**Introduction**

- Fear-induced stress is different from that which is induced physically or mentally.
- Emotions begin in the amygdala, mental tasks in the cortex, and physical reactions in other areas (Hayashi et al., 2009).
- Emotions are separate from mental tasks and physical reactions, though all are capable of inducing a stress response (Hayashi et al., 2009).
- Cranial nerve X, the vagus nerve, is the main input to the parasympathetic nervous system, which slows down physiological actions.
- Vagal tone refers to the level of vagus nerve activity (Beauchaine, 2001).
- Cannot be quantified directly, though RSA can be calculated and used as a marker of vagal tone degree (Grossman & Taylor, 2007).
- RSA only accounts for half of all heart rate variability (HRV).

**Method**

- 29 adults participated in this study.
- All data was collected using equipment and software from iWorx, Inc.
- Equipment included a plethysmograph for pulse, respiration monitor, and electrodes for the facial electromyography (EMG).
- Participants were shown images, taken from the International Affective Picture System (IAPS), at one image per two seconds, with an audio stimulus.
- HRV was calculated by finding the root mean square of successive differences (RMSSD) of pulse peaks intervals (Giardino, LeFever, & Edleng, 2002).
- Since the sample HRV distribution approximated a normal distribution, two-tailed correlation tests were done.
- HRV was compared to:
  - Heart rate reaction and recovery (average rate of change)
  - Changes in the EMG signal root mean square (RMS) of the muscle used to frown (corrugator supercilii) and the muscle used to smile (zygomaticus major)
  - Memory of presented images
  - Reported feelings of anxiety

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<tr>
<th>HRV vs. Average Resting Heart Rate in Adults</th>
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<td><img src="chart1.png" alt="Graph" /></td>
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**Procedure**

- Five-minute baseline recording of pulse, EMG, and respiration.
- Sixty neutral images paired with neutral audio, followed by a two-minute recovery.
- Sixty fear images paired with fear audio, followed by a two-minute recovery.
- Debriefing.

**Results**

<table>
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<tr>
<th>Sample Heart Rate Variability (HRV) Distribution</th>
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<th>HRV vs. Average Rate of Change in Heart Rate at Four Stimulus Offset</th>
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**Discussion**

- The HRVs calculated in this study were viewed as markers for the degrees of individual vagal tone.
- Based on results, higher vagal tone indicates the following: lower resting heart rate, faster reaction to and recovery from fear-provoking stimuli, less activity in the muscle used to smile while afraid, and less reported anxiety than their lower vagal tone counterparts.
- HRV, indicating vagal tone, is not correlated with memory capacity, nor with activity in the muscle used to frown while afraid.
- Vagal tone can effectively serve as a predictor of testing heart rate, fear-induced stress response magnitude, zygomaticus major muscle expression during fear, and reported feelings of anxiety.
- These results provide more information about the vagus nerve and how vagal activity can be used to predict the effects of fear before they occur. They offer a foundation for further evaluations of individual susceptibilities to anxiety disorders, as well as for additional treatment options for such disorders.

**References**