Is there a maximum desirable heart rate variability?

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June, 2021 citation: Mather (in press). Is there a maximum desirable heart rate variability? *Neuroscience and Biobehavioral Reviews*.

Low heart rate variability, in particular reduced oscillations in heart rate in response to breathing, provides a marker of diverse psychopathologies. However, eating disorders violate this pattern (Heiss, Vaschillo, Vaschillo, Timko, & Hormes, 2021). People suffering from anorexia nervosa and, in some cases, bulimia, have higher HRV than age-matched healthy people (Peschel et al., 2016; Peyser, Scolnick, Hildebrandt, & Taylor, 2020). Based on these published correlational findings, Heiss et al., (2021) attempt to quantify an 'ideal range' of HRV.

The causal links between eating disorders and HRV matter for the field of HRV biofeedback, which induces high heart rate variability via slow paced breathing and heart rate biofeedback to improve emotional well-being (Lehrer et al., 2020; Mather & Thayer, 2018). HRV biofeedback does not induce random heart rate variability, but instead, amplifies how much heart rate decreases during exhalation and increases during inhalation. Heiss et al. state, "Findings preliminarily support the hypothesis that there is an "ideal range" of HRV that could be targeted in biofeedback interventions" (see abstract). They argue, "This raises the question of a possible alternative approach to the current focus on increasing HRV to alleviate symptoms of psychopathology, one that aims to *normalize* abnormally high or low HRV by bringing it into a range associated with ideal functioning." (p. 147). In other words, for those with eating disorders who exhibit high HRV, biofeedback should aim to reduce HRV to improve function. This argument assumes that the high HRV seen in people suffering from anorexia nervosa and bulimia is something that contributed to the eating disorder rather than resulted from the eating disorder.

In both animal and human studies, fasting increases HRV (Peyser et al., 2020). As Heiss et al. discuss, activating the parasympathetic system when starving helps conserve energy. Thus, given the compelling evidence that fasting causes an increase in HRV, a straightforward explanation of why those with anorexia nervosa and bulimia have higher HRV is because these disorders involve fasting, and fasting increases HRV.

No evidence to date suggests that high HRV is a risk factor for eating disorders. In particular, there are no findings of abnormally high HRV preceding onset of an eating disorder. This lack of evidence is not conclusive, of course, as prospective studies of eating disorders are challenging. However, bulimia provides an informative case, as bulimics tend to show high HRV only when in a fasting state, and not otherwise (Peschel et al., 2016).

In addition, multiple studies indicate that HRV in anorexics returns to normal with weight restoration (Peyser et al., 2020). One study failed to show changes in HRV in individuals with anorexia nervosa who had restored their body weight but it suffered from a small N (with 50% not included in the recovery phase) and some puzzling findings at baseline with the participants with anorexia nervosa having significantly lower standard deviation of the successive difference in RR intervals and total spectral frequency power than controls (Lachish et al., 2009), contrary to typical findings of greater HRV in individuals with anorexia nervosa than in controls.

Even if individual differences in resting HRV do not cause initiation of an eating disorder, couldn't the high HRV state induced by fasting or binging reinforce the behavior? By providing a pleasant relaxing feeling, the high HRV could promote repeating the fasting behavior. However, even if the high HRV induced by fasting can act as a reinforcer for fasting behaviors, inducing high HRV during HRV biofeedback sessions should not promote anorexia or bulimia, as the rewarding high HRV state induced during biofeedback would not be associated with

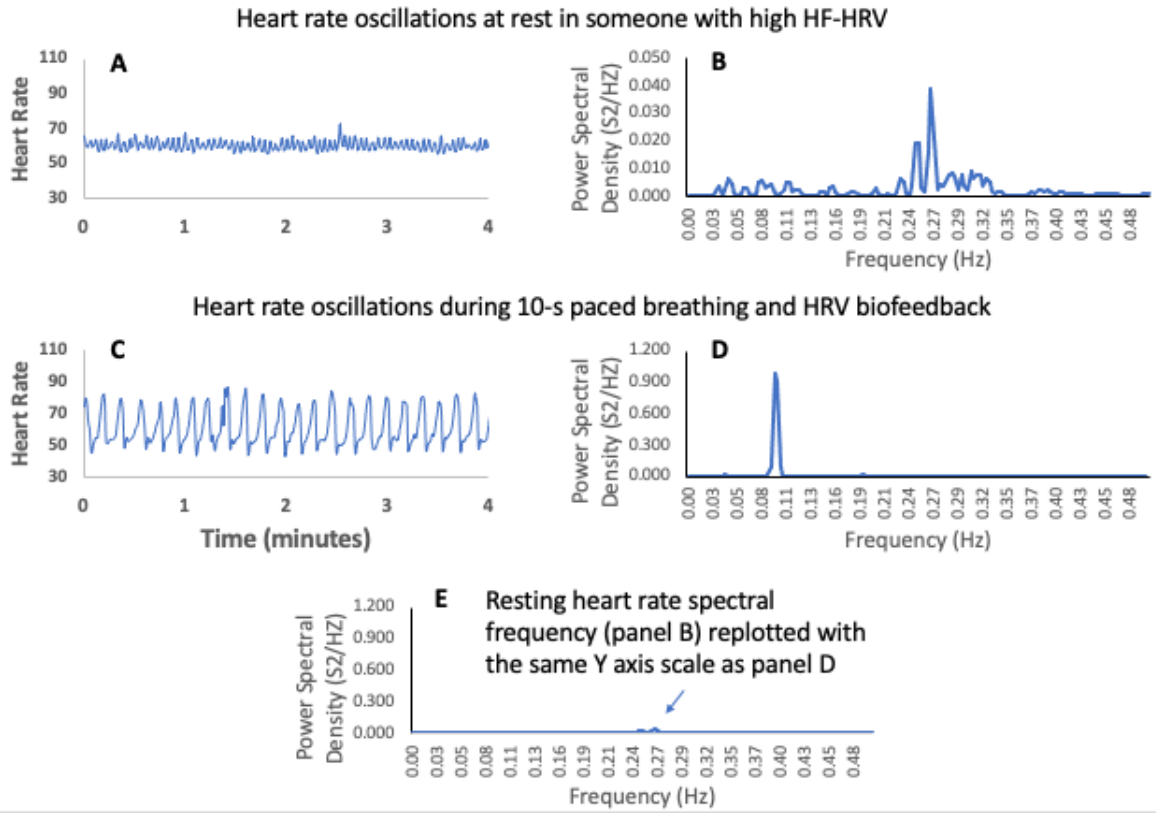
fasting or binging behaviors but instead with the context of the biofeedback practice and the slow paced breathing behavior.

In their concluding remarks of their review, Heiss et al. state, “The conventional wisdom so far has been that increasing HRV serves to improve symptoms. As individuals with anorexia nervosa have HRV parameters that appear to be above the ‘healthy range,’ however, it is possible that decreasing HRV may be beneficial in this population” (p. 152). As there is no evidence that high HRV causes or intensifies anorexia nervosa, and on the other hand, there is compelling evidence that fasting increases HRV, it seems unlikely that decreasing HRV would be any more beneficial in this population than in any other population. It is important to distinguish between HRV as a diagnostic marker and as a target to be increased (or decreased) by HRV biofeedback. While unusually high resting HRV may signal an eating disorder, it does not mean reducing HRV will reduce the behaviors causing the disorder.

In summary, observing high HRV in people with anorexia nervosa and bulimia does not mean that high HRV contributes to the disorders. As fasting states lead to high HRV, a more parsimonious explanation is that the fasting states involved in these disorders increase resting HRV. This distinction has important implications for HRV biofeedback. Contrary to the authors’ argument, there is no evidence that there is an ‘ideal range’ of HRV to target as an outcome. Instead, the simple goal of increasing heart rate oscillations during the biofeedback seems appropriate. Indeed, one study that offered HRV biofeedback to 25 in-patients with eating disorders found no serious side effects (Scolnick, Mostofsky, & Keane, 2014). Over 80% of the 17 who completed at least five sessions and who filled out the questionnaire reported that the biofeedback decreased their anxiety. Thus, despite their already high resting HRV, individuals with eating disorders may nevertheless still experience anxiety-reducing benefits of HRV biofeedback.

It may seem that HRV biofeedback would be superfluous for someone who already has high resting HRV. However, the magnitude of the oscillations induced during HRV biofeedback suggest even someone with high resting HRV could experience physiological effects from biofeedback sessions. Figure 1 displays heart rate from someone with naturally high resting HRV (Figs. 1A, B) who shows dramatic increases in the amplitude of heart rate oscillations when they start doing 10-s paced breathing during biofeedback (Figs. 1A-E). This illustrates the massive increase in heart rate oscillations that occur during HRV biofeedback even in someone who already has high resting HRV. We hypothesize that large oscillations in autonomic signals enhance brain feedback loops that help control heart rate variability and also contribute to emotion regulation (Mather & Thayer, 2018). However, research is needed to clarify whether those whose heart rate already strongly responds to breathing influences and so can achieve especially high oscillations during biofeedback or those whose heart rates do not oscillate as much in response to breathing due to weaker feedback loops will benefit more from this type of stimulation.

Figure 1. A) Heart rate over a 4-minute recording from a healthy young adult who had high HRV while sitting and resting quietly. B) The variability in heart rate is not random, but instead oscillates with the person's breathing, leading to a spectral frequency peak at around the breathing pace (0.27 Hz or 3.7 s). C) Breathing at a 10-s pace during HRV biofeedback led to larger oscillations at the slower breathing frequency. D) This slow paced breathing created a large spectral frequency peak at 0.1 Hz. E) Note the Y-axis scale differences between Figs. 1B and 1D; the power at 0.1 Hz during 10-s breathing (in D) far exceeded the peak power at 0.27 Hz during normal resting breathing (shown in E at the same scale as D).



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Acknowledgements

M.M. acknowledges support of NIA grant R01AG057184.