Effects of Exercise on Anxiety Behaviors in Zebrafish

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Background

- Exercise has been shown to improve cognitive function and decrease anxiety-like behaviors in humans and mammalian models of human research (Trejo *et al.*, 2008).
- Zebrafish (*Danio rerio*) are a widely used animal model in neurobehavioral research, and exercise has been shown to have beneficial effects on learning in these fish (Luchiari *et al.*, 2013).
- However, the impact of exercise on anxiety-like behaviors has yet to be explored in zebrafish.

Research Questions

- Do the effects of exercise in humans and mammalian models transfer to other model vertebrates?
- How does aerobic exercise affect zebrafish behavior in a test of anxiety?

Methods

- Fish were randomly placed into two groups. Both groups were placed in a swim tunnel five days per week, for one hour, over six weeks.
  - **Exercise:** Fish aerobically challenged (water velocity range: 0.5-5 m/s; $n = 25$).
  - **Control:** Fish freely moving in little to no flow (water velocity range: 0-0.5 m/s; $n = 26$).
- Flow measurements were taken at front, middle, and back of each channel (exercise $P^1 = 3.66$, $P^2 = 1.98$, $P^3 = .77$; control $P^1 = .17$, $P^2 = 0$, $P^3 = 0$).
- After six weeks, fish were individually tested in a novel tank diving test for anxiety-like behaviors (Fig. 1).

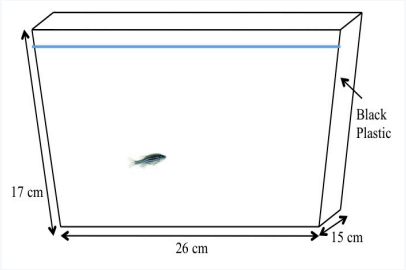

Fig. 1: *The novel tank diving test. Consisted of a plain tank surrounded by black plastic on three sides. An acetate grid was used to evaluate zebrafish swimming activity, with three vertical zones (bottom, middle, and top). Trials lasted 5 minutes. Variables analyzed included: total time spent in bottom; total time spent in top; rate of movement; latency to enter top; number of entries into top; average time spent in top per entry.*

Results

- Across the full 5 minute trial, there was no difference between treatments in the amount of time fish spent in the bottom of the tank ($F_{(1,48)} = 3.59$, $p = 0.06$; Fig. 2).
- However, control fish spent significantly more time in the bottom of the tank during the first three minutes of observation ($F_{(1,48)} = 5.85$, $p = 0.02$; Fig. 2).

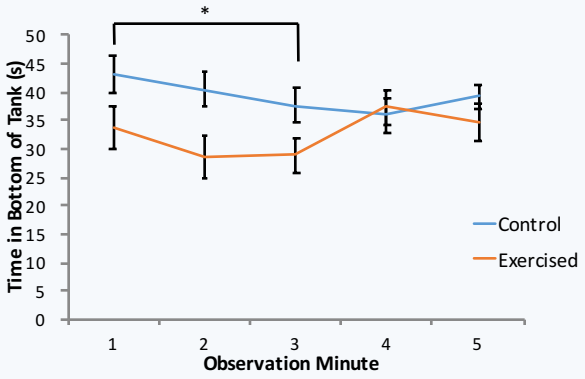

Fig. 2: *Time spent in the bottom of the tank during each minute of the novel diving tank test. Mean ± s.e.m.*

- Exercised fish moved into the top of the tank sooner than control fish ($F_{(1,41)} = 7.51$, $p = 0.004$; Fig. 3), and overall spent more total time there ($F_{(1,41)} = 15.95$, $p = 0.01$; Fig. 4).
- There were no differences between treatments in rate of movement ($F_{(1,41)} = 0.02$, $p = 0.97$), number of top entries ($F_{(1,41)} = 0.34$, $p = 0.59$), or average top entry duration ($F_{(1,41)} = 1.47$, $p = 0.29$).

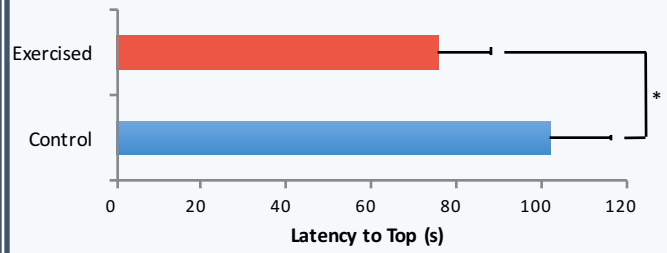

Fig. 3. *Differences between exercise and control fish in the time to first enter into the top of the tank. Mean ± s.e.m.*

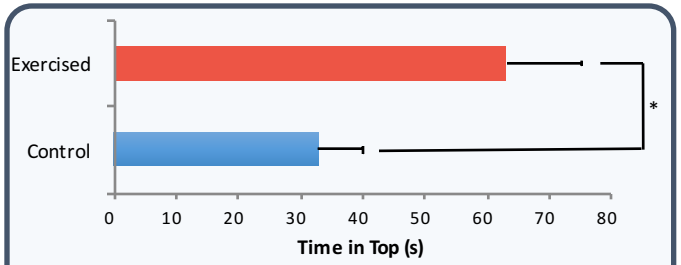

Fig. 4. *Differences between exercise and control fish in the total amount of time spent in the top of the tank. Mean ± s.e.m.*

Discussion

- The results indicate that aerobic exercise is associated with reduced anxiety-like behavior in zebrafish.
- Zebrafish that were exposed to exercise were quicker to enter the top of the tank and spent more time there at the start of the trail. This suggests that exercise reduces initial aversion to novel experience.
  - ie., zebrafish "warm up" to novel experiences quicker having been exercised
- These results extend research that has already been done on humans and mammalian animal models of neurobehavioral studies, and provide evidence for a new model to look at the effects of exercise on behavior.
- **Limitations:**
  - This study utilized only one test of anxiety-like behavior.
- **Future Research:**
  - Utilize multiple tests of anxiety-like behavior.
  - Use more specific flow rates to standardize exercise experience.
  - Look into the lack of differences between time spent in the bottom of the tank during the later stages of the trial.

References

Trejo, J., Llorens-Martin, M., & Torres-Aleman, I. (2008). The effects of exercise on spatial learning and anxiety-like behavior are mediated by an IGF-I dependent mechanism related to hippocampal neurogenesis. *Molecular and Cellular Neuroscience, 37*, 402-411.

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Acknowledgements

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