



Heart Rate Variability, Mindfulness, and Compassion

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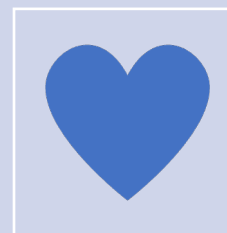




Mindfulness

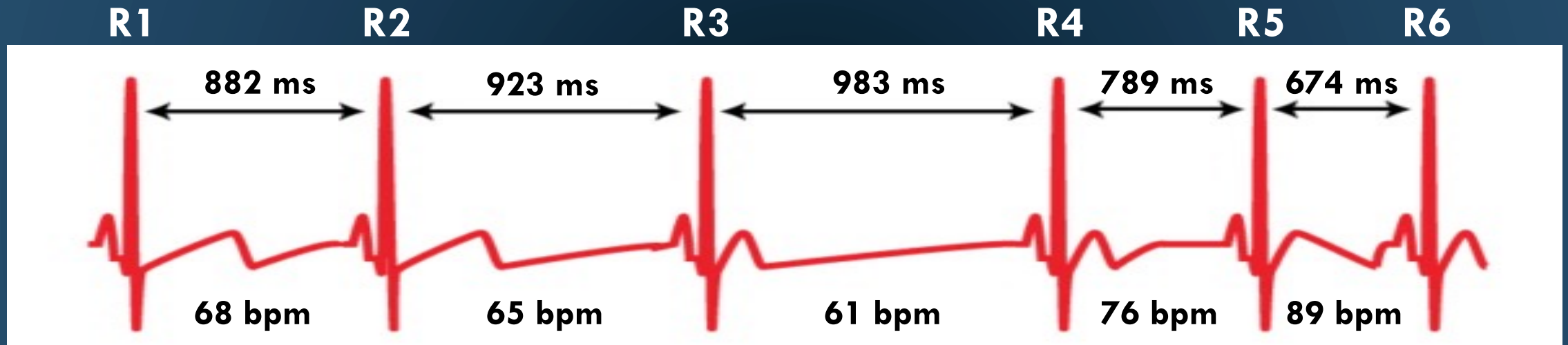


HRV



Compassion

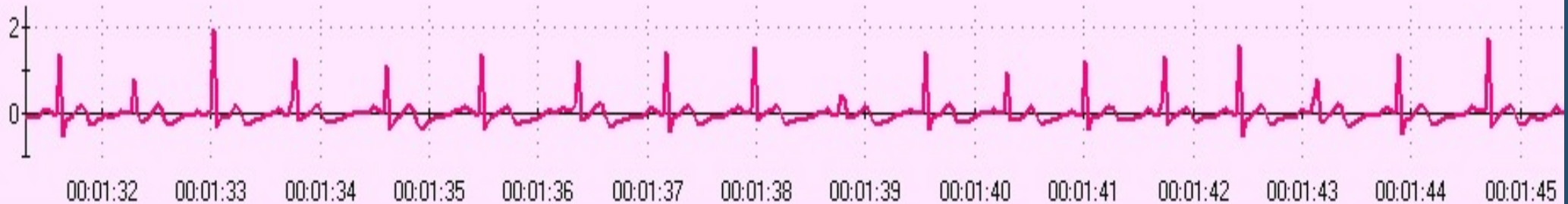
Heart Rate Variability (HRV)



The time between individual heart beats varies all the time

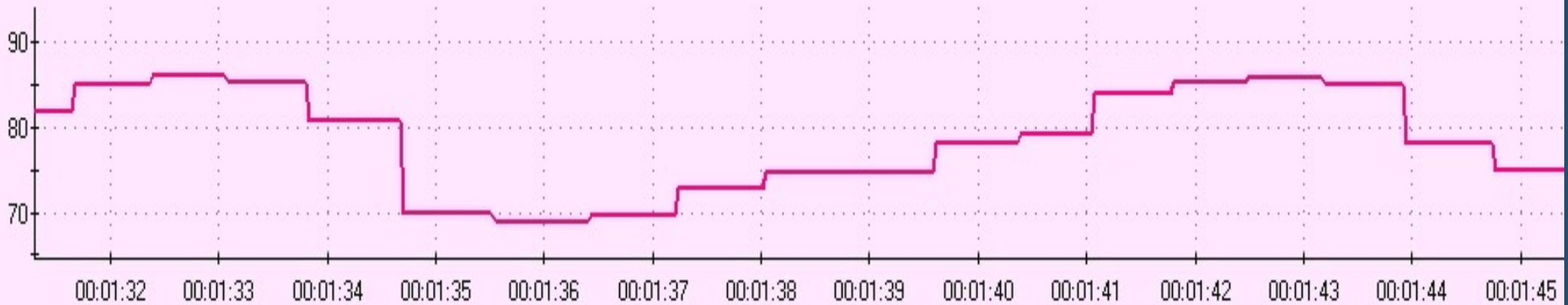
Heart Rate and Heart rate Variability

Raw EKG



Heart Rate

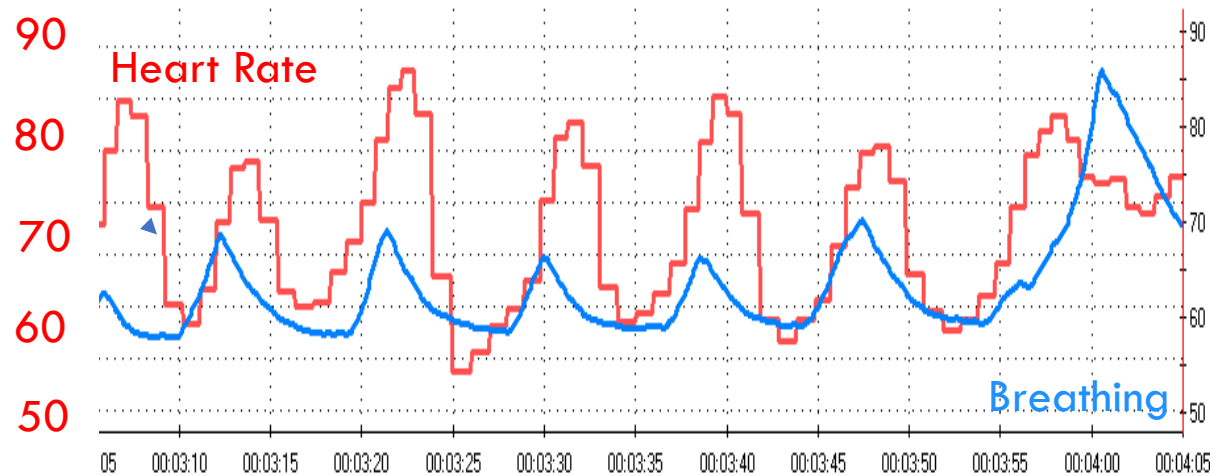
88.72





High HRV

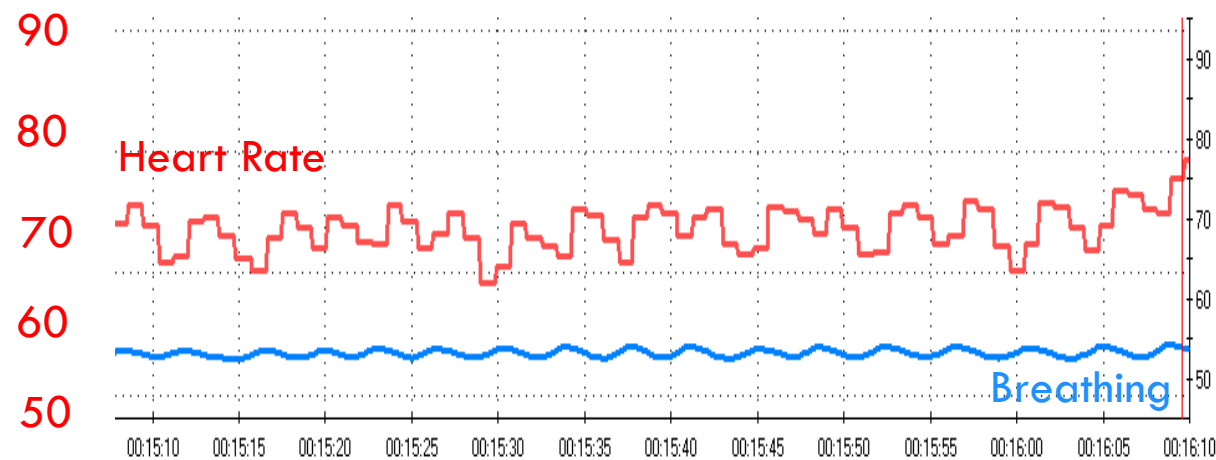
Heart Rate Variability ~20bpm



Average Heart Rate: 70.79bpm

Low HRV

Heart Rate Variability ~5bpm

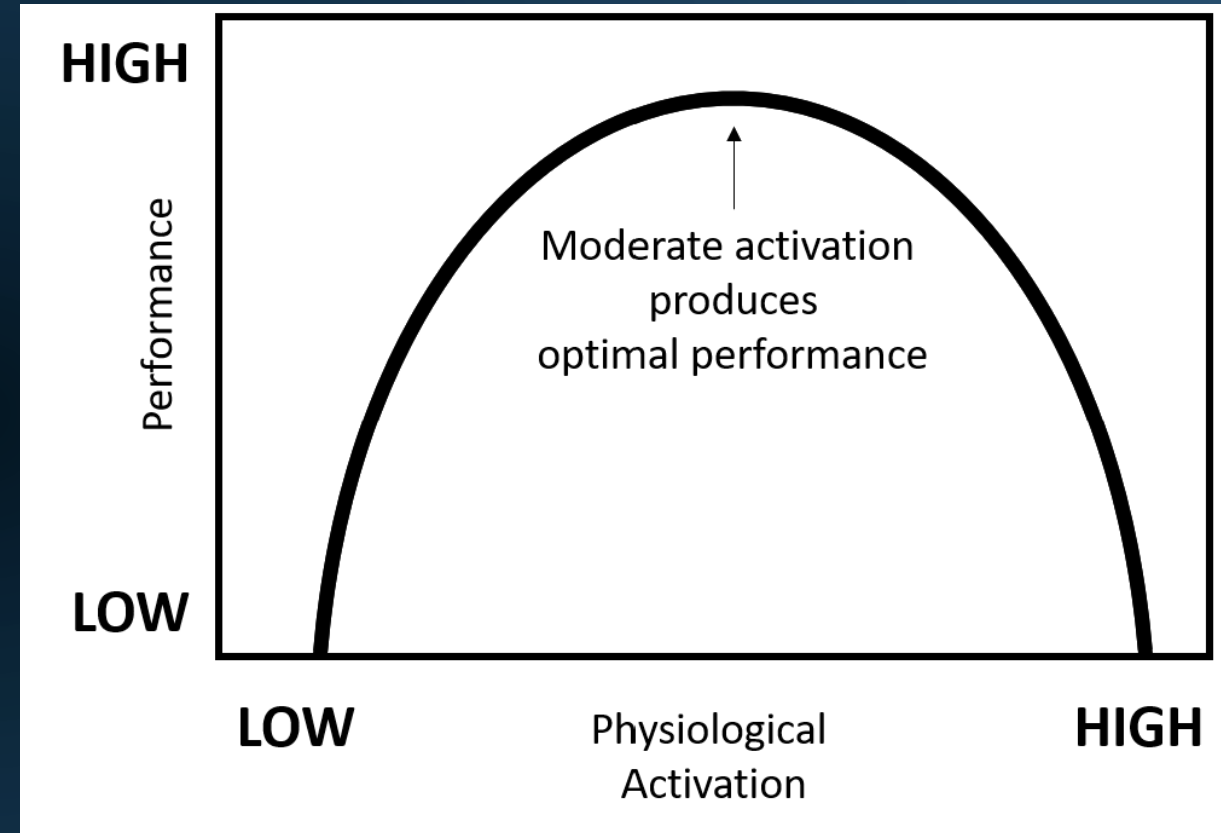


Average Heart Rate: 70.06bpm




Function of HRV


- Reflects ability of autonomic nervous system to regulate itself
- Strengthens ability of the parasympathetic nervous system to put on the brakes to sympathetic activation as needed
- Enables optimal physiological arousal



Yerkes-Dodson curve

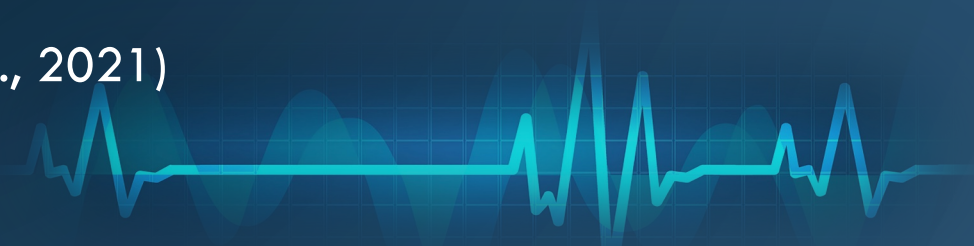


Empirical basis for the Importance of HRV

- **Cardiovascular health**
 - Better predictor of long-term cardiovascular health than blood pressure, cholesterol levels, and resting heart rate (Framingham Heart study; Tsuji et al, 1996)
 - **Resilience** (e.g., An et al, 2020; Perna et al, 2020; Minassian et al., 2015)
 - **Stress** (e.g., Herbell & Zauszniewski, 2019; Kenned & Parker, 2019; Kim et al., 2018)
 - **Optimal performance** (Forte et al., 2019; Lehrer, et al., 2020; Pagaduan et al., 2020; 2021; Tinello et al., 2021)
 - athletic
 - cognitive
 - **Psychophysiological health** (e.g., Fournié et al., 2021, Lehrer et al., 2020)
- 



HRV and Psychophysiological Health

- Anxiety (e.g., Cheng et al., 2022; Goessl et al., 2017; Lehrer et al., 2020)
 - Chronic pain (Tracy et al., 2016; Reneau, 2020)
 - Depression (Koch et al., 2019; Pizzoli et al., 2021)
 - Diabetes Mellitus (Benichou, et al., 2018)
 - Hypertension (Singh et al., 1998, Framingham heart study; Vital et al., 2021)
 - Irritable bowel syndrome (IBS) and other functional GI disorders (e.g., Mazurak et al., 2012; Shah et al., 2020; Stern et al., 2014)
 - PTSD (Ge et al., 2020, Lehrer et al., 2020; Schneider & Schwerdtfeger, 2020)
 - Preeclampsia (Moors et al., 2020, Siepmann et al., 2014)
 - Traumatic brain injury (TBI) (Lee et al., 2021, Wearne et al., 2021)
 - Migraine (Fleischman and Khazan, 2022; Zhang et al., 2021)
- 



• Influences on HRV

- HRV is increased by

- Exercise
- Healthy lifestyle (sleep, nutrition, etc)
- Biofeedback
- Mindfulness and Self-compassion

- HRV is decreased by

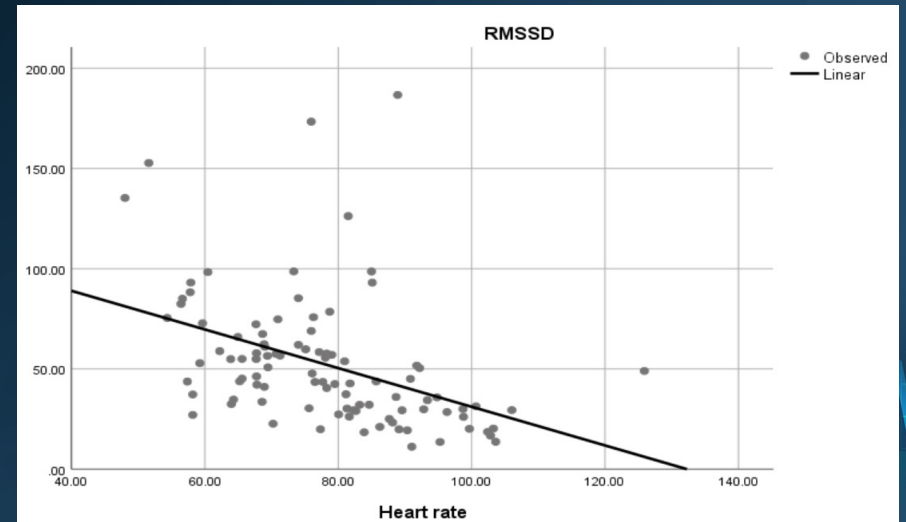
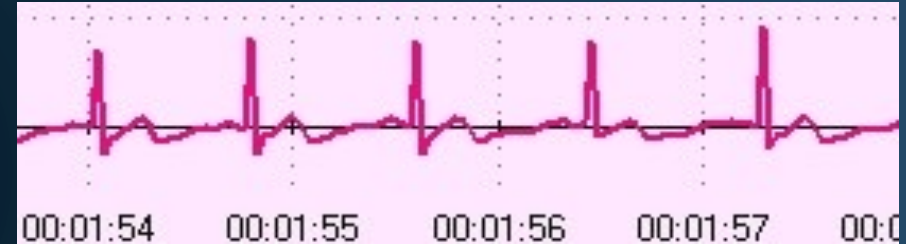
- Age
- Poor sleep
- Stress
- Illness



Measuring HRV: time domain measures

Graph HR over time

- Max-min
 - Peak to valley
- SDNN
 - Standard deviation of normal to normal interval
- RMSSD
 - Root mean square of successive intervals



Measuring HRV: spectral analysis

- Decomposes total variation of a data series into its frequency components (via Fast Fourier Transform)
- Total heart rate signal is broken down into component frequencies

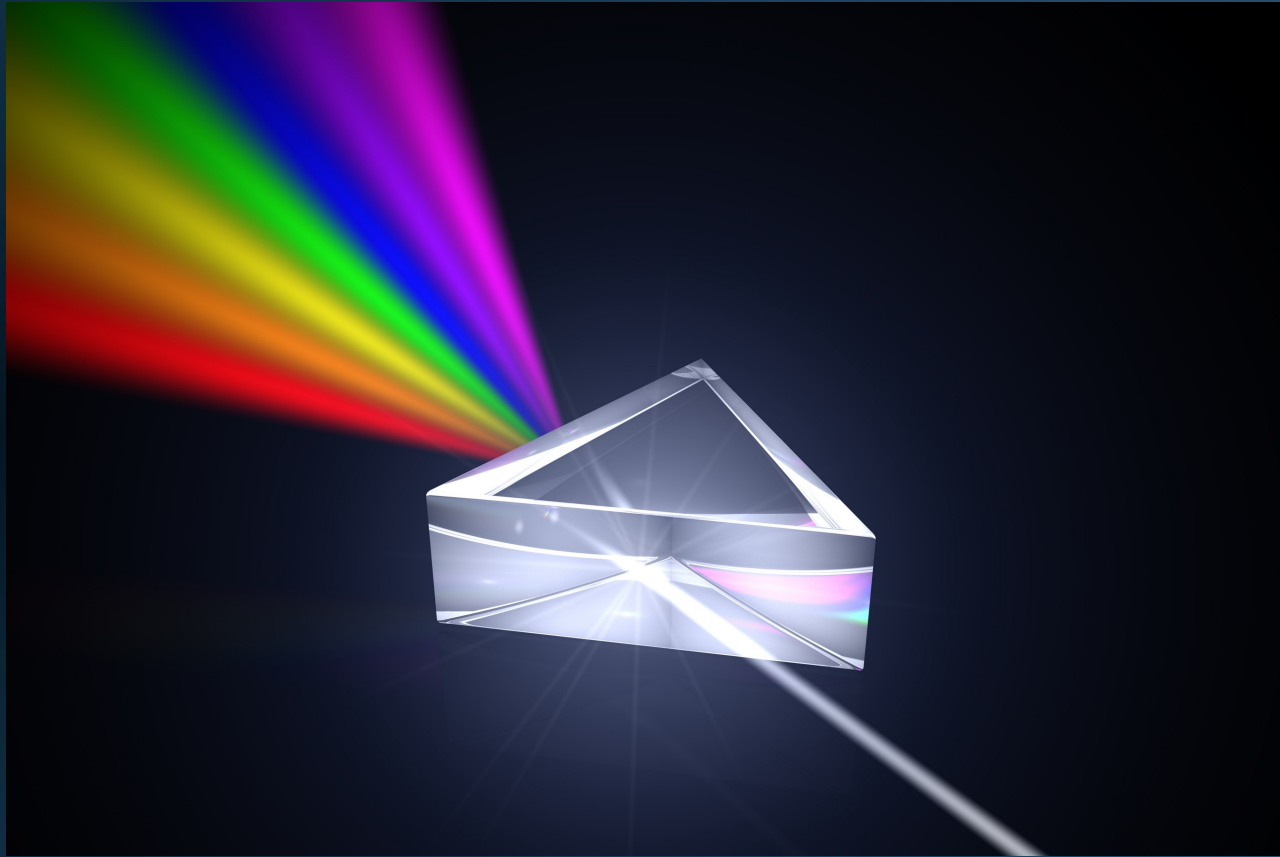
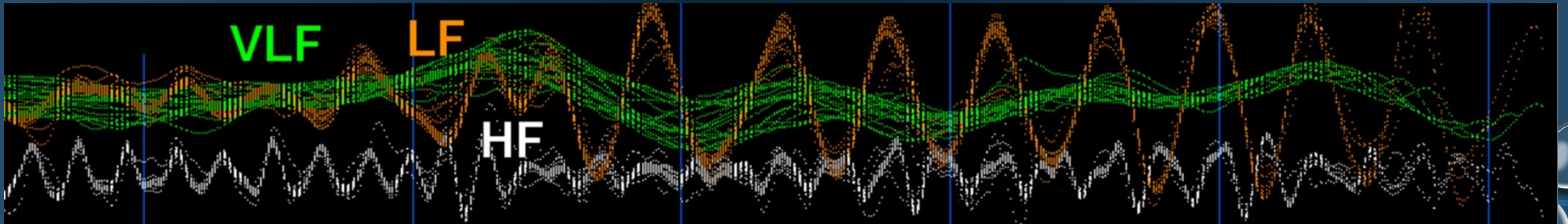


image by steveunit4 /shutterstock



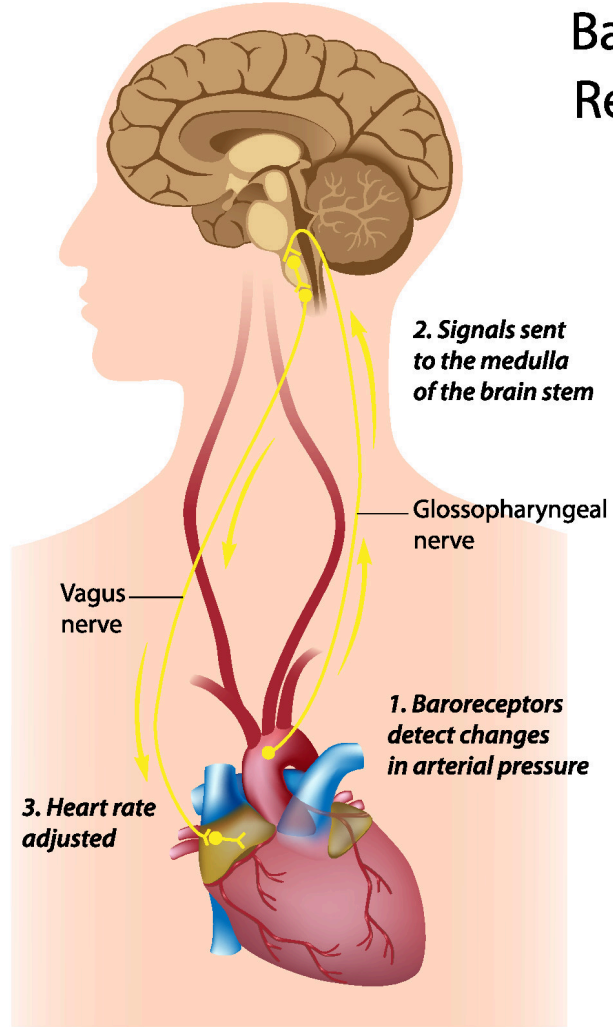
HRV Frequency Components

- High Frequency (HF)
 - 0.15 - 0.4 Hz
 - parasympathetic NS (vagal nerve)
- Low Frequency (LF)
 - 0.05 – 0.11 Hz
 - Baroreflex and parasympathetic
- Very Low Frequency (VLF)
 - <0.04 Hz
 - primarily sympathetic NS



Sources of HRV

Baroreceptor Reflex



Respiratory Sinus Arrhythmia

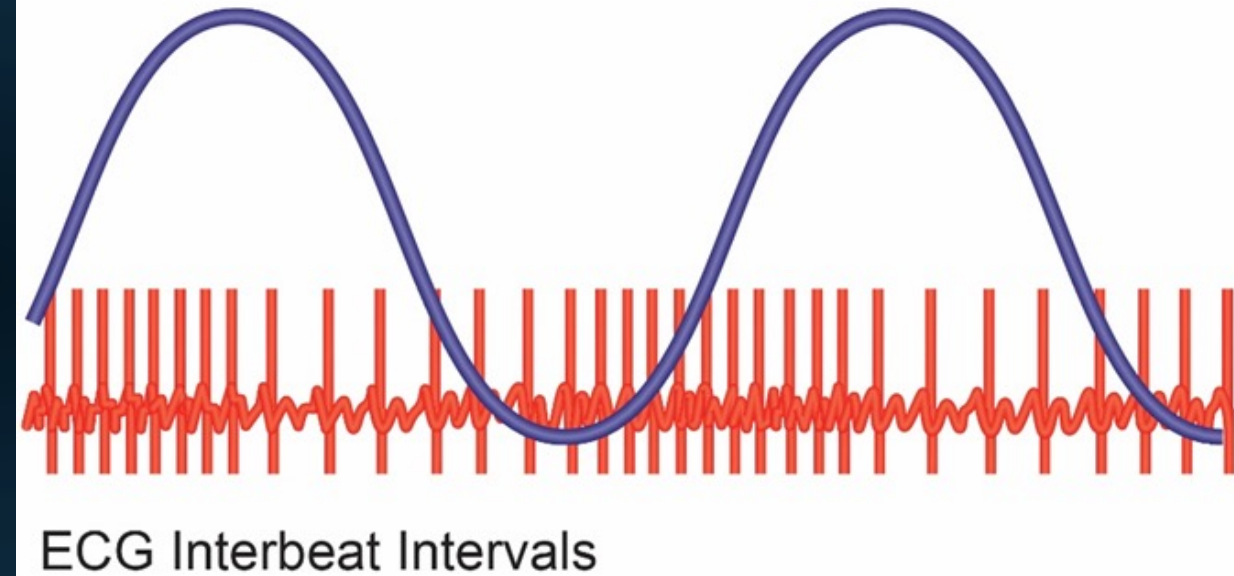


Image courtesy of
Fred Schaffer



HRV, Mindfulness, Compassion



All responsible for self-regulation




Parasympathetic nervous system functioning is a major source of HRV and underlies mindfulness and compassion



HRV can be used as a biomarker for mindfulness and compassion



HRV training can be used to complement mindfulness and compassion training





HRV and Mindfulness





HRV and Mindfulness

- HRV and Mindfulness amplify each others' effect on wellbeing
(Schmid & Thomas, 2021)
 - Separately, both state HRV and Mindfulness are related to lower emotional exhaustion and greater relaxation in healthcare workers
 - Interaction effect, such that emotional exhaustion was lowest and relaxation was highest when BOTH HRV and Mindfulness were high
- HRV may serve as a biomarker for treatment response to MBIs
(Ferreira-Garcia et al., 2021)
 - Comparison of MBI and fluoxetine in treating Generalized Anxiety Disorder
 - Pre-treatment HRV measurement identified a subgroup of patients for whom MBI was less effective





HRV as Biomarker for Mindfulness

- HRV is an objective way to show effectiveness of MBIs
 - Numerous studies have used HRV to quantify effectiveness of MBIs
 - Review study (Christodoulou, Salami, & Black, 2020) determined HRV to be an objective biomarker to quantify effects of MBIs





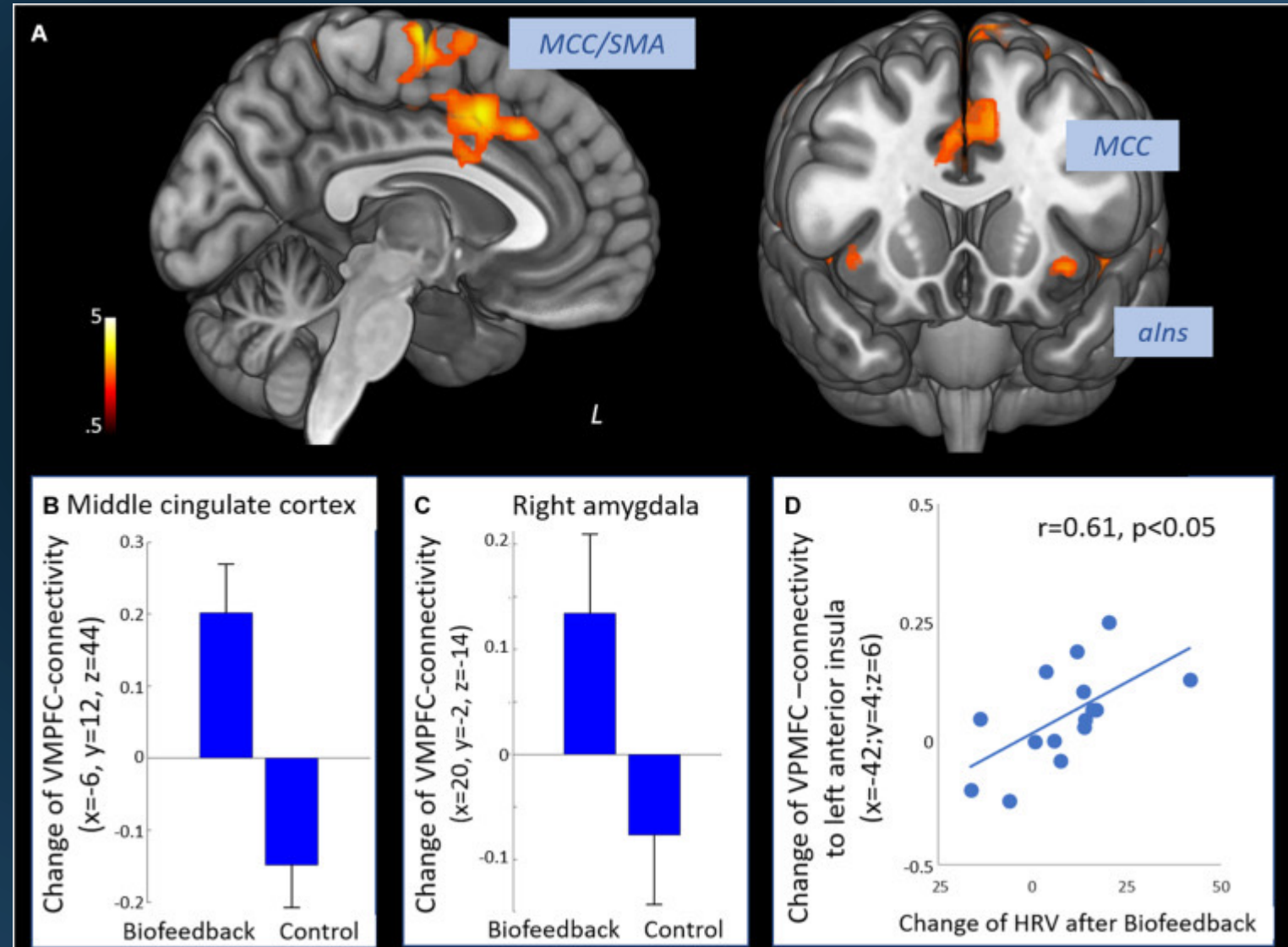
HRV and Compassion



HRV and Compassion – Brain imaging studies

- Higher HRV associated with greater connectivity between vmPFC and areas of the brain also strongly connected with experience of compassion (e.g., Mulhahy et al, 2019; Schumann et al, 2021)
 - insula
 - anterior cingulate cortex
 - middle cingulate cortex
 - amygdala

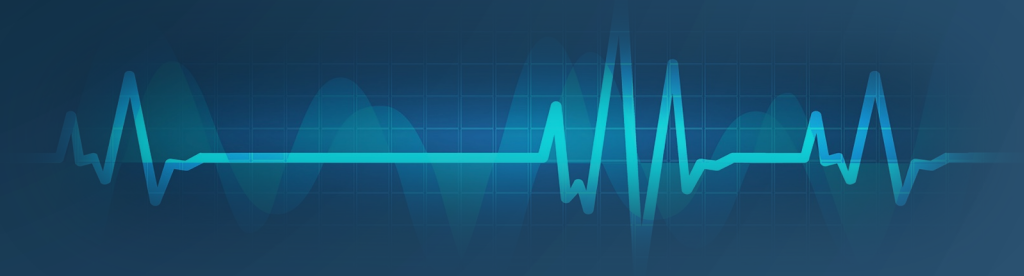
Image from Schumann et al, 2021





HRV and Compassion: strong connection

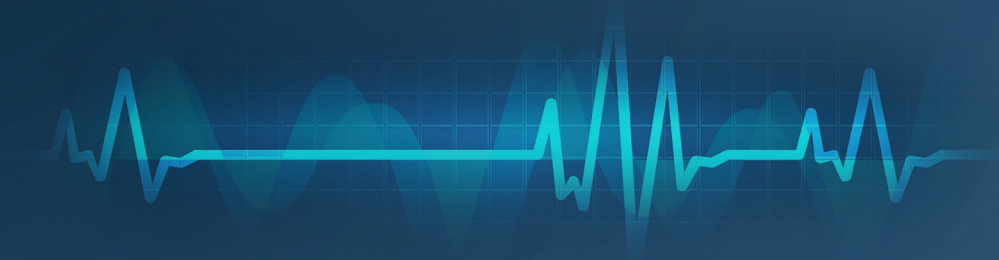
- Meta analysis reveals strong association between HRV and compassion, with medium effect sizes (DiBello et al., 2020)
- Increased HRV associated with higher likelihood of compassionate action (e.g., Bornemann et al, 2016)
- Higher baseline HRV associated with both state (induced) and trait (dispositional) compassion (e.g., DiBello et al, 2020; Svendsen et al, 2016)
- Compassion-focused practices improve HRV (e.g., Arch et al., 2014; Matos et al., 2017; Petrocchi et al, 2017)





HRV and compassion – nuanced connection

- Self-compassion associated with higher HRV reactivity (Steffen et al, 2021)
 - Self criticism associated with lower HRV at the time, with higher HRV during recovery
 - Willingness to engage with the task!
 - Increase in HRV only for those who also increased self-compassion
- Compassionate action matters (DiBello, Ottaviani, Petrocchi, 2021)
 - Greater attention and sensitivity to other's suffering associated with lower HRV
 - Compassionate action associated with higher HRV



HRV and Self-Compassion in pain: interaction (Tian et al, 2020)

- Cold induced pain
- Measured trait self compassion and resting HRV
- Self compassion was associated with lower pain when HRV was high
- Self compassion was associated with higher pain when HRV was low



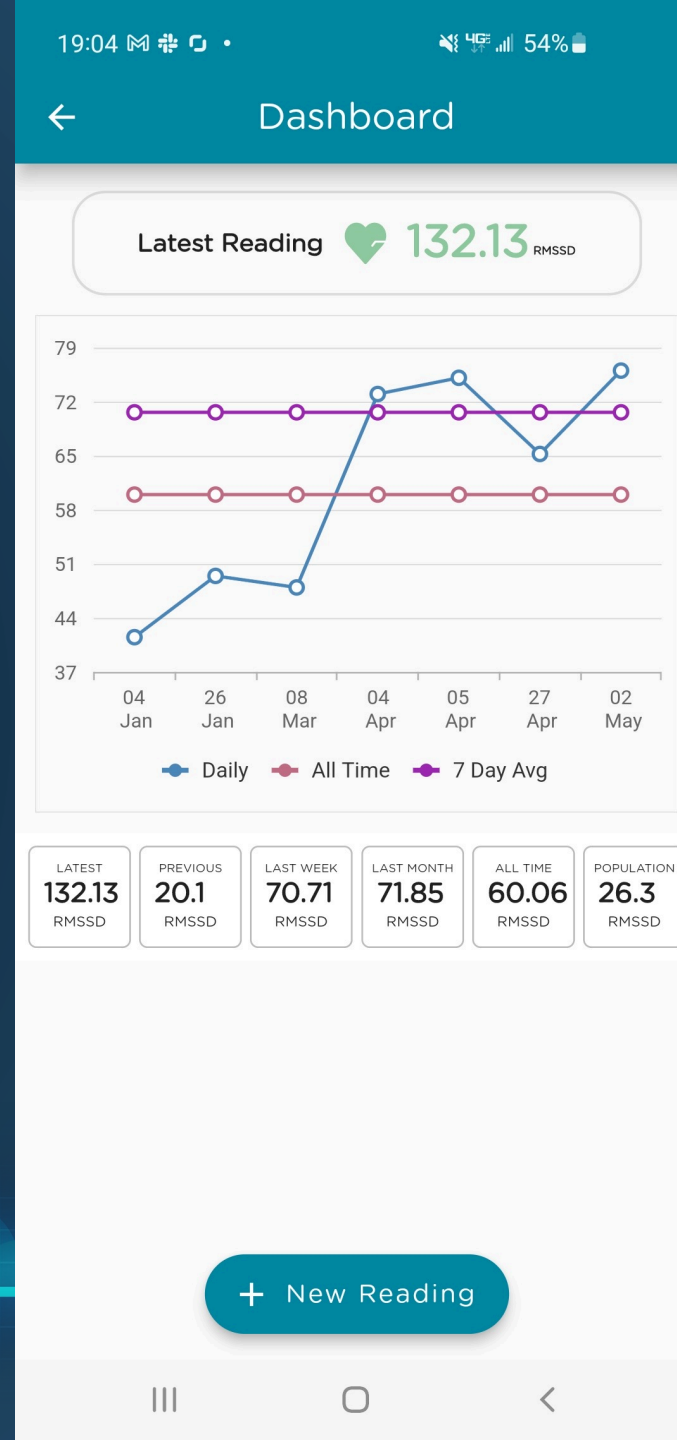


Integrating HRV into Mindfulness and Self-Compassion Practice



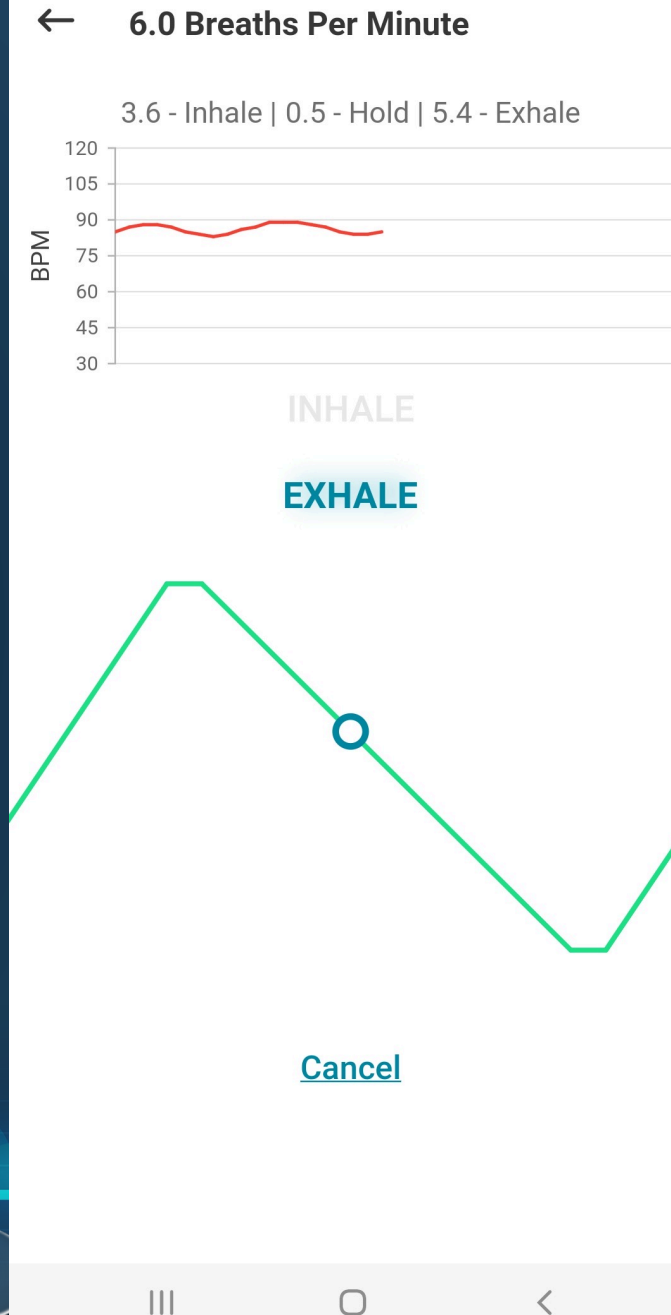
HRV as biomarker of compassion and mindfulness

- Daily HRV monitoring
 - Establish baseline
 - Monitor progress
 - Define physiological outcomes
- Assess and train capacity to engage in mindfulness and compassion-based interventions
- Data driven approach may increase appeal of mindfulness and compassion-based interventions

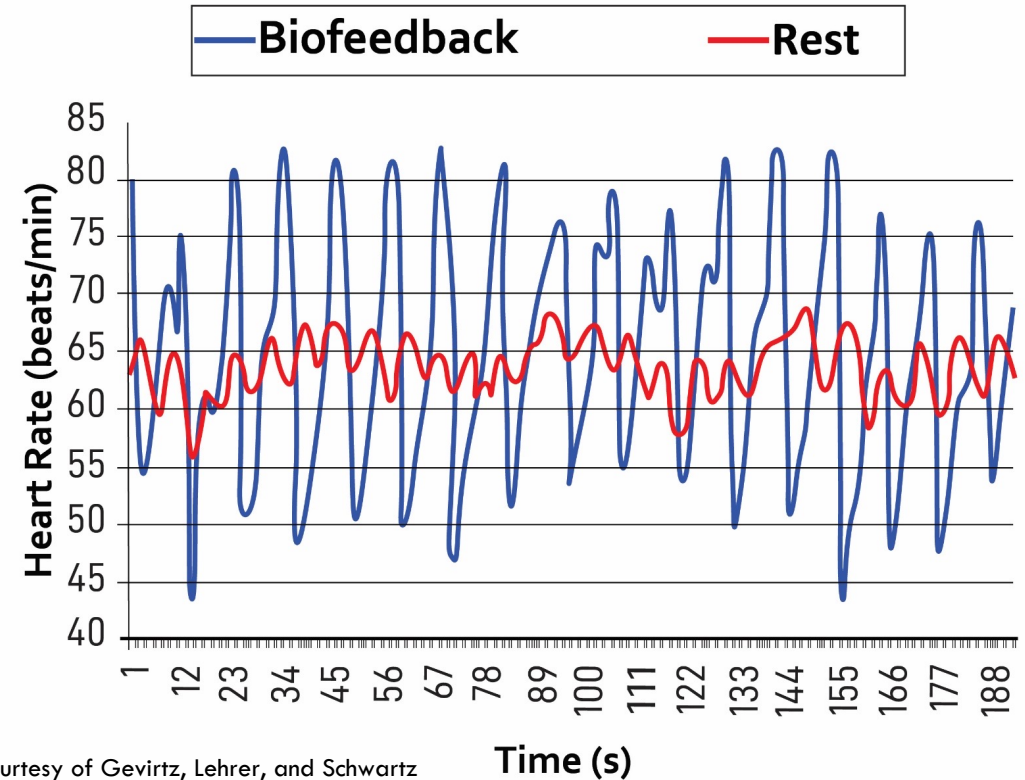


HRV Biofeedback

- Real time feedback on HRV
- Effective in increasing baseline HRV over time
 - To directly increase self-regulation
 - To facilitate mindfulness and self-compassion training
- Done through breath training



HRV training through resonance frequency breathing




Graphic courtesy of Gevartz, Lehrer, and Schwartz

Time (s)



How HRV biofeedback enhances meditation

- Amplifies the effectiveness of mindfulness and self-compassion practices
 - Decreases physiological arousal
 - Improves self-regulation and reduces intensity of suffering without a struggle
 - Makes it easier to accept experiences that may otherwise be fundamentally unacceptable (i.e., panic)
 - Increases body awareness
 - Facilitates connection between physiological and emotional states
 - Provides real time feedback on the effects of meditation
- 

The middle way – Parable of the Lute

- We find the middle way between goal directed action and letting go
- Like tuning the strings of a lute, not too tight, not too loose





Integrating HRV training, mindfulness and self-compassion

- Begin each meditation practice with HRV breathing at resonance frequency rate
- During meditation, pacer may be available as an anchor for wondering attention only
- Compassionate attitude during HRV practice – we are all human, we make mistakes, no one is perfect
 - Content of self-talk
 - Tone of self-talk



Low and Slow Breathing

Inhale

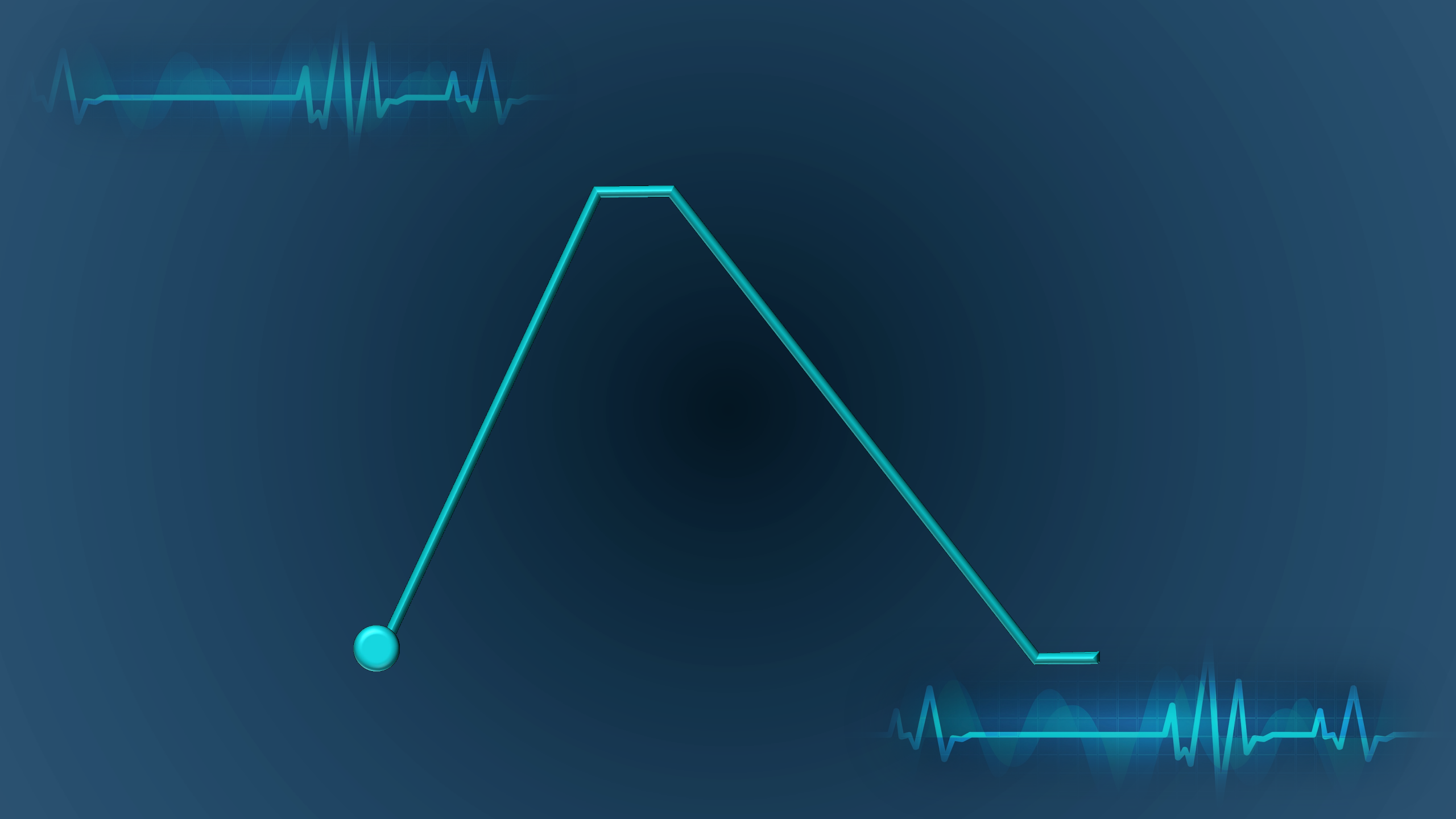


- Shift the breath to the belly
- Slow down the rate of breathing
- Take a normal size inhalation

Exhale



- Exhale slowly, through nose or pursed lips





Compassion with Equanimity

(Chris Germer)

*Everyone is on his or her own life
journey*

*I am not the cause of this person's
suffering*

*Nor is it entirely within my power to
make it go away,*

Even if I wish I could.

Moments like this are difficult to bear

Yet I may still try to help if I can.





Thank you!

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