The Effects of Lead on Memory and Learning in Zebrafish

Andrew Trute, Dylan Demaske, Alex Suhr
MAUSTON HIGH SCHOOL

Abstract:

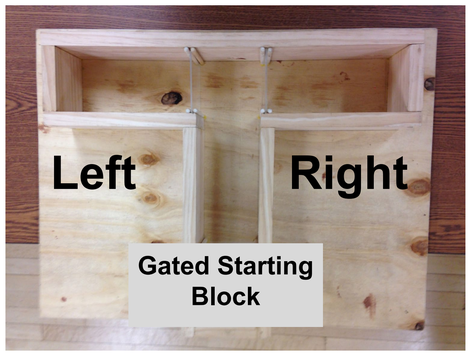
The goal of this experiment was to find out how lead affects the memory and learning in Zebrafish. Lead is an environmental toxin that can lead to many negative effects regarding cognitive flexibility. Zebrafish are commonly used in experimentation to model the effects of certain toxicants on human development since there are many similarities between Zebrafish and human DNA. In this experiment Zebrafish were exposed to 10 µm of lead, while also being compared to a control group with 0 µm of lead. More specifically, we examined a process called cognitive flexibility. Cognitive flexibility is the mental ability to switch between thinking about two different concepts, and to think about multiple concepts simultaneously. The Zebrafish used in this experiment were previously exposed to lead and were acquired through UW-Milwaukee's SEPA program. Our results show that the lead-free Zebrafish showed better cognitive flexibility than those exposed to lead.

Introduction:

"Since the 1960s, the Zebrafish (**Danio rerio**) has become increasingly important to scientific research." They have helped us immensely in understanding the mechanisms of development and diseases. Cognitive flexibility is also a vital area of research as it directly impacts learning in the classroom. Currently, there are many environmental pollutants that negatively affect this flexibility. For this investigation, we used a model contaminant, lead, to see how lead exposure can affect memory and learning in Zebrafish. Our research question is, do Pb exposed fish have a harder time with cognitive flexibility than non-exposed fish? Our hypothesis is, if Zebrafish are exposed to Pb, then they will show less cognitive flexibility than non-exposed Zebrafish. If this experiment shows, overall, that Pb has a negative effect on cognitive flexibility then we can conclude that humans might also suffer similar effects.

Materials and Methods:

- 1 - T-maze unit/group (3 students)
- 4 L dechlorinated water 79C-82C
- 1 L holding tank (1 L beaker-aeration optional) for each fish being tested (renew water once each day)
- 1 plastic pipet/T-maze
- Marking tape/pens to label tanks
- 1 fishnet/T-maze
- 1 mini aquarium heater/fish tank or beaker (for zebrafish)



Day 1 = Training

Control Group

Acclimation (no gates): 5 minutes → **Place in Starting Block: 15 secs** → **Left-Right Discrimination: 45 secs**

Lead Group

Acclimation (no gates): 5 minutes → **Place in Starting Block: 15 secs** → **Left-Right Discrimination: 45 secs**

If the fish enters the "correct" arm close opposite gate and allow fish to remain undisturbed for 45 secs. If the fish enters the "wrong" arm then disturb fish and net immediately. Place in starting block for 15 seconds and start over.

Days 2 & 3 = Testing

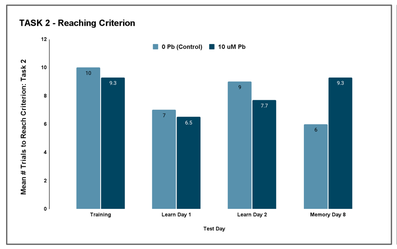
Place in Starting Block: 5 mins → **Left-Right Discrimination: 45 secs**

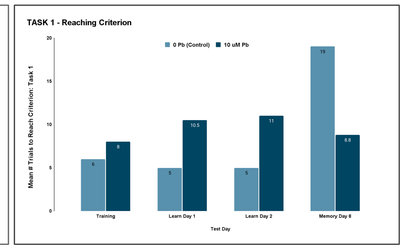
Day 8 = Memory

Place in Starting Block: 5 mins → **Left-Right Discrimination: 45 secs**

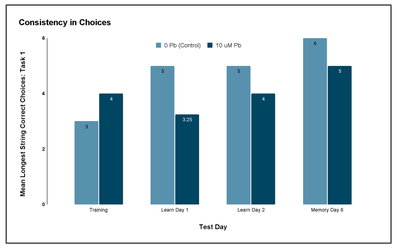
Data

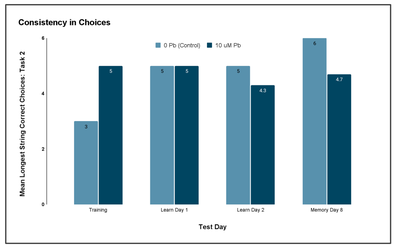
A. Reaching Criterion



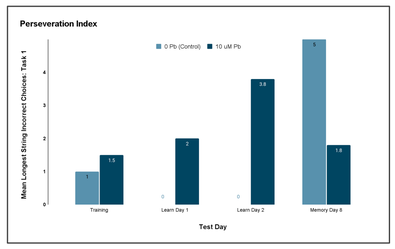


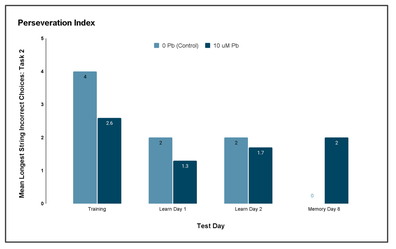
B. Consistency in Choices





C. Perseveration Index

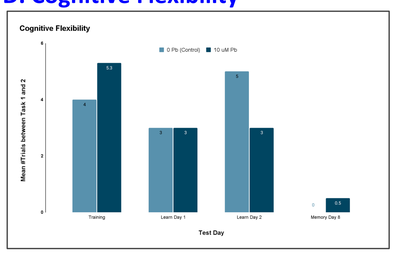




Discussion

Reaching Criterion - Our results show that the control did better at learning the reversal task.
Consistency in Choices - Memory leads to consistent choices and our results indicate that our control was more consistent in making correct choices and therefore had better memory.
Perseveration - Perseverative behavior generally interferes with learning and adaptive behavior and is believed to result from neurologic impairment or brain damage. The lead poisoned fish exhibited more perseveration than the control which could have been as a result of the lead exposure.
Cognitive Flexibility - This is a direct measure of cognitive flexibility, i.e., learning a rule and applying it to a new situation and the control had better overall cognitive flexibility. It seems that the control had better cognitive flexibility.
Our results support our hypothesis that Zebrafish not exposed to lead will perform better than those exposed to lead.

D. Cognitive Flexibility



Results

In Task 1, our control did worse than the lead-poisoned fish and in Task 2 our control did better than the lead-poisoned fish.

The control exhibited better memory and was more consistent in making correct choices than the lead-poisoned fish.

The lead-poisoned fish seemed more impaired than the control in Task 1 but less so in Task 2. However, it did take them longer to make a choice.

The control seemed to have better cognitive flexibility 3 out of 4 times.

Works Cited
Petering, David H., Craig Berg, HenryTomasiewicz, Michael Carvan, Louise Petering, and
Renee Hesselbach. "Zebrafish as Models: Studying the Effects of Environmental Agents on Human Health." 1-96.
UWM, L&S @. "Dan Tmaze Intro Video." Vimeo, 25 Oct. 2021, vimeo.com/192471920.
UWM, L&S @. "Fish Maze Video 1." Vimeo, 7 Mar. 2022, vimeo.com/242307939.
UWM, L&S @. "Fish Maze Video 2." Vimeo, 22 Oct. 2021, vimeo.com/242308857.
"Why Use the Zebrafish in Research?" Facts, The Public Engagement Team at the Wellcome Genome Campus, 21 July 2021, www.yourgenome.org/facts/why-use-the-zebrafish-in-research.