by the effects of antidepressants."*

Arch Gen Psychiatry. 2008;65(12):1358-1367. Carmilla M. M. Licht, MSc; Eco J. C. de Geus, PhD; Frans G. Zitman, MD, PhD; Witte J. G. Hoogendijk, MD, PhD; Richard van Dyck, MD, PhD; Brenda W. J. H. Penninx, PhD
Association Between Major Depressive Disorder and Heart Rate Variability in the Netherlands Study of Depression and Anxiety (NESDA) FREE. *From the Abstract: "This study shows that depression is associated with significantly lowered heart rate variability. However, this association appears to be mainly driven by the effect of antidepressants. Depression results in unfavorable health outcomes, such as cardiovascular morbidity and mortality. Alterations in the autonomic nervous system have been hypothesized to be an underlying physiological mechanism that may partly explain these unfavorable health outcomes among depressed persons. Such alterations are believed to reduce heart rate variability, a well-known prognostic risk factor for cardiovascular disease (e.g., myocardial infarct and arrhythmias), and mortality. In research on autonomic nervous system correlates of depression, most attention has been focused on low cardiac vagal control, which may impair social engagement and flexible adjustment to environmental demands and may be a major determinant of a reduction in heart rate variability. Cardiac vagal control can be assessed by examining heart rate variability, particularly that in the respiratory frequency range. This part of heart rate variability is also known as respiratory sinus arrhythmia (RSA).In a recent meta-analysis, Rottenberg examined the association between depression and RSA. The meta-analysis summarized 13 studies that reported on RSA measures, with a total of 312 depressed subjects and 374 controls.*

Depressed persons were found to have a significantly shorter RSA, though the summarized effect size was small to medium according to Cohen conventions (d = 0.332). As pointed out by Rottenberg, data collection and analysis differed considerably among the studies and only a few of them had the required sample size to address confounding by lifestyle (smoking, use of alcohol, high body mass index, and low physical activity) and comorbid anxiety. However, many of these factors—substance use, low physical activity, and comorbid anxiety—occur frequently in depression and have been associated with decreased cardiac vagal control.

Finally, antidepressants are a particularly relevant source of potential confounding when examining the association between depression and cardiac vagal control. The suppressive effects of tricyclic antidepressants (TCAs) on autonomic function are already well established. The effect of other antidepressants on autonomic function, however, are not as well studied and inconsistent results have been reported.

The present study reports cross-sectional analyses from a large depression cohort study (Netherlands Study of Depression and Anxiety [NESDA], N = 2981). We examined whether heart rate variability, as indexed by the standard deviation of normal-to-normal beats (SDNN), and cardiac vagal control, as indexed by RSA derived from peak-valley estimation, differed between depressed individuals and healthy controls. The study was sufficiently powered to examine the extent to which these associations are confounded by lifestyle, comorbid anxiety, and effect of antidepressants."

International Journal for Psychophysiology 37 (2000) 121-133. Rod K. Dishman, Yoshio Nakamura, Melissa E. Garcia, Ray W. Thompson, Andrea L. Dunn, Steven N. Blair, Department of Exercise Science, Ramsey Center, The University of Georgia, 300 River Road, Athens, GA, USA. Division of Epidemiology and Clinical Applications, The Cooper Institute, 12330 Preston Road, Dallas, TX, USA. Heart rate variability, trait anxiety, and perceived stress among physically fit men and women. *From the Abstract: "There was an inverse relationship between perceived emotional stress during the past week and the normalized*

HF component of HRV (P=0.038). This indicates a lower cardiac vagal component of HRV among men and women who perceived more stress. That relationship was independent of age, gender, trait anxiety, and cardiorespiratory fitness. It was also independent of heart rate; mean arterial blood pressure; and respiration rate, factors which can influence HRV and might be elevated among people reporting anxiety and perceived stress. We conclude that vagal modulation of heart period appears to be sensitive to the recent experience of persistent emotional stress, regardless of a person's level of physical fitness and disposition toward experiencing anxiety."

International Journal of Psychophysiology 63 (2007) 39–47. Jos F. Brosschot, Eduard Van Dijk a, Julian F. Thayer Division of Clinical and Health Psychology, Department of Psychology, Leiden University, Leiden, The Netherlands, Department of Psychology, The Ohio State University Columbus, OH, USA. Daily worry is related to low heart rate variability during waking and the subsequent nocturnal sleep period. *From the Abstract: "The finding of a link between worry and low waking and sleeping HRV extends previous findings with HRV (Brosschot et al., 2006). As mentioned, low HRV is a risk factor for CV disease and overall somatic morbidity and mortality, but it also has specific significance for psychopathology (Friedman and Thayer, 1998; Musselman et al., 1998; O'Connor et al., 2005; Thayer et al., 1998; Yeragani et al., 2002). Low HRV is an index of low parasympathetic activity, and as such also an index of disinhibition of sympathoexcitatory neural circuits that are normally under tonic inhibitory control via the prefrontal cortex.*

During worry and other states characterized by vigilance and arousal, priority is given to pre-potent cognitive and behavioral programs, and the prefrontal cortex is taken temporarily "offline." Parasympathetic inhibitory action is withdrawn (i.e. low HRV) and a relative sympathetic dominance associated with disinhibited defensive circuits is released. The result is a pattern of perseverations in cognitive, affective, and autonomic behavior that when sustained for long periods, can be pathogenic, somatically as well as psychologically. Psychopathological conditions such as anxiety, depression, post-traumatic stress disorder, and schizophrenia are all associated with prefrontal hypo-activity and a lack of inhibitory neural processes. This is reflected in poor habituation to novel neutral stimuli, a pre-attentive bias for threat information, deficits in working memory and executive function, and poor affective information processing and regulation (Thayer and Friedman, 2004), all of which have been linked to low HRV (Thayer and Brosschot, 2005). Together, low HRV may be the final common pathway linking psychopathology with psychosomatics, including cardiovascular disease."

Hansen, A., Johnsen, B., & Thayer, J. (2008). Relationship between heart rate variability and cognitive function during threat of shock. Anxiety, Stress & Coping, 9, 1-12. *From the Abstract:" The aim of the study was to investigate the relationship between resting heart rate variability (HRV) and cognitive functions during threat of shock. A Continuous Performance Task and a Working Memory Task were used to measure cognitive functions. Sixty-five male participants from the Royal Norwegian Navy participated. HRV was measured during baseline, test conditions and recovery. Participants were randomly assigned into non-threat and threat groups. Based on the median split of the high frequency (HF) spectral power, groups were divided into two additional groups. Overall, the high HRV participants showed superior performance on cognitive tasks independent of non-threat or threat conditions. During threat condition the low HRV group showed improved performance. Thus, individuals with high HRV were more stress tolerant and resilient in the face of environmental changes. The results from the study might have implications with regard to performance in operational settings, but also for other fields of psychological research such as individual differences, anxiety and coping."*

Integrative Physiological and Behavioral Science; April–June 1997, Volume 33, Issue 2, pp 151-170. Rollin McCraty M.A., Bob Barrios-Choplin Ph.D., Deborah Rozman Ph.D., Mike Atkinson, Alan D. Watkins M.D. The impact of a new emotional self-management program on stress, emotions, heart rate variability, DHEA and cortisol. *From the Abstract: "This study examined the effects on healthy adults of a new emotional self-management program, consisting of two key techniques, "Cut-Thru" and the "Heart Lock-In." These techniques are designed to eliminate negative thought loops and promote sustained positive emotional states. The hypotheses were that training and practice in these techniques would yield lowered levels of stress and negative emotion and cortisol, while resulting in increased positive emotion and DHEA levels over a one-month period. In addition, we hypothesized that increased coherence in heart rate variability patterns would be observed during the practice of the techniques.*

Forty-five healthy adults participated in the study, fifteen of whom acted as a comparison group for the psychological measures. Salivary DHEA/DHEAS and cortisol levels were measured, autonomic nervous system function was assessed by heart rate variability analysis, and emotions were measured using a psychological questionnaire. Individuals in the experimental group were assessed before and four weeks after receiving training in the self-management techniques.

The experimental group experienced significant increases in the positive affect scales of Caring and Vigor and significant decreases in the negative affect scales of Guilt, Hostility, Burnout, Anxiety and Stress Effects, while no significant changes were seen in the comparison group. There was a mean 23 percent reduction in cortisol and a 100 percent increase in DHEA/DHEAS in the experimental group. DHEA was significantly and positively related to the affective state Warmheartedness, whereas cortisol was significantly and positively related to Stress Effects. Increased coherence in heart rate variability patterns was measured in 80 percent of the experimental group during the use of the techniques.

The results suggest that techniques designed to eliminate negative thought loops can have important positive effects on stress, emotions and key physiological systems. The implications are that relatively inexpensive interventions may dramatically and positively impact individuals' health and well-being. Thus, individuals may have greater control over their minds, bodies and health than previously suspected."

Psychosomatic Medicine, 65, 796–805. Lehrer, P. M., Vaschillo, E., Vaschillo, B., Lu, S.-E., Eckberg, D. L., Edelberg, R., et al. (2003). Department of Psychiatry, Robert Wood Johnson Medical School, 671 Hoes Lane, Piscataway, NJ, USA. Heart rate variability biofeedback increases baroreflex gain and peak expiratory flow.
From the Abstract: "Heart rate variability biofeedback had strong long-term influences on resting baroreflex gain and pulmonary function. It should be examined as a method for treating cardiovascular and pulmonary diseases. Also, this study demonstrates neuroplasticity of the baroreflex."

Journal of Electrocardiology, Volume 23, Supplement, 1990, Pages 85–94. Marie J. Cowan, RN, PhD, Helen Kogan, RN, PhD, FAAN, Robert Burr, MSEE, PhD, Sue Hendershot, RN, PhC, Lynne Buchanan, RN, PhD
School of Nursing, University of Washington, Seattle, Washington, USA. Power spectral analysis of heart rate variability after biofeedback training. *From the Abstract: "These data indicate that subjects who have had sudden cardiac arrest can, through biofeedback/self-management, cognitively increase their HRV over a 5-week period, consequently increasing parasympathetic activity."*

Psychosom Med. 2003 Sep-Oct; 65 (5):796-805. Paul M. Lehrer, PhD, Evgeny Vaschillo, PhD, Bronya Vaschillo, MD, Shou-En Lu, PhD, Dwain L. Eckberg, MD, Robert Edelberg, PhD, Weichung Joe Shih, PhD, Yong Lin, PhD, Tom A. Kuusela, PhD, Kari U. O. Tahvanainen, MD and Robert M. Hamer, PhD, Department of Psychiatry Robert Wood Johnson Medical School, Piscataway, New Jersey, USA. Heart Rate Variability Biofeedback Increases Baroreflex Gain and Peak Expiratory Flow. *From the Abstract: "Heart rate variability biofeedback had strong long-term influences on resting baroreflex gain and pulmonary function. It should be examined as a method for treating cardiovascular and pulmonary diseases. Also, this study demonstrates neuroplasticity of the baroreflex."*

The American Journal of Cardiology, Volume 76, Issue 14, 15 November 1995, Pages 1089–1093. Rollin McCraty, MA[1], Mike Atkinson, William A. Tiller, PhD, Glen Rein, PhD, Alan D. Watkins, MBBS. From the Institute of HeartMath, Boulder Creek, California, USA. The effects of emotions on short-term power spectrum analysis of heart rate variability. *From the Abstract: "In summary, this work extends previous findings by demonstrating that anger produces a sympathetically dominated power spectrum, whereas appreciation produces a power spectral shift toward MF and HF activity. Results suggest that positive emotions lead to alterations in HRV, which may be beneficial in the treatment of hypertension and in reducing the likelihood of sudden death in patients with congestive heart failure and coronary artery disease."*

Applied Psychophysiology and Biofeedback, September 2000, Volume 25, Issue 3, pp 177-191. Paul M. Lehrer, Evgeny Vaschillo, Bronya Vaschillo. Resonant Frequency Biofeedback Training to Increase Cardiac Variability: Rationale and Manual for Training. *From the Abstract: "Heart rate and blood pressure, as well as other physiological systems, among healthy people, show a complex pattern of variability, characterized by multi-frequency oscillations. There is evidence that these oscillations reflect the activity of homeostatic reflexes. Biofeedback training to increase the amplitude of respiratory sinus arrhythmia (RSA) maximally increases the amplitude of heart rate oscillations only at approximately 0.1 Hz. To perform this task, people slow their breathing to this rate to a point where resonance occurs between respiratory-induced oscillations (RSA) and oscillations that naturally occur at this rate, probably triggered in part by baroreflex activity. We hypothesize that this type of biofeedback exercises the baroreflexes, and renders them more efficient. A manual is presented for carrying out this method. Supporting data are provided in Lehrer, Smetankin, and Potapova (2000) in this issue."*

Applied Psychophysiology and Biofeedback, June 2006, Volume 31, Issue 2, pp 129-142. Evgeny G. Vaschillo, Bronya Vaschillo, Paul M. Lehrer. Characteristics of Resonance in Heart Rate Variability Stimulated by Biofeedback. *From the Abstract: "As we previously reported, resonant frequency heart rate variability biofeedback increases baroreflex gain and peak expiratory flow in healthy individuals and has positive effects in treatment of asthma patients. Biofeedback readily produces large oscillations in heart rate, blood pressure, vascular tone, and pulse amplitude via paced breathing at the specific natural resonant frequency of the cardiovascular system for each individual. This paper describes how resonance properties of the cardiovascular system mediate the effects of heart rate variability biofeedback. There is evidence that resonant oscillations can train autonomic reflexes to provide therapeutic effect. The paper is based on studies described in previous papers. Here, we discuss the origin of the resonance phenomenon, describe our procedure for determining an individual's resonant frequency, and report data from 32 adult asthma patients and 24 healthy adult subjects, showing a negative relationship between resonant frequency and height, and a lower resonant frequency in men than women, but no relationship between resonant frequency and age, weight, or presence of asthma. Resonant frequency remains constant across 10 sessions of biofeedback training. It appears to be related to blood volume."*

Applied Psychophysiology and Biofeedback; September 2010, Volume 35, Issue 3, pp 229-242. Amanda L. Wheat, Kevin T. Larkin. Biofeedback of Heart Rate Variability and Related Physiology: A Critical Review. *From the Abstract: "Low heart rate variability (HRV) characterizes several medical and psychological diseases. HRV biofeedback is a newly developed approach that may have some use for treating the array of disorders in which HRV is relatively low. This review critically appraises evidence for the effectiveness of HRV and related biofeedback across 14 studies in improving (1) HRV and baroreflex outcomes and (2) clinical outcomes. Results revealed that HRV biofeedback consistently effectuates acute improvements during biofeedback practice, whereas the presence of short-term and long-term carry-over effects is less clear. Some evidence suggests HRV biofeedback may result in long-term carry-over effects on baroreflex gain, which is an area most promising for future investigations. On the other hand, concerning clinical outcomes, there is ample evidence attesting to efficacy of HRV biofeedback. However, because clinical and physiological outcomes do not improve concurrently in all cases, the mechanism by which HRV biofeedback results in salutary effects in unclear. Considerations for the field in addressing shortcomings of the reviewed studies and advancing understanding of the way in which HRV biofeedback may improve physiological and clinical outcomes are offered in light of the reviewed evidence."*

The American Journal of Cardiology, Volume 76, Issue 14, 15 November 1995, Pages 1089–1093. Rollin McCraty, MA[1], Mike Atkinson, William A. Tiller, PhD, Glen Rein, PhD, Alan D. Watkins, MBBS. From the Institute of HeartMath, Boulder Creek, California, USA. The effects of emotions on short-term power spectrum analysis of heart rate variability. *From the Abstract: "In summary, this work extends previous findings by demonstrating that anger produces a sympathetically dominated power spectrum, whereas appreciation produces a power spectral shift toward MF and HF activity. Results suggest that positive emotions lead to alterations in HRV, which may be beneficial in the treatment of hypertension and in reducing the likelihood of sudden death in patients with congestive heart failure and coronary artery disease."*

Applied Psychophysiology and Biofeedback, June 2009, Volume 34, Issue 2, pp 135-143. Terri L. Zucker, Kristin W. Samuelson, Frederick Muench, Melanie A. Greenberg, Richard N. Gevirtz. The Effects of Respiratory Sinus Arrhythmia Biofeedback on Heart Rate Variability and Posttraumatic Stress Disorder Symptoms: A Pilot Study. *From the Abstract: "Recent studies have found a significant association between PTSD and low heart rate variability (HRV), a biomarker of autonomic dysregulation. Research indicates that respiratory sinus arrhythmia (RSA) biofeedback increases HRV while reducing related pathological symptoms. This controlled pilot study compared RSA biofeedback to progressive muscle relaxation (PMR) as adjunctive interventions for 38 persons with PTSD symptoms in a residential treatment facility for a substance use disorder. Both groups were assessed at pre-intervention and 4-week post-intervention. Group × time interactions revealed significantly greater reductions in depressive symptoms and increases in HRV indices for the RSA group. Both groups significantly reduced PTSD and insomnia symptoms and a statistical trend was observed for reduced substance craving for the RSA group. Increases in HRV were significantly associated with PTSD symptom reduction. Overall, these results provide preliminary support for the efficacy of RSA biofeedback in improving physiological and psychological health for individuals with PTSD."*

Biomedical Research 29 (5) 242-250, 2008. Shr-Da Wu, Pei-Chen Lo, Department of Electrical and Control Engineering, National Chiao Tung University. Inward-attention meditation increases parasympathetic activity: a study based on heart rate variability. *From the Abstract: "Phenomenon of the heart rate variability (HRV) during various meditation techniques has been reported. However, most of these techniques emphasized the skill of slow breathing (< 0.15 Hz). This paper reports our study on HRV during meditation, which emphasizes inward attention. Inward attention has been an important approach for the Zen-meditation practitioners to enter into transcendental consciousness. Two groups of subjects were investigated, 10 experimental subjects with Zen-meditation experience and 10 control subjects without any meditation experience. We analyzed HRV both in time and frequency domains. The results revealed both common and different effects on HRV between inward-attention meditation and normal rest. The major difference of effects between two groups were the decrease of LF/HF ratio and LF norm as well as the increase of HF norm, which suggested the benefit of a sympathovagal balance toward parasympathetic activity. Moreover, we observed regular oscillating rhythms of the heart rate when the LF/HF ratio was small under meditation. According to previous studies, regular oscillations of heart rate signal usually appeared in the low-frequency band of HRV under slow breathing. Our findings showed that such regular oscillations could also appear in the high-frequency band of HRV but with smaller amplitude."*

International Journal of Cardiology, Volume 130, Issue 3, 28 Nov. 2008, Pages 481–484. Sukanya Phongsuphap, Yongyuth Pongsupap, Pakorn Chandanamattha, Chidchanok Lursinsap, Department of Computer Science, Faculty of Science, Mahidol University, Bangkok, Health Care Reform Project, National Health Security Office, Nonthaburi, Thailand, Department of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Department of Mathematics, Faculty of Science, Chulalongkorn University, Bangkok. Changes in heart rate variability during concentration meditation. *From the Abstract: "This study aims at investigating changes in heart rate variability (HRV) measured during meditation. The statistical and spectral measures of HRV from the RR intervals were analyzed. Results indicate that meditation may have different effects* *on health depending on frequency of the resonant peak that each meditator can achieve. The possible effects may concern resetting baroreflex sensitivity, increasing the parasympathetic tone, and improving efficiency of gas exchange in the lung."*

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Task Force. Heart rate variability: Standards of measurement, physiological interpretation and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Circulation 1996; 93:1043–1065.

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Hekmat, H. Groth, S. & Rogers, D. (1994) Pain ameliorating effects of eye movement desensitization. Journal of Behavior Therapy and Experimental Psychiatry, 25, 121-130.

Mazzola, Alexandra, Calcagno, Marea, Lujon, Goicochea, et al., (2009) EMDR in the treatment of Chronic Pain. (2009). Journal of EMDR Practice and Research. N= 30; 3 conditions: EMDR, EMDR with music and no-treatment group. Pain tolerance was significantly improved for the two eye-movement groups. Harvard Hypnotic Sueptibility Scale (Hypnotizability = not relevant)

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Silver, Steve, Rogers, S, Russell, M. (2008) Eye Movement Desensitization & Reprocessing in the treatment of war veterans. J. Clin. Psychology Aug. 64(8):947-57. N = 2 (combat veterans); Reduced anxiety, depression, anger and physical pain

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Electroencephalography Coherence, Memory Vividness, and Emotional Valence Effects of Bilateral Eye Movements During Unpleasant Memory Recall and Subsequent Free Association: Implications for Eye Movement Desensitization and Reprocessing

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