Changes in Respiratory CO_2 Chemosensitivity Using Early- and Late-Stage Tadpoles

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Abstract

Isolated tadpole brainstems provide a robust model for quantifying central respiratory CO_2 chemosensitivity. Whole-nerve recordings were used to identify respiratory responses of early- and late-stage tadpoles to different CO_2 levels in order to characterize the sensitivity of different developmental stages to respiratory stimuli. Some significance has been determined when comparing baseline and individual treatment values; however, further research needs to be done in order to fully characterize the CO_2 influence on respiration.

Introduction

Breathing is important for pH homeostasis and is driven by the exchange of CO_2 and O_2. The control system for breathing consists of neurons located in the brainstem.

CO_2 drives respiration. Impairments in the ability to sense changes in this respiratory stimulus factor into several breathing pathologies.

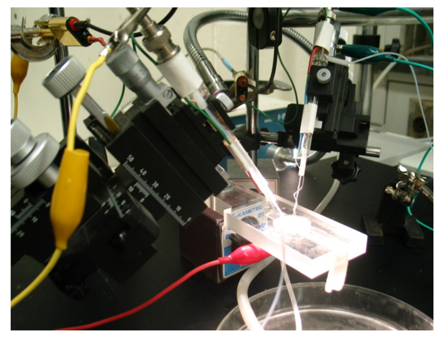
Bullfrog tadpoles are an excellent model for studying the neuronal control of breathing because isolated brainstems can remain fully functioning and display strong CO_2 chemosensitivity.

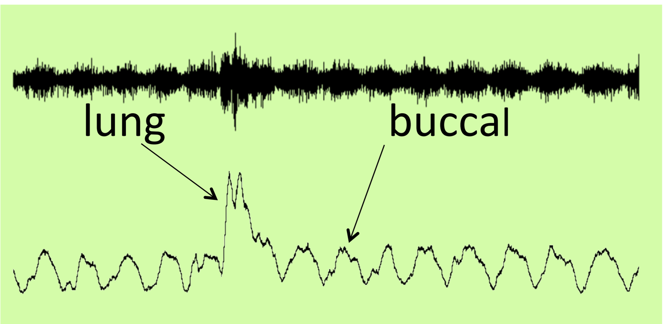
We investigated the influence of chemosensitivity on ventilation of early (stage 1-17) and late stage (stage 17-25) tadpoles.

Early Stage

Late Stage

Methods





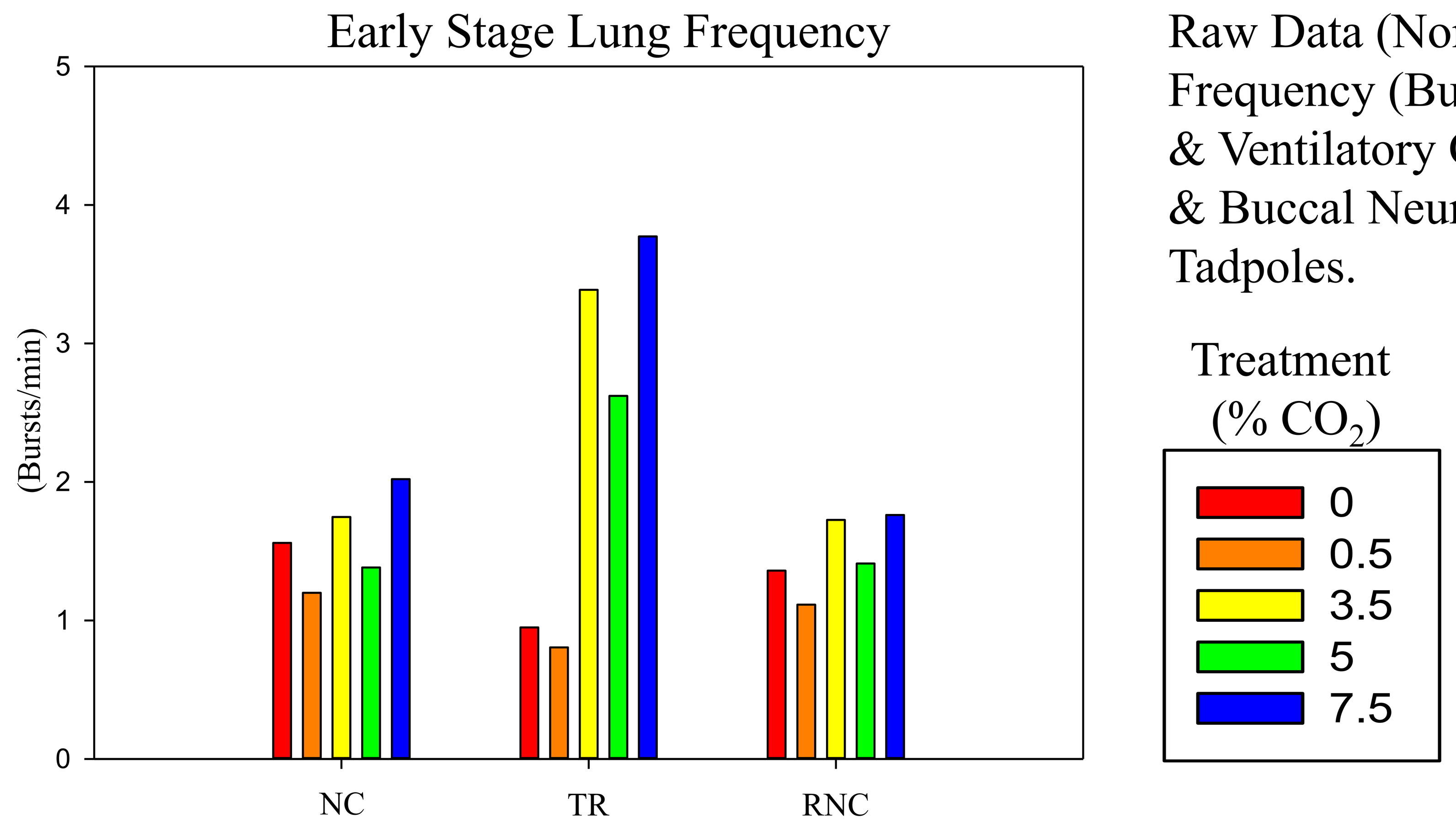
Whole-nerve output recording

- Isolated decerebrate brainstems were placed in a recording dish and perfused with artificial cerebrospinal fluid (aCSF) equilibrated with a given concentration of CO_2, balance O_2.
- Suction electrodes were attached to cranial nerve roots responsible for driving respiration and neural activity was recorded.

Treatment Protocol:

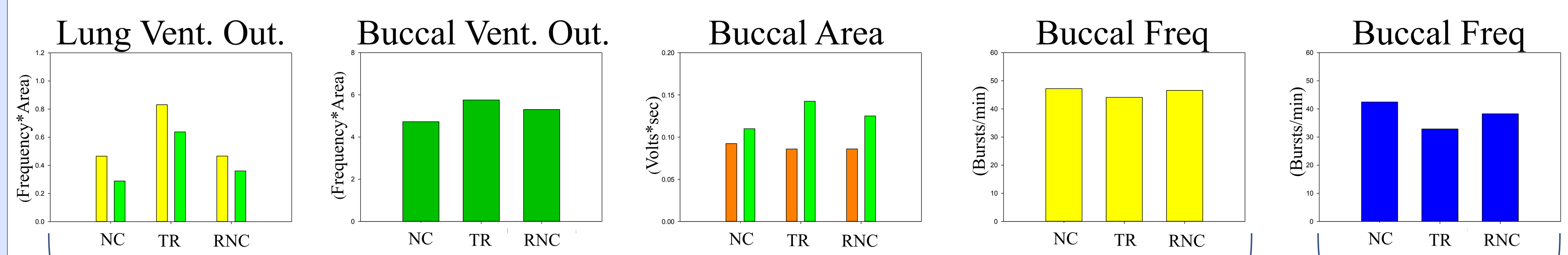
CO_2 level (%)	**Duration (min)**
Normocapnia (NC; 1.5)	90
Treatment (TR; 0,0.5, 3.5, 5, 7.5, 10)	30
Recovery Normocapnia (RNC; 1.5)	60

Results



Raw Data (Normocapnia vs Treatments) for Frequency (Bursts/Minute), Area (Volts x Seconds), & Ventilatory Output (Frequency x Area) for Lung & Buccal Neuroventilation in Early & Late State Tadpoles.

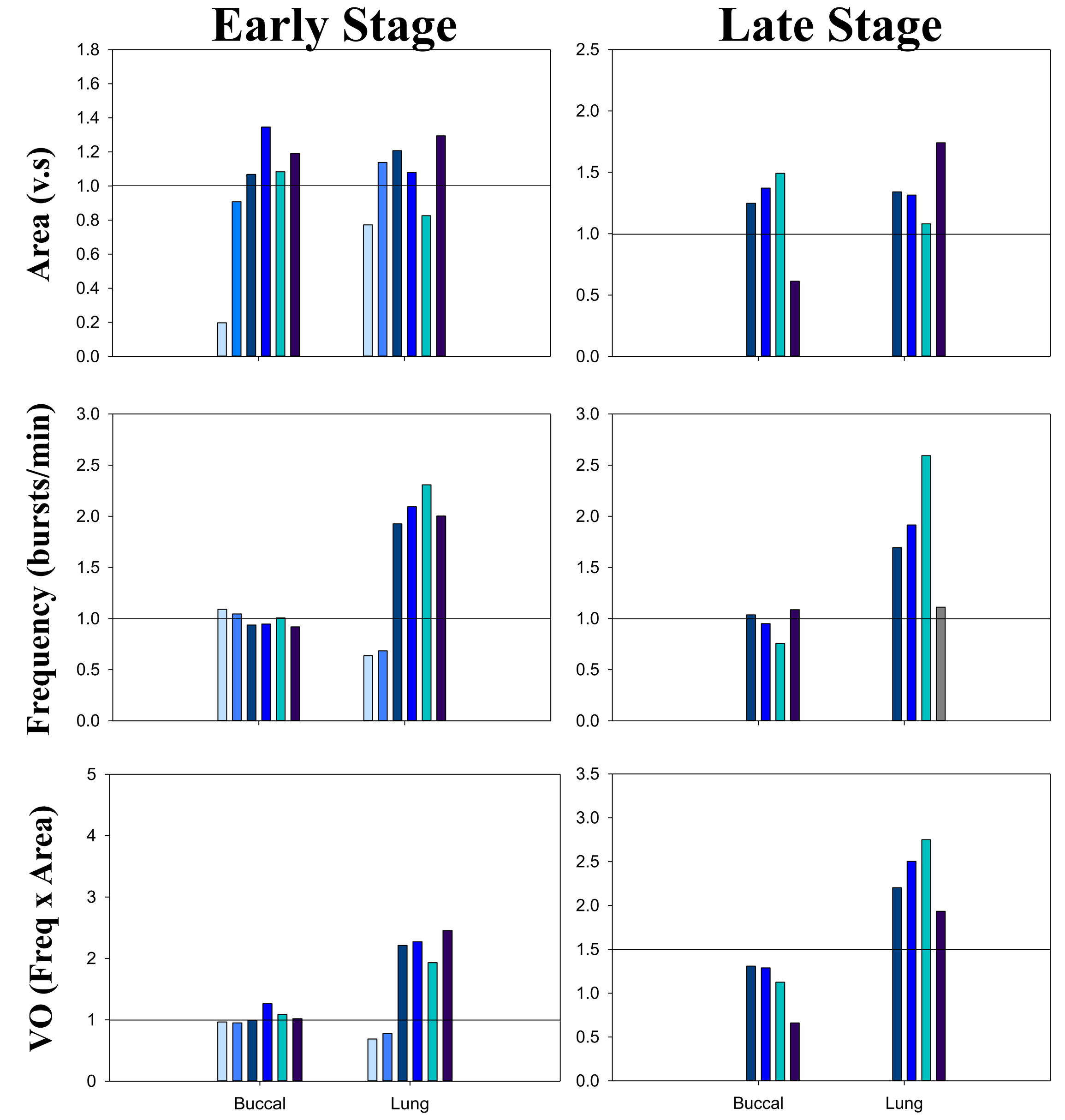
These graphs show absolute values for all parameters **where significant variation was detected**. Our significance was detected via One Way Repeated Measures ANOVA.



- Parameters that increased activity in response to treatment were lung frequency (early; 3.5, 5, 7.5 %), lung ventilatory output (VO; early; 3.5, 5 %), buccal area (early; 5%), and buccal VO (early; 5%).
- Parameters that decreased activity in response to treatment were lung frequency (early; 0, 0.5 %), buccal area (early; 0.5 %), and buccal frequency (late; 7.5 %).

Results

Data show the relative (to NC; y=1) trend of all treatment variables even though the n is too low to resolve statistical significance between treatments.



$$\text{Relative Change} = \frac{\text{Treatment parameter}}{\text{Normocapnia parameter}}$$

Conclusion

For early-stage animals, lung frequency appears the most responsive to changes in gas concentrations, though evidence suggests that frequency, area and/or ventilatory output for lung and buccal are at least somewhat responsive. In late-stage, only buccal frequency during 7.5% CO_2 was significant. All parameters for all treatments that were not significant failed the Power of Performance test, indicating that more experiments need to be conducted.

References

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