UNIVERSITY OF MIAMI
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THE ROLE OF SEROTONIN IN THE CONTROL OF HEART RATE AND VENTILATION IN *APLYSIA CALIFORNICA*

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Introduction

- *Aplysia californica* are marine mollusks that are exposed to low environmental oxygen levels
- The acute response to hypoxia involves changes in both heart rate and ventilation
- Cardiac contraction in *Aplysia* is controlled through pressure gradients resulting in blood flow through the gill into the cardiac atrium then to the ventricle
- The role of 5-HT in *Aplysia* muscle contraction is comparable to the role of catecholamines in vertebrate nervous systems
- Fluoxetine (FLX) blocks the reuptake of 5-HT by the 5-HT transporter, increasing the extracellular concentrations of circulating 5-HT
- Studying heart rate and ventilation response to 5-HT and FLX will provide understanding of 5-HT and the 5-HT transporter on the *Aplysia* cardio-ventilatory response to hypoxia

Objective and Hypothesis

Objective

To determine the acute response of heart rate and ventilation to intra-hemocoel injection of 5-HT or FLX

Hypothesis

Heart rate and ventilation will be unchanged in Aplysia injected with NaCl and will increase in *Aplysia* injected with 5-HT or FLX

Materials and Methods

- The experimental animals were obtained from the Rosenstiel School National Resource for *Aplysia californica* (n = 32; 128.6 ± 5.46 g)
- A photo was taken to evaluate physical response to injection
- A 30 sec baseline of heart rate using an ultrasound machine was taken 10 min after weighing (t = 0 min).
- Immediately after (30 sec), a dose of either 100 mL saline $\cdot g^{-1}$Aplysia (control), 3 µg 5-HT$\cdot$100 mL^{-1} saline$\cdot g^{-1}$ (5-HT-treated), or 0.1 µg FLX $\cdot$100 mL^{-1} saline $\cdot g^{-1}$ (FLX-treated) were injected into the hemocoel.
- 30 sec heart rate was immediately recorded after injection at (t = 2 min) (t = 7 min) (t = 32 min).
- After ultrasound recording a final picture of the *Aplysia* was taken

- Ventilation changes was measured by mantle cavity pressure using a parapodial catheter attached through surgery 24 hours prior
- Pressure transducers were connected to a Biopac System
- *Aplysia* was then connected to the pressure transducer by the parapodial catheter
- *Aplysia* were then injected with either NaCl, 5-HT, or FLX and a photo was taken to evaluate injection response
- The experimental animal was left for 30 min while the Biopac System tracked the ventilation
- At the end of the 30-min trial a final photograph was taken

Results

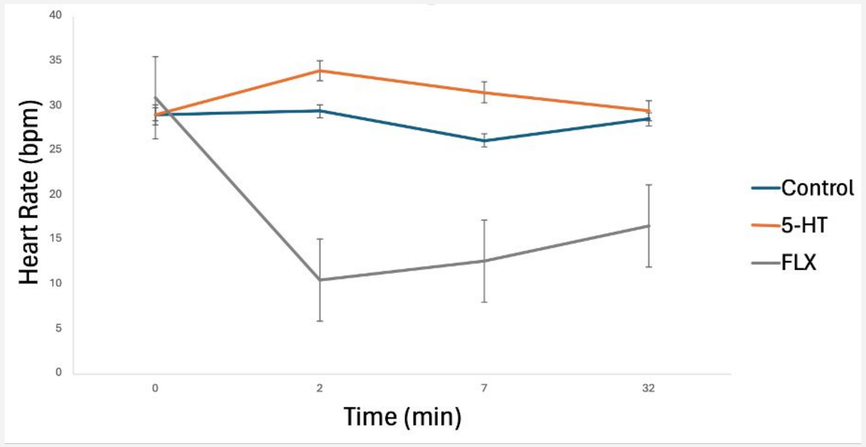

Figure 1: Mean heart beats per second over 30-min after NaCl (control), 5-HT, or FLX injection into the hemocoel. Values are means ± SEM. Different letters denote significant difference ($p < 0.05$).

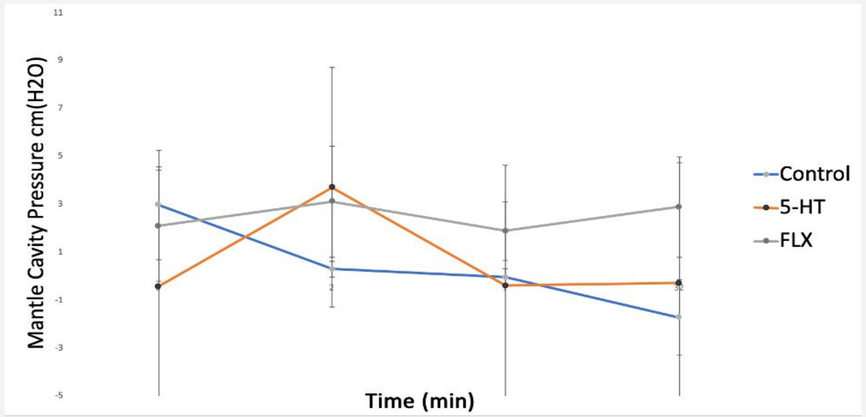

Figure 2: Mantle cavity pressure over 30-min after NaCl (control), 5-HT, or FLX injection into the hemocoel. Values are means ± SEM.

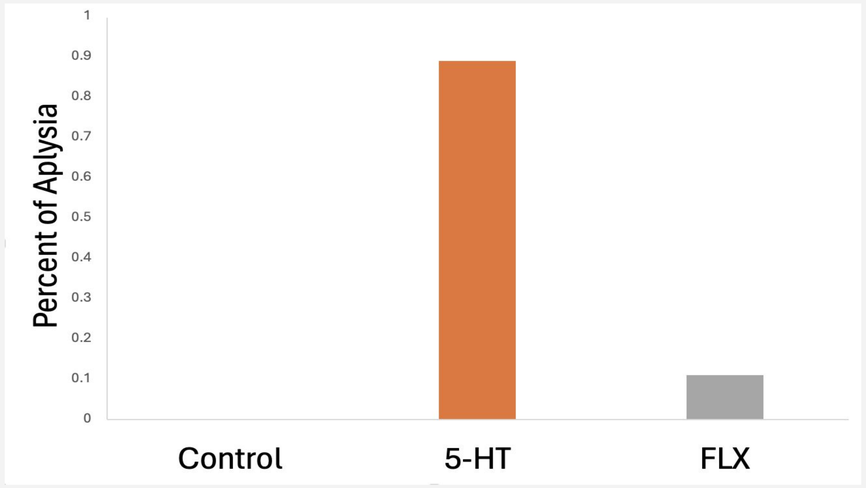

Figure 3: Number of 5-HT injected Aplysia and fluoxetine- injected Aplysia that exhibited scrunching after injection.

Discussion

Our data supported the hypothesis in 5-HT- injected Aplysia heart rate experiments as the heart rate increased

Our FLX injection experiments did not support the original hypothesis, as heart rate decreased in response to FLX

5-HT and FLX had no effect on ventilation

The NaCl injected animals acted as a control, so their heart rates and ventilation remained the same after the baseline reading

89% of the animals that exhibited scrunching were the FLX-injected *Aplysia* compared to only 11% that were 5-HT injected *Aplysia*

- Ventilatory amplitude and respiratory pumping are major components in Aplysia and could be analyzed in response to 5-HT and FLX injection
- The physical reaction could indicate that the heart rate and ventilation response was because of the injection
- More studies understanding what the scrunching behavior means would need to be conducted

Broader Impacts

There is an increase in hypoxic dead zones occurring with climate change

The 5-HT ability to regulate heart rate could implicate functions of *Aplysia* hypoxia resistance as shifting heart rate is a strategy for hypoxic resistant organisms

Fluoxetine is metabolized and excreted into many wastewater systems resulting in increased levels in fish in the areas nearby

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