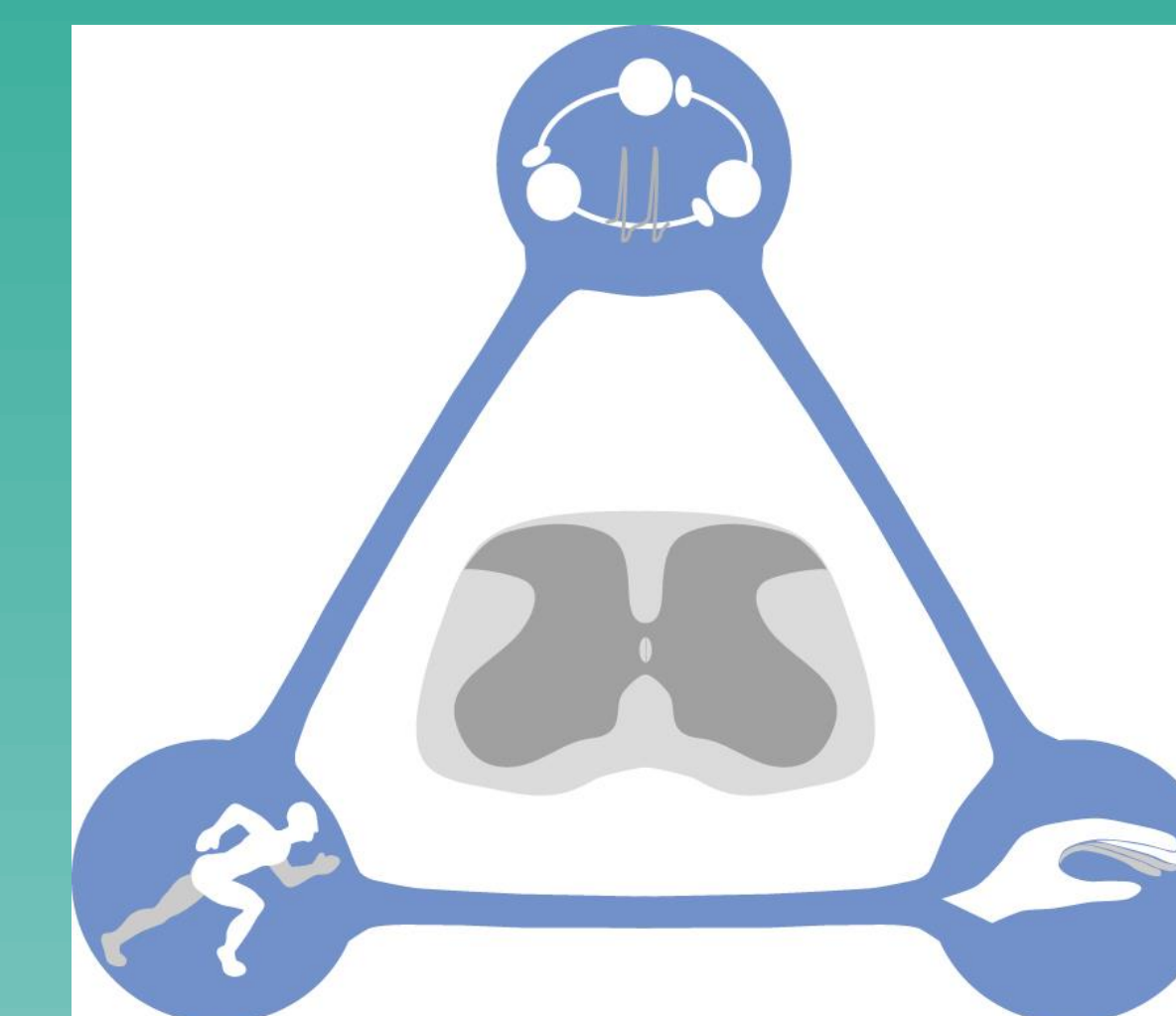




Dopamine Deficiency on Escape Response in Zebrafish Larvae

Gerry Huynh, Adib Dehghany, Marc Ekker, Tuan Bui
Department of Biology, University of Ottawa



uOttawa

Introduction

The **escape response** is an essential survival behaviour adaptively evolved in most organisms. In a recent study by Dunn et al., the escape response has been investigated in zebrafish to gain a better understanding on the conditions required to trigger an escape.¹ In confrontation of a potentially dangerous stimuli, the zebrafish would initiate a quick, sharp turn followed by rapid tail beats away from the stimulus. This instinctive action appears simple at first glance but may involve a complex neural system.

The **neurotransmitter dopamine (DA)** is well known to have many fundamental implications on brain function, not all completely understood yet. A less studied DA function is its involvement in motor control. A deficiency in DA has been found to have negative implications in making motor decisions in those with Parkinson's Disease. Thus, a potential connection can be made between DA and motor processes such as the escape response.

Using larval zebrafish as our model of study, our goal is to determine the effects of DA deprivation on the accuracy of the escape response. We hypothesize that the selection of the direction of escape in zebrafish without DA neurons will demonstrate errors compared to a control group. The findings from this relationship will contribute to a better understanding on the significance of DA on motor decisions from the perspective of a basic response. Ultimately, this can be linked to the role of DA in motor functions in humans and related motor impairments.

Methods

Zebrafish Model

A transgenic strain (Tg(dat:CFP-NTR)) of zebrafish is exposed to metronidazole (MTZ) in the embryo stage. Interacting with NTR, MTZ is converted into a cytotoxic product that selectively ablates DA neurons. After 5 days of continuous drug treatment, the zebrafish larvae are put in an observation chamber for experimentation.

Stimulus

A dark looming circle on a bright white background was found to be effective in previous works and was used as the stimulus to evoke an escape response in the zebrafish for this experiment.² The looming circle was designed to appear to approach with constant velocity.

Experiment

Zebrafish larvae were placed in a Petri dish with the sides covered in black. The looming circle was projected from below and positioned to appear in certain positions relative to the zebrafish. Using a microscope and camera, the escape directions of the zebrafish were recorded.

Methods

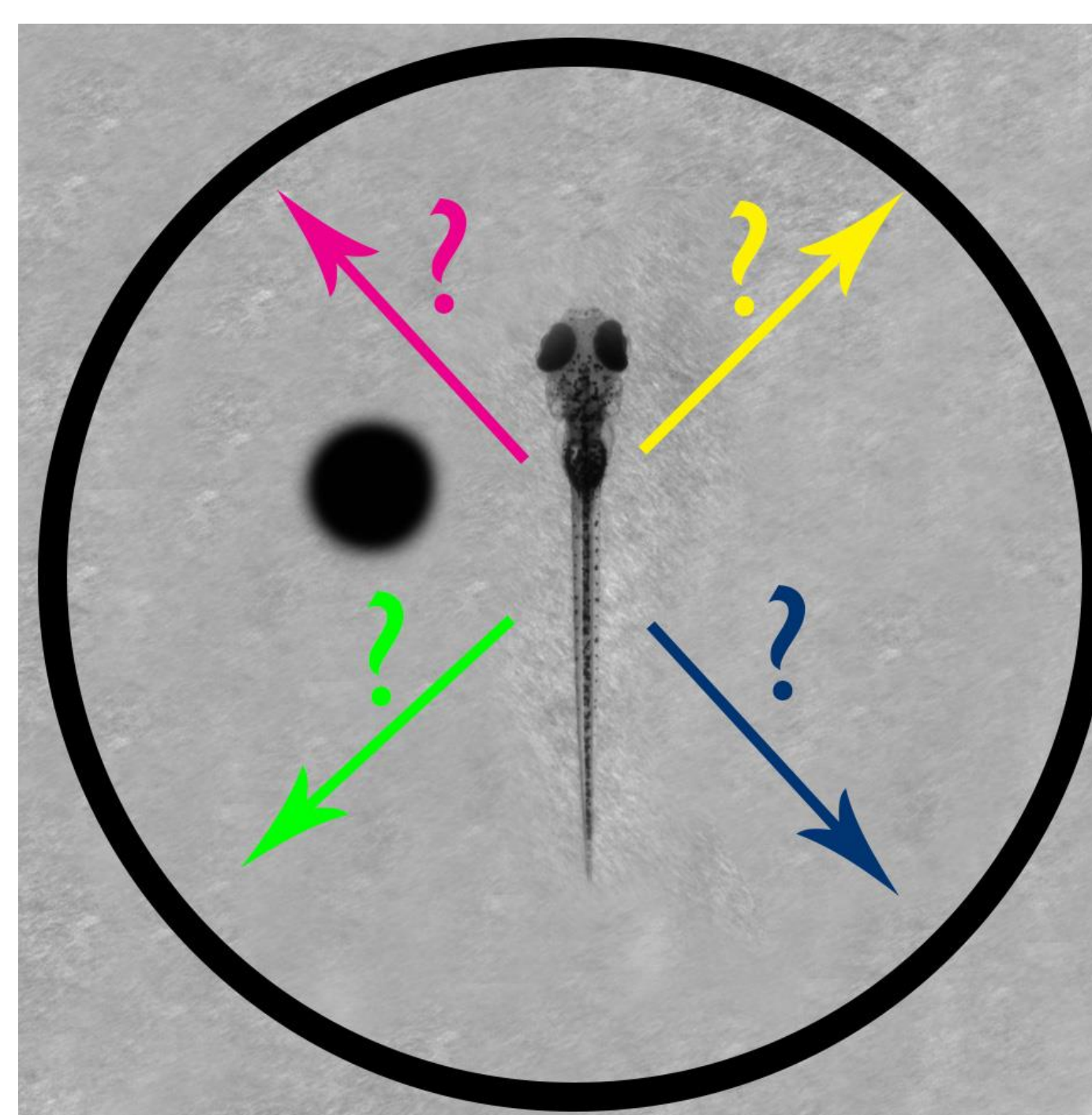


Figure 1. Experimental design with larval zebrafish. The small black-filled circle represents the stimulus. The outer black ring represents the Petri dish observation chamber.

Results

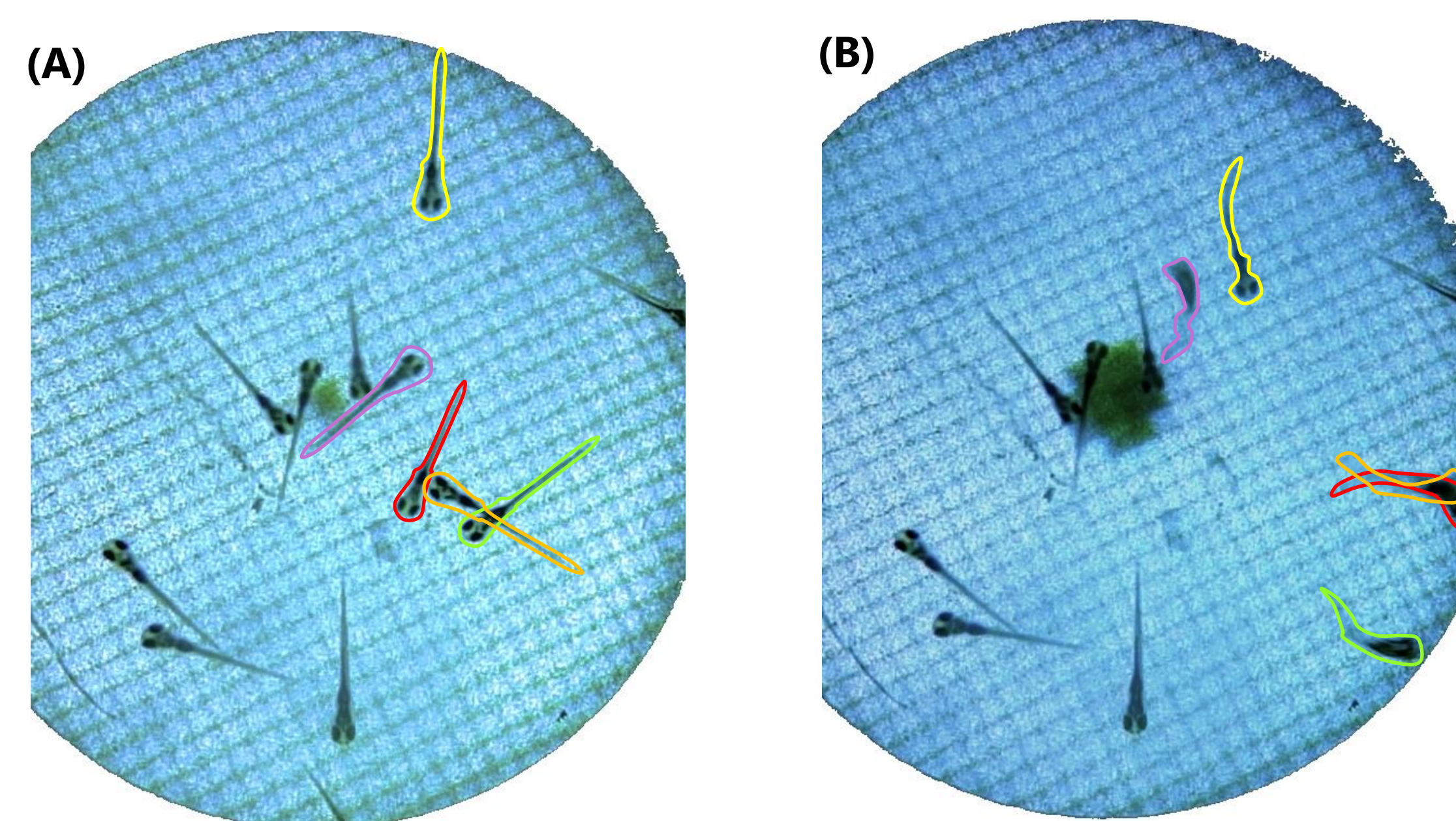


Figure 2. Before (A) and after (B) escape response triggered by looming circle in centre for control group. Highlighted in colour are fishes that have displaced after looming circle started.

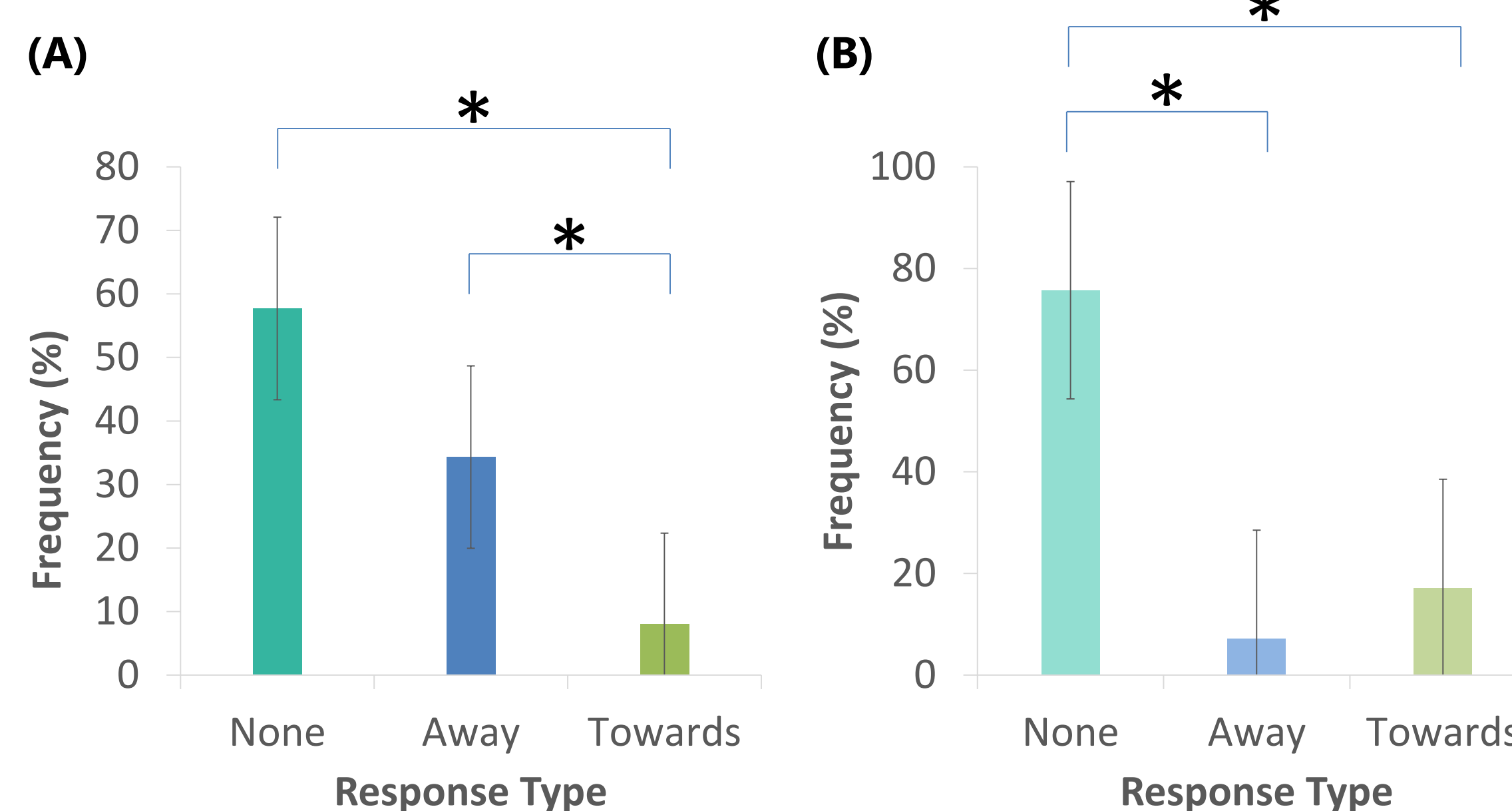


Figure 3. (A) Average frequency of direction of escape from larval zebrafish in **control** group. (n=10 average). Number of trials=7. (B) Average frequency of direction of escape in **experimental** group. (n=4 average). Number of trials=8. Single factor ANOVA followed by paired t-tests with bonferroni correction. *p<0.01.

Conclusions

We were able to successfully evoke movement responses in a group of free swimming larval zebrafish of the control group through a dark looming circle visual stimulus. It can be seen that the majority of the responses were away from the stimulus rather than towards, and this has consistently been the case through multiple trials. Therefore, a convincing direction of escape is ready to be used for further analysis of the escape response in larval zebrafish deprived of DA neurons.

Future Steps

In the future we will test the effects of looming circle stimulus that disappears from one side and reappears on the other side of the zebrafish. By doing this, we will have the opportunity to further our understanding of the effects of dopamine on the escape response and how the decision making process is influenced. Additionally we hope to identify neurons significant in this decision making process.

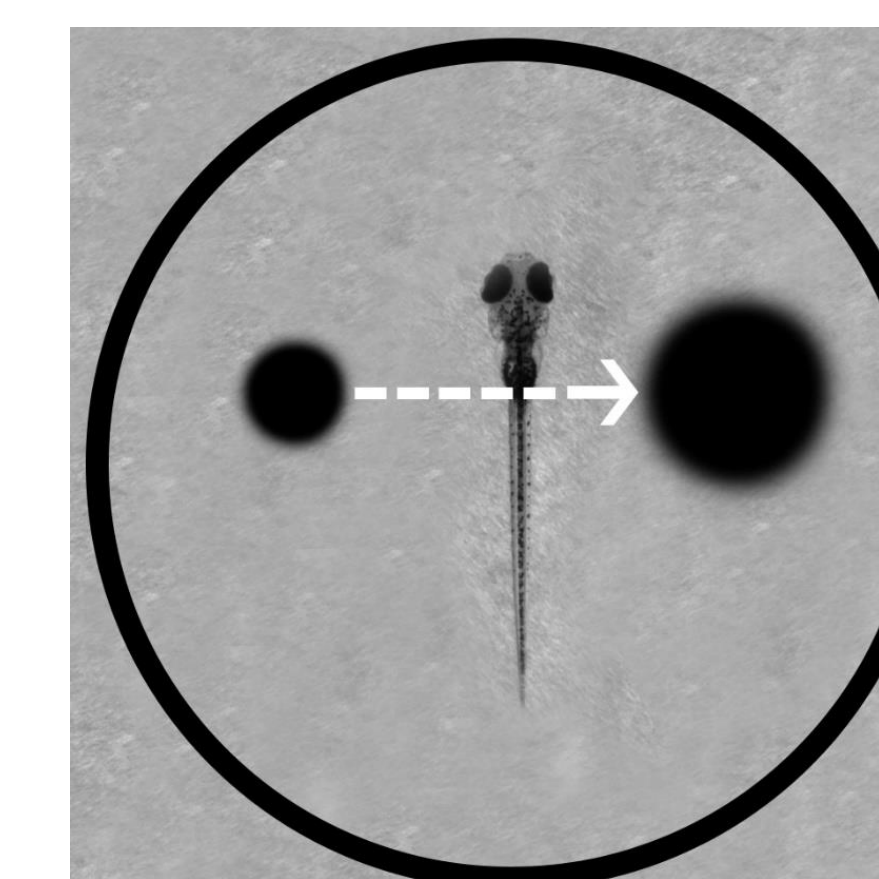


Figure 4. Representation of future experiment where looming circle disappears and reappears on opposite side of zebrafish.

Bibliography

- Dunn et al. (2016). Neural circuits underlying visually evoked escapes in larval zebrafish. *Neuron* 89(3): 613-628
- Termizer et al. (2015). A visual pathway for looming-evoked escape in larval zebrafish. *Current Biology* 25(14): 1823-1834.

Acknowledgements

I would like to thank Adib Dehghany and Dr. Tuan Bui for their mentorship, guidance, and continued support, as well as UROP and NSERC for funding for the project.

