Neural Basis of Speech Sound Discrimination

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Introduction

- Neural mechanisms of language learning can help illuminate efficient learning strategies
- First, we must design a behavioral model for studying sound discrimination in animals
  - Mice are good animal models for their ability to discriminate human speech sounds and for accessibility in brain recording
- In this project, we trained the mice to do a two-alternative choice task with simple sounds

Project Goals

To train to discriminate sounds stimuli and assess their ability to learn the task

Methods

- Daily head-fixed sound discrimination training (Fig. 1)
- Behavioral data analysis with Python
- Goals of each of the training stages:
  - Stage 1: Mice associate water award with presentation of sounds
  - Stage 2: Mice lick after the presentation of a sound to receive award
  - Stage 3: Mice lick correct side for water reward
  - Stage 4: We can assess the mice's ability to discriminate sounds
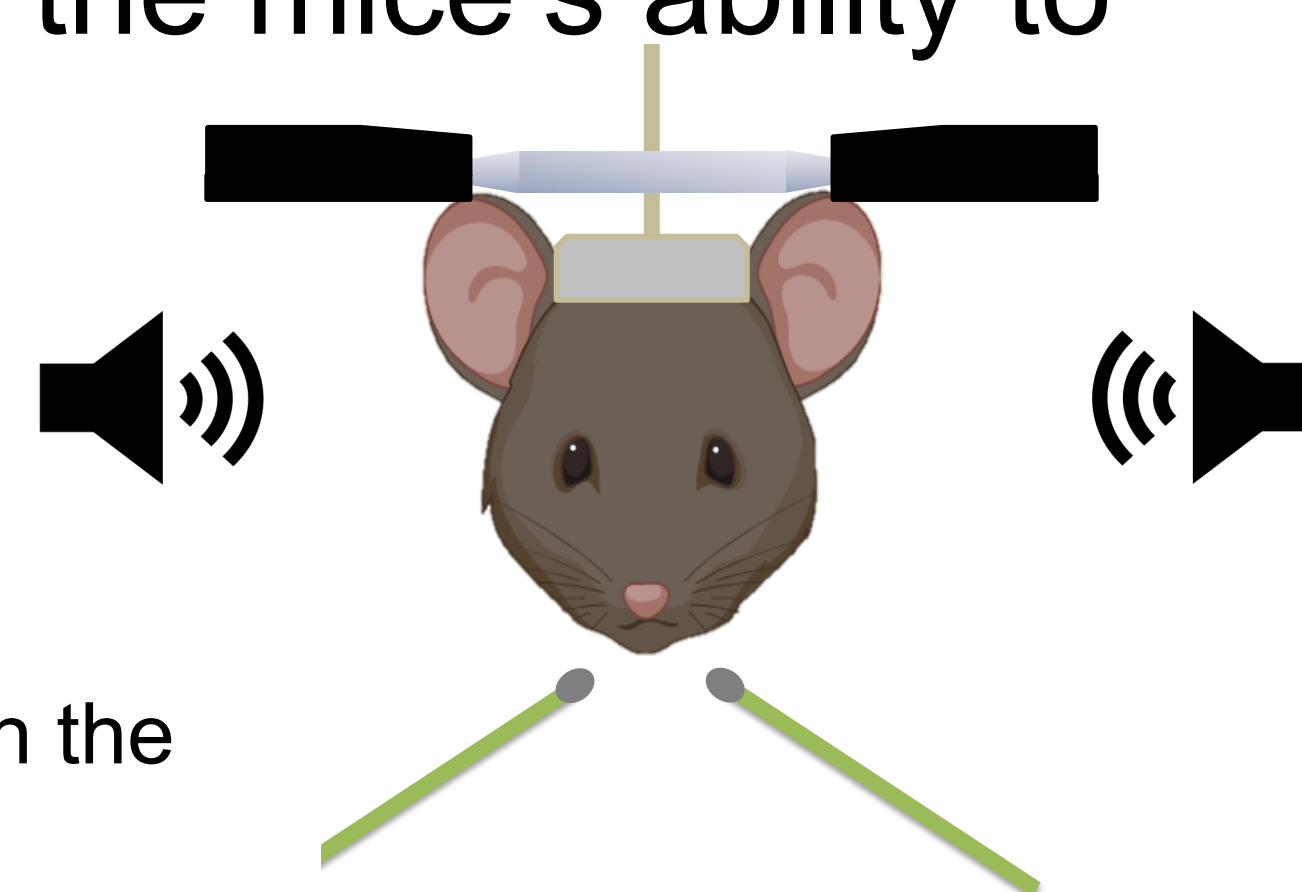 - Repeat last two stages using different sounds

Figure 1. Set-up of mice in the head-fixed rig

Performance in frequency discrimination tasks

When we used high/low frequencies for the discrimination, mice showed significant improvement between the first and last sessions of training (Fig. 2). However, when using middle frequencies, mice exhibit little to no improvement from baseline (Fig. 3).
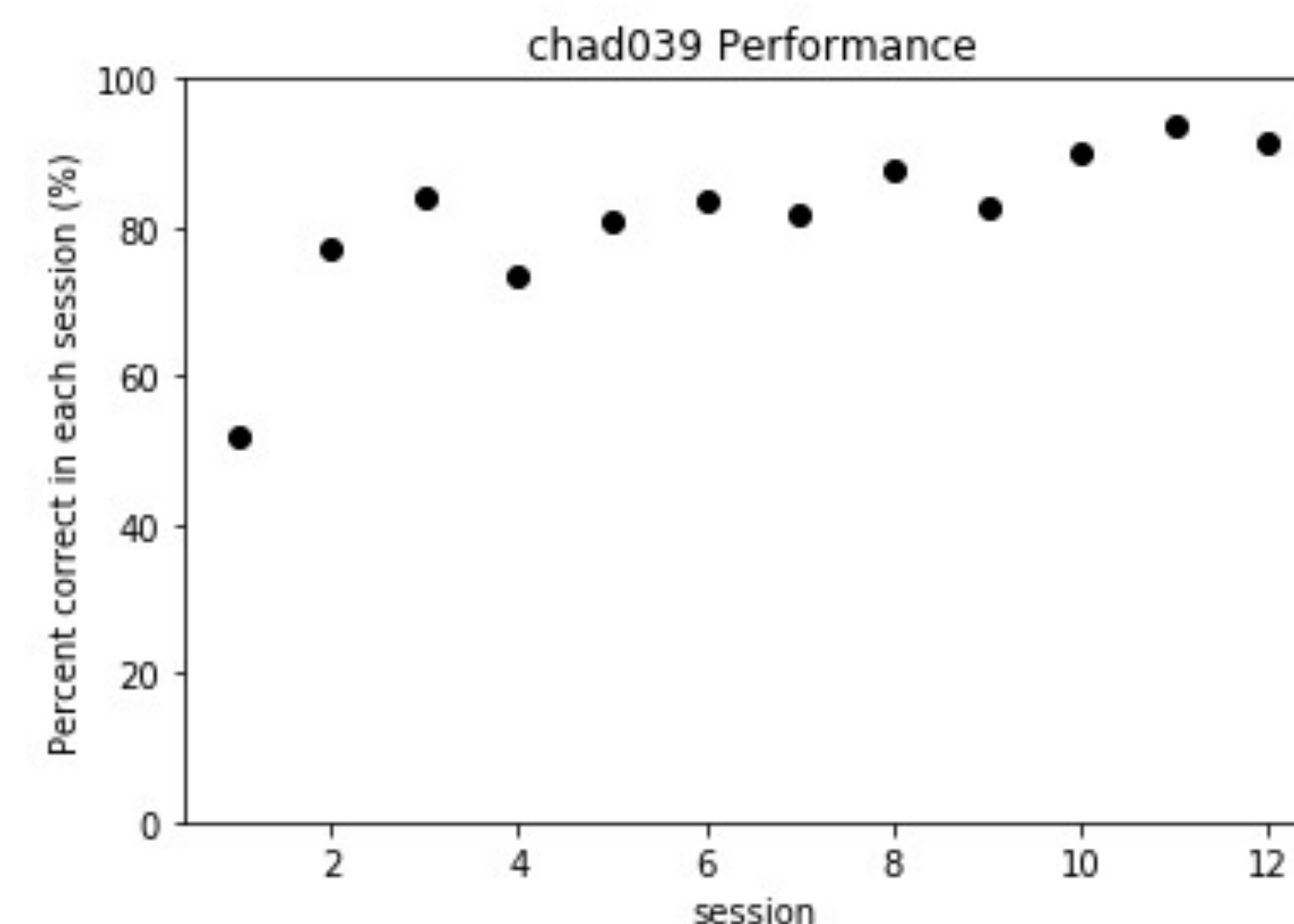
Figure 2. Example: chad039's performance in the high/low frequency discrimination task.
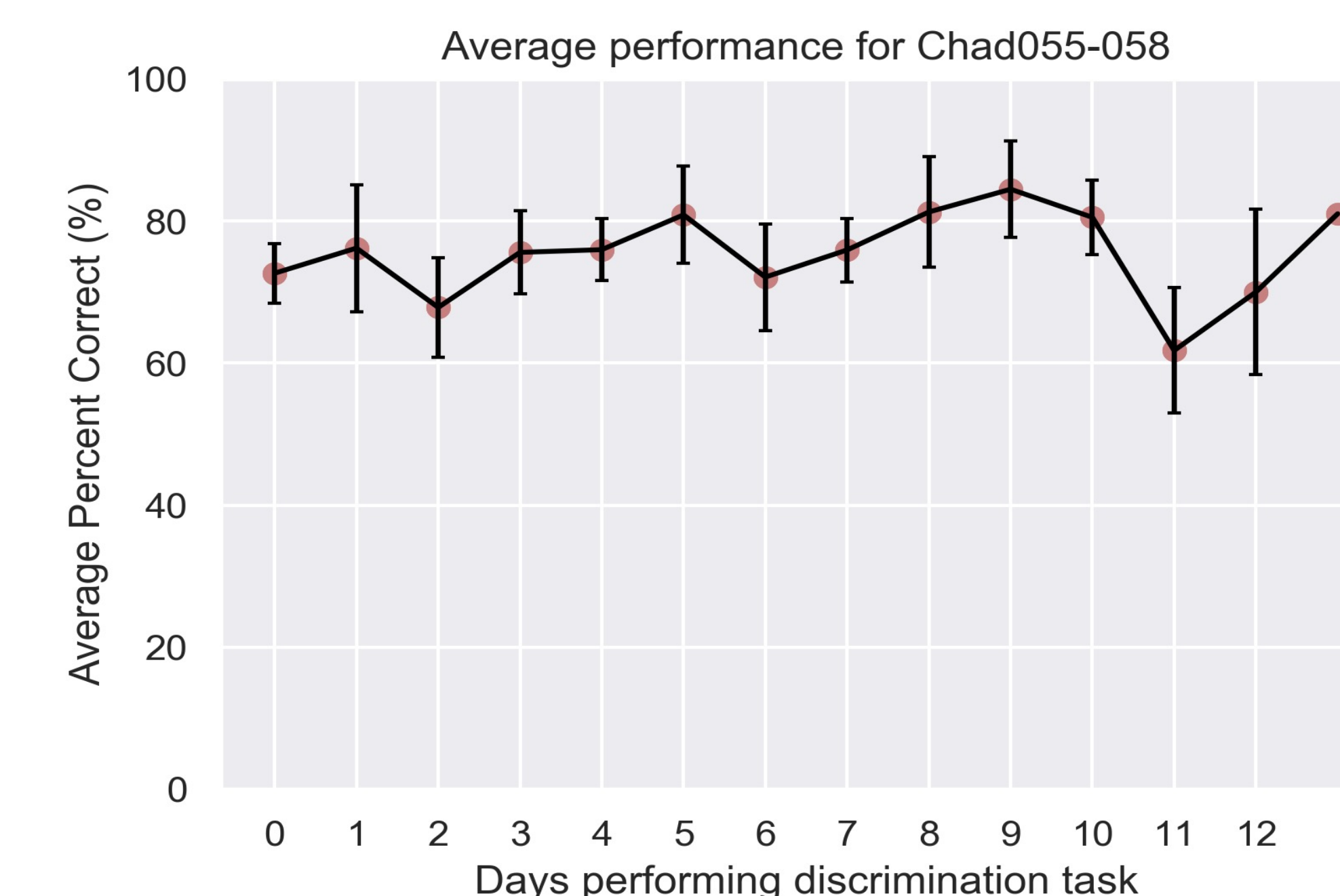
Figure 3. Average mouse performance for middle frequency discrimination task

Performance in AM frequency discrimination tasks

Despite multiple weeks of training, mice were unable to move past stage 3 in AM frequency discrimination tasks (Fig. 4). We expect mice to lick 0.3 sec after sound presentation, but perhaps they lick too early. Changing the procedure to implement a listening period for the mice (Stage 3.5) failed to result in a delayed lick time. (Fig. 5). Punishment paradigm might be substituted instead.
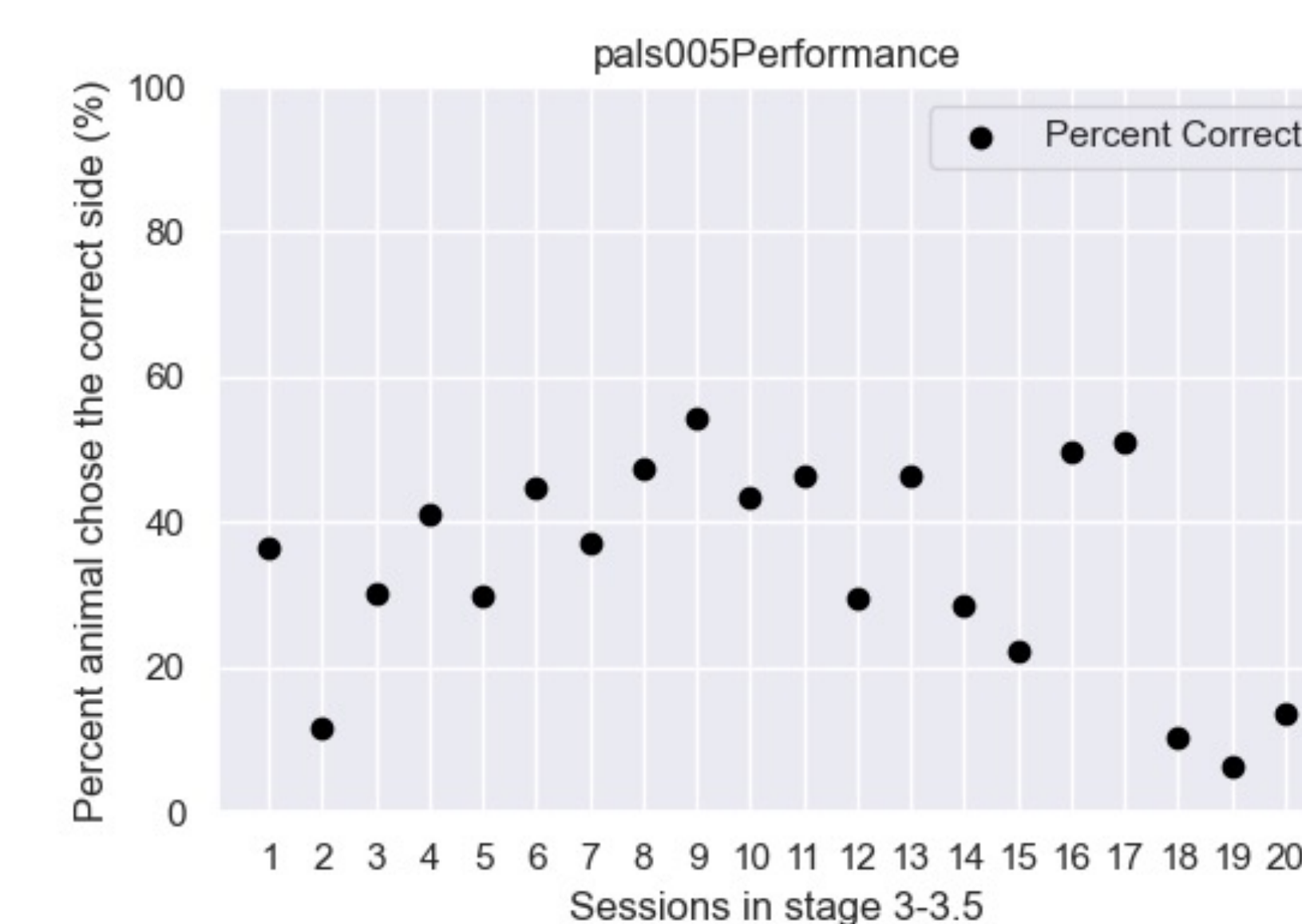
Figure 4. Example: pals005's performance for AM frequency discrimination
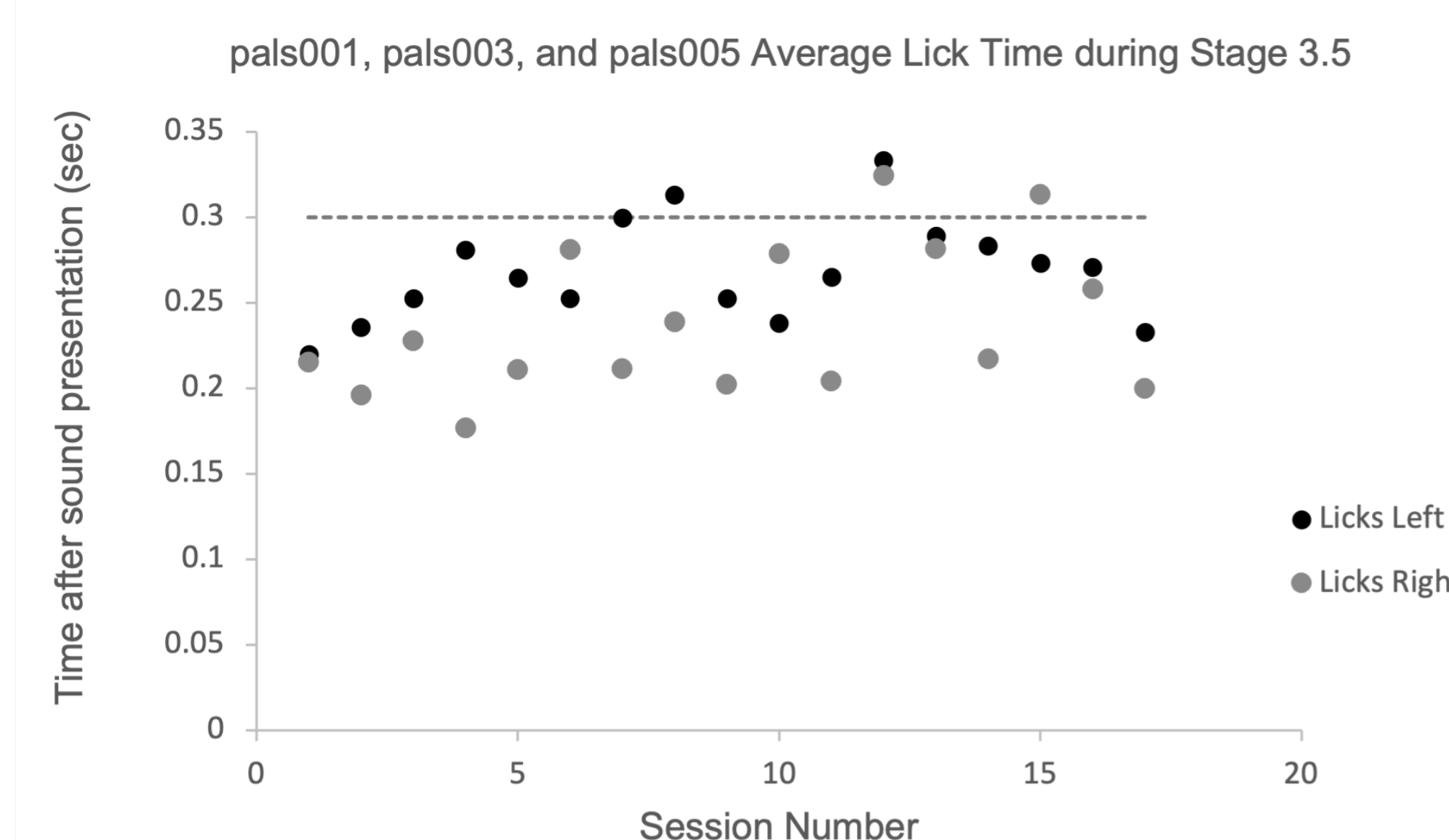
Figure 5. Average time of first licks for pals001, pals003, and pals005

Conclusions

Mice have demonstrated ability to discriminate between high and low frequencies, but not middle frequencies. Currently, we are still working on strategies to teach mice to discriminate between AM frequencies

Future Directions

- Train the mice with simple sounds using combinations of active training and passive exposure
- Train using active / passive approaches with complex sounds
- Train during electro-physiological recordings

Acknowledgments