Behavioral Assay for Evaluating Sound Change Detection in Mice

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Introduction

- We want to determine which parts of the auditory system are necessary for performing change detection tasks.
- We designed a change detection task in which a mouse will respond when and if a sound changes.
- **How do we design a training protocol that teaches an animal to perform the change detection task?**

Methods

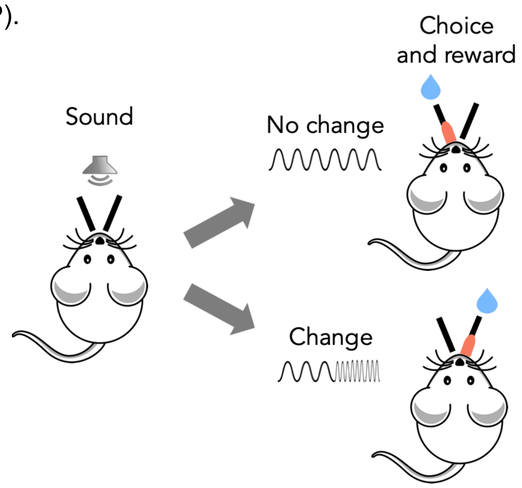
Set Up for Experiment

- 6 head-fixed mice were used.
- We designed a two-choice change detection task using a lickometer that dispensed a water reward when the mouse correctly performed the task.
- The mice were placed on water restriction to incentivize them to respond to the task.

Change Detection Task

A sound could be presented in two ways:

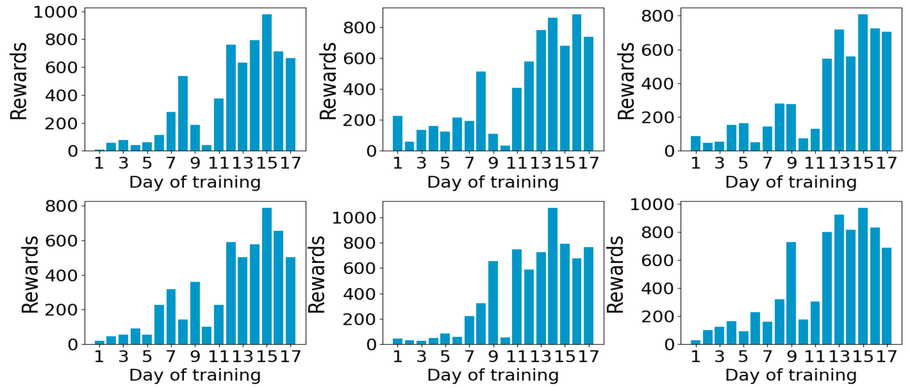
- In an unchanging trial, the presented sound doesn't change, and a reward is available after the sound at the left port.
- In a changing trial, the sound changes halfway through the presentation, and a reward is available as soon as the sound changes at the right port.
- There was a limited amount of time to receive the water reward, defined here as the reward availability period (RAP).



Results from Training Stages

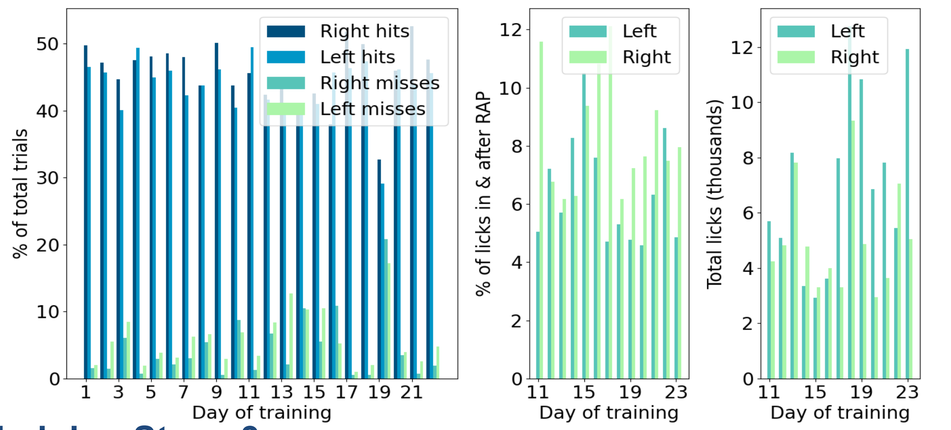
Training Stage 1

A mouse will learn that licking will produce a water reward.



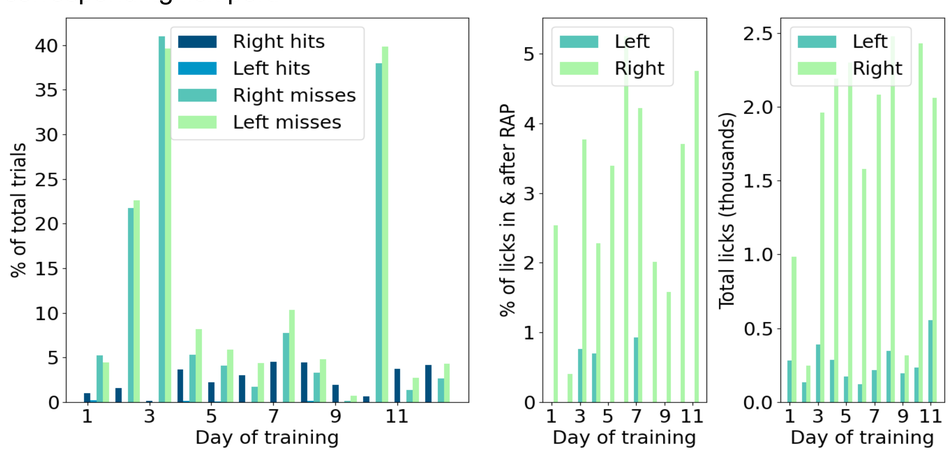
Training Stage 2

A mouse will learn there is a limited amount of time to receive the water reward.



Training Stage 3

A mouse will learn the correct association between the sound and corresponding lick port.

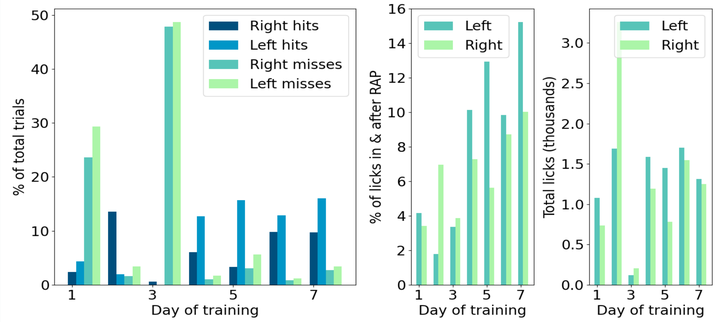


Analysis

- Stage 1 was successful in teaching the mice to lick the ports for the reward.
- Stage 2 focused on reward timing with no penalties for licking at the wrong time or licking the wrong port. Because there were no repercussions, they learned to lick constantly until they received a reward.
- In Stage 3, the mice developed a bias towards the right port because the changing trial gave a reward sooner than the unchanging trial.

Results from Stage 4

To address these problems, we implemented a negative reinforcement (buzzer) to teach the mice when they licked the wrong port or at the wrong time.



This mouse unlearned the bias from Stage 3 and decreased the overall amount of licks, which meant the mouse was more willing to engage in the task.

Conclusion

- By analyzing the original three training stages, we realized that the mice were not engaged in the task because of the large number of licks in each training session. Through implementing the negative reinforcement, the mouse became more engaged with the task by licking less overall and performed better over time.
- Because of the buzzer's success, we will implement it sooner when training future cohorts of mice.
- Once a mouse can perform the change detection task, we can implement optogenetic techniques allowing us to determine the role of different auditory brain areas in change detection tasks.

Acknowledgments

NIH National Institutes of Health

SPUR University of Oregon Summer Program for Undergraduate Research

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