The Cardiovascular Mechanisms of Interoceptive Awareness: Effects of Paced Breathing

Shahriar Islam & Mateo Leganes Fonteneau, PhD
Rutgers Center of Alcohol Studies

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Introduction

- Interoceptive awareness is the ability to perceive internal bodily sensations such as hunger, thirst, and specifically for the purpose of this project, the rhythm of one's heartbeat
- Being aware of interoceptive signals in your body is critical to overall mental health and well-being, as difficulties in interoceptive processing can disrupt emotional and cognitive regulation[3]
- Interoceptive awareness can be quantified by assessing sensitivity to heartbeats. Recent studies have aimed to develop new techniques to increase *cardiovascular* interoceptive awareness as a potential clinical tool but without much success
- This project seeks to investigate whether a paced breathing task that modulates the cardiovascular system can increase interoceptive awareness, indexed by the ability to perceive heart beats

Background

- Cardiac interoceptive signals are hypothesized to be generated by the triggering of baroreceptors which are mechanoreceptors located in the aortic artery. These sensors relay information to the brain about the timing and intensity of each heartbeat and are a part of the baroreflex feedback loop in the cardiac axis[1] (see Fig 1)
- Baroreflex sensitivity is an index of the ability of the feedback loop to regulate this system. Importantly, it is possible to experimentally increase baroreflex sensitivity through a simple resonance paced breathing task that can maximize engagement of baroreceptor firing[2]

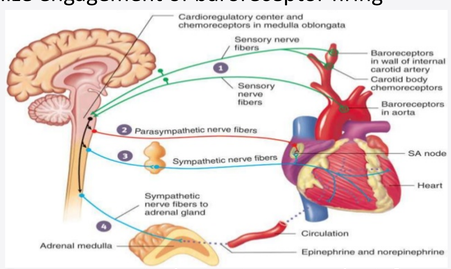

FIGURE 1. Baroreceptors in the aortic artery relay information to the brain about the timing and intensity of each heartbeat

Hypothesis

- The hypothesis of this project is that there will be an increase in interoceptive awareness after completing a resonance paced breathing task compared to a control task

Methods and Materials

Overview of tasks:

- 64 participants consented to take part in the 2-session study in which they were connected to physiological equipment (i.e. ECG electrodes and respiration straps) and completed the tasks below
- *Baseline interoception*. This 20-trial task evaluates one's cardiac interoceptive awareness. For each trial, participants heard 10 consecutive beeps that were either synchronized or not synchronized with their heartbeat. At the end of each trial participants indicated whether the tones were synchronized or not synchronized and how confident they were in their response using a visual analog scale (0-100). *Accuracy and confidence for the interoception task served as the dependent variables.*
- *Vanilla task*. This task served as a baseline measure of cardiac physiology. Participants had to count how many "Blue" squares they observed from a series of colored squares presented on the screen
- *Paced breathing (6P)*. On the 6P breathing task, participants breathed at a frequency of 6 times per minute following a visual pacer presented on the screen. This task is hypothesized to increase in interoceptive awareness
- *Variable breathing control (VP)*. On the VP breathing task (control condition), participants breathed at different frequencies, from 10 breaths per minute to 15 breaths per minute, reflective of natural breathing frequencies
- *Biofeedback interoception*. The 20-trial task is performed again, however, after every 2 trials, a 30-second period of 6P breathing or VP breathing will be included to potentiate the effects of either breathing task on interoceptive awareness

Procedure:

- *Session 1*. Participants completed tasks in order: baseline interoception (10 min), the vanilla task (5 min), either 6P or VP breathing task (5 min), and the biofeedback interoception task (20 min)
- *Session 2*. Participants completed tasks in order: the vanilla task, either the 6P or VP breathing task not completed during session 1, and the biofeedback interoception task (20 min). See Figure 2 for details

Experimental Setup

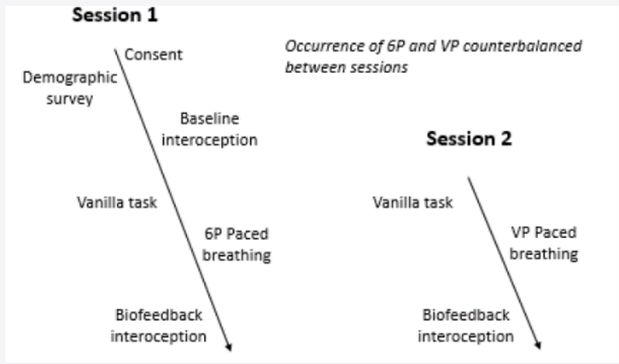

FIGURE 2. Experimental procedure for sessions 1 and 2

Results

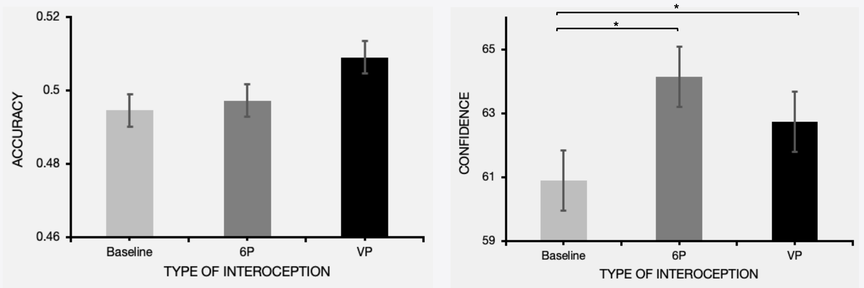

FIGURE 3. Interoceptive accuracy (left) and confidence (right) for baseline interoception, biofeedback interoception with 6P breathing, and biofeedback interoception with VP breathing. Error bars represent SEM.

- A one-way repeated measures ANOVA showed no significant effect of breathing intervention on accuracy. Post-hoc t-tests showed no increase in 6P accuracy compared to VP accuracy ($p>0.05$)
- There was a significant effect of breathing intervention on confidence. Post-hoc t-tests showed an increase in both 6P and VP confidence compared to baseline confidence ($p<0.05$, in both cases)

Conclusions

- Both 6P and VP tasks were successful in producing significant increases in confidence relative to baseline for the interoception task. However, this may be due to practice effects
- Importantly, participants did not have significantly greater accuracy for biofeedback interoception with 6P breathing relative to biofeedback interoception with VP breathing. This project concludes that the 6P breathing task may not be used as an effective method to improve interoceptive awareness
- For the future, the lab will investigate the physiological changes generated by paced breathing on baroreflex sensitivity, and how these might map into individual differences in interoceptive awareness. This will allow the lab to evaluate the hypothesis that interoceptive awareness is triggered by baroreceptor signaling

References

[1]Benarroch, E. E. (1993). The Central Autonomic Network: Functional Organization, Dysfunction, and Perspective. *Mayo Clinic Proceedings, 68*(10), 988–1001.
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[3]Price, C. J., & Hooven, C. (2018). Interoceptive Awareness Skills for Emotion Regulation: Theory and Approach of Mindful Awareness in Body-Oriented Therapy (MABT). *Frontiers in psychology, 9,* 798.

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