

Computational Tools for Behavioral Analysis of Zebra Finch Attractin Mutants

Minh Nhat Le

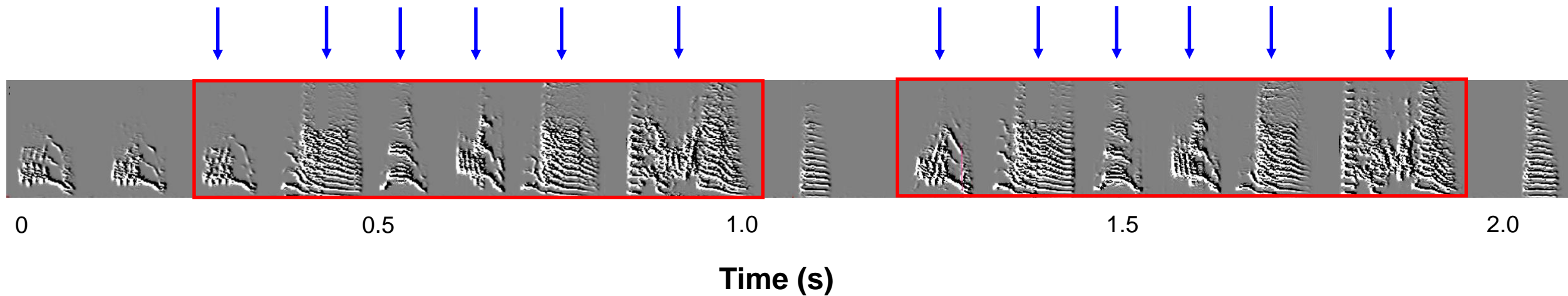
Mentors: Carlos Lois and Tarciso Velho



The zebra finch as a model for vocal learning

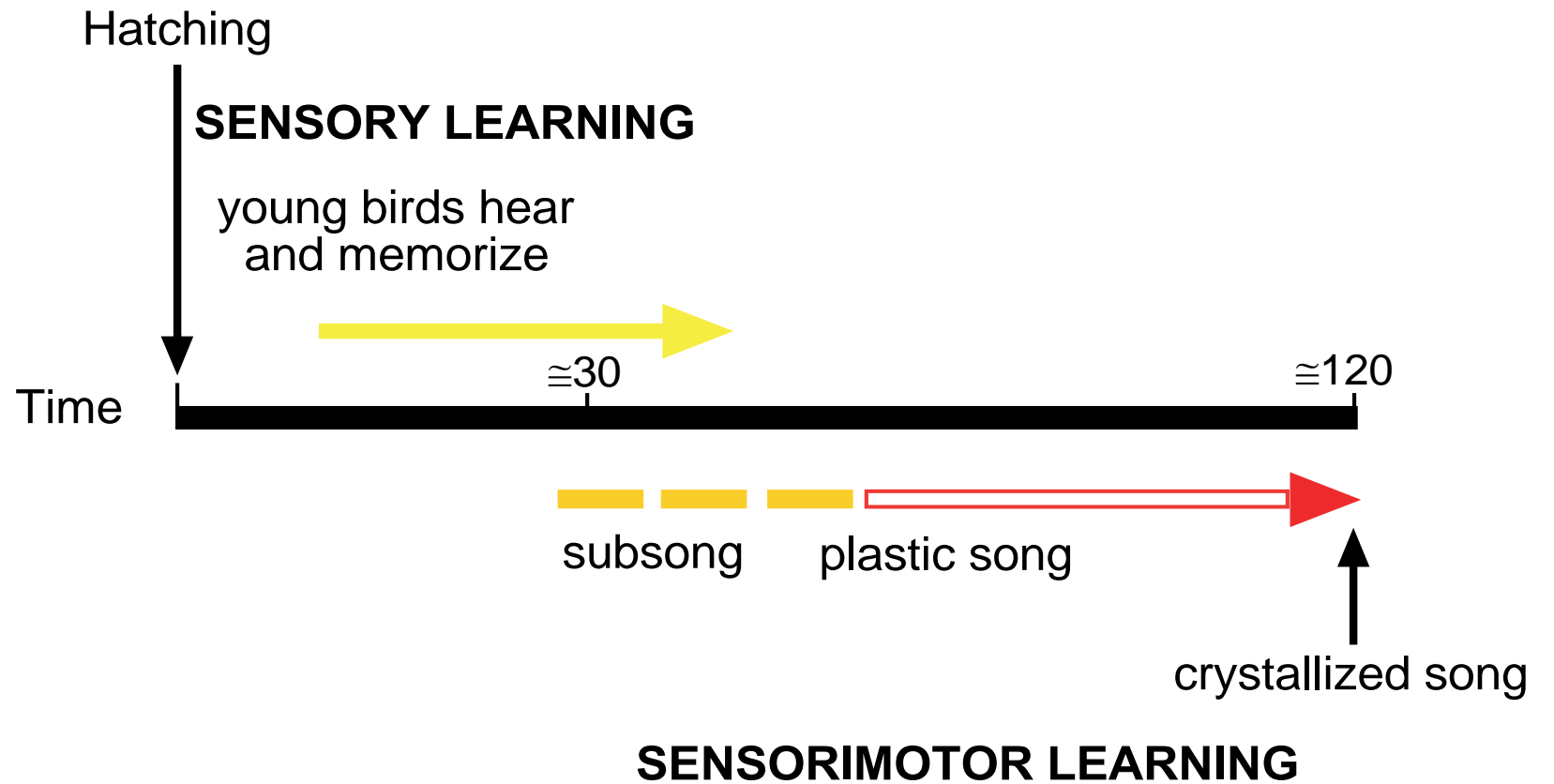


Bird songs consist of repeatable patterns of *motifs*, which are made up of *syllables*



The zebra finch as a model for vocal learning

Zebra finches
*learn their songs
from their tutors.*



The zebra finch as a model for vocal learning

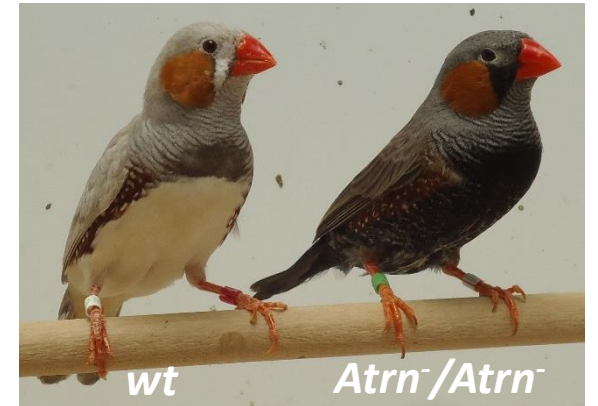
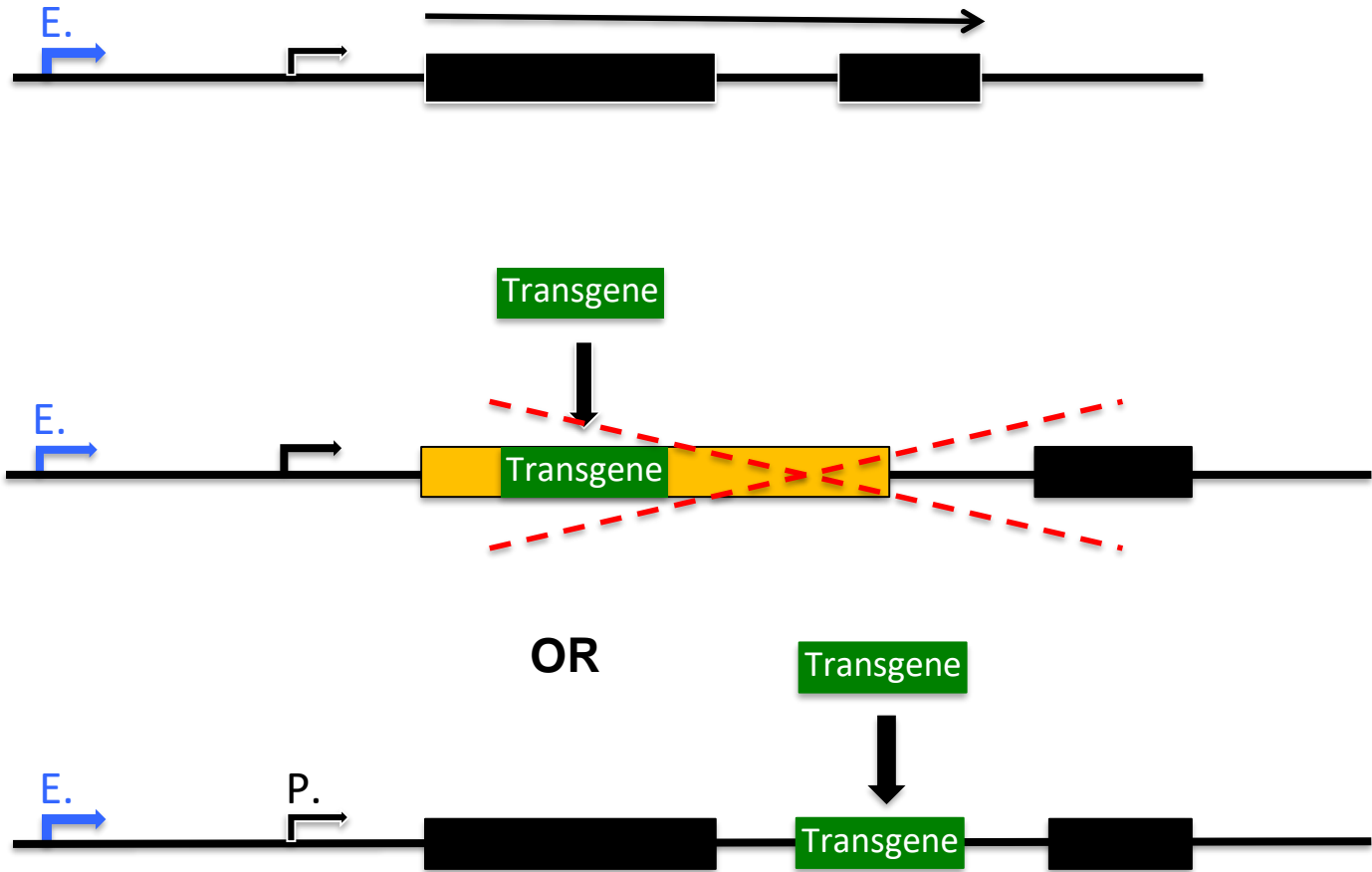


Song development is similar to speech acquisition:

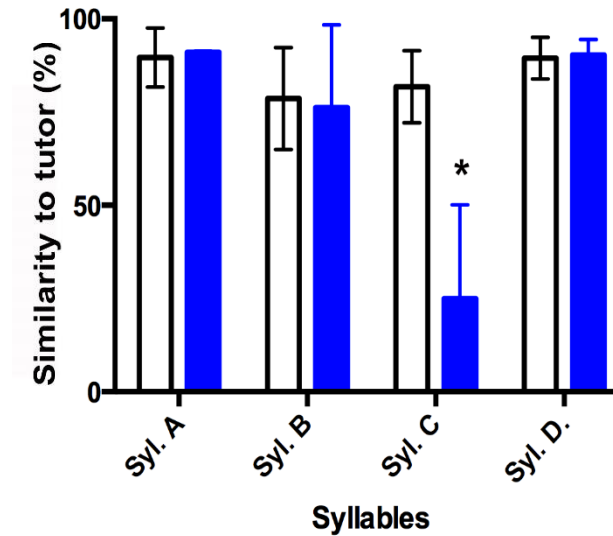
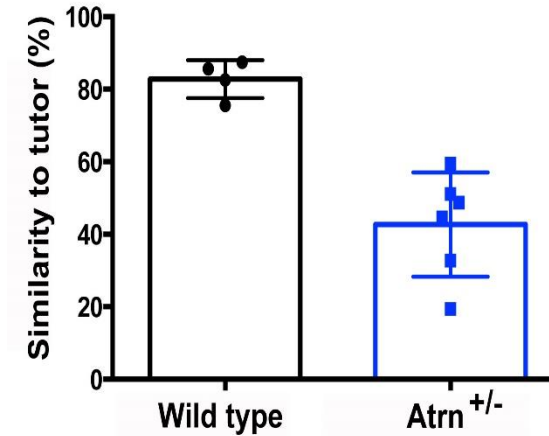
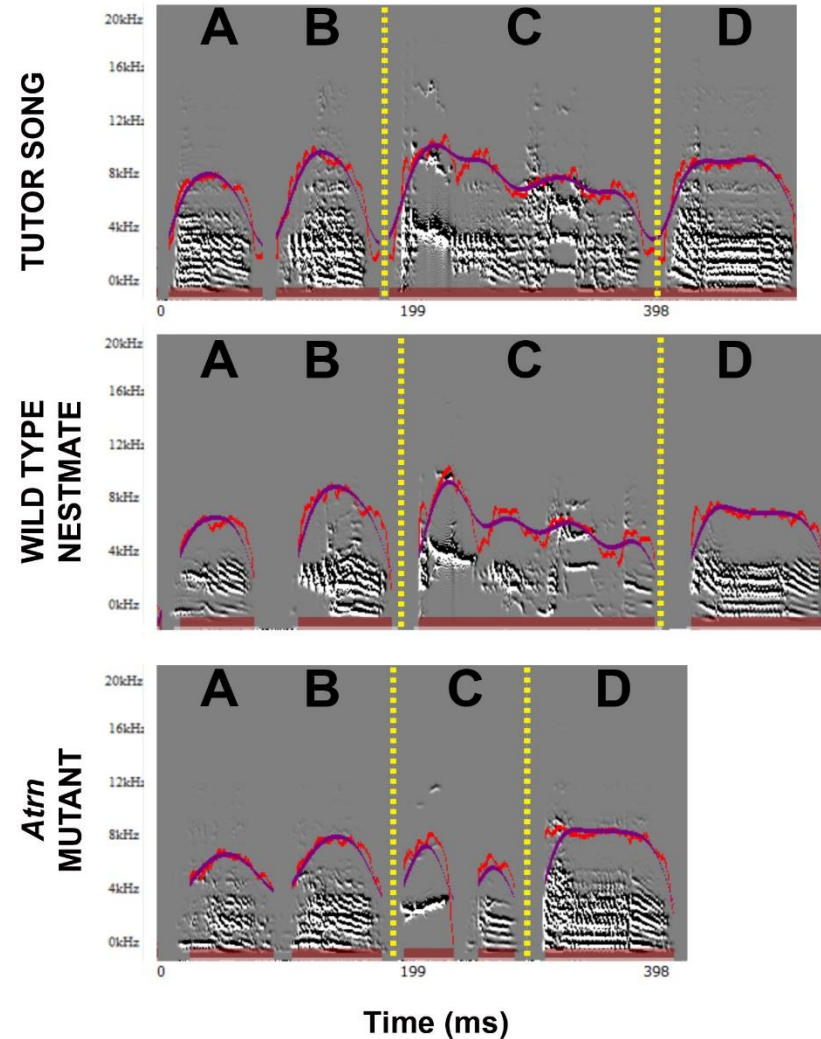
- A **critical period** of vocal learning
- Requirement of **intact hearing**
- **Set of circuits** dedicated for learning and production of vocalizations.

→ Important in studying neurodevelopmental disorders, including autism spectrum disorders (ASD).

Lentivirus-mediated transgenesis in zebra finches



Lentivirus-mediated transgenesis in zebra finches



Questions

1. Do Atrn mutants exhibit other behavioral abnormalities?
2. What causes the song-learning deficit in Atrn mutants?



Questions

- 1. Do Atrn mutants exhibit other behavioral abnormalities?**
2. What causes the song-learning deficit in Atrn mutants?



Motivation



Attractin mouse mutants

- ✓
- ✓
- ✓

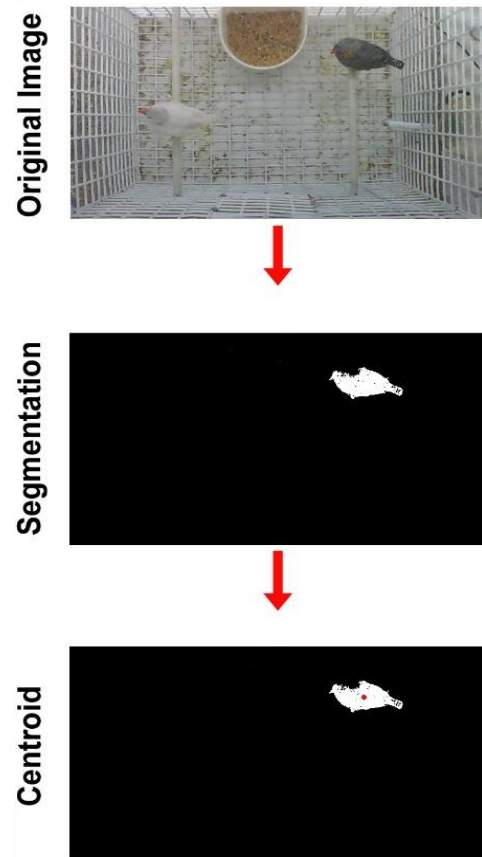


Attractin finches

- ✓
- ?
- ?

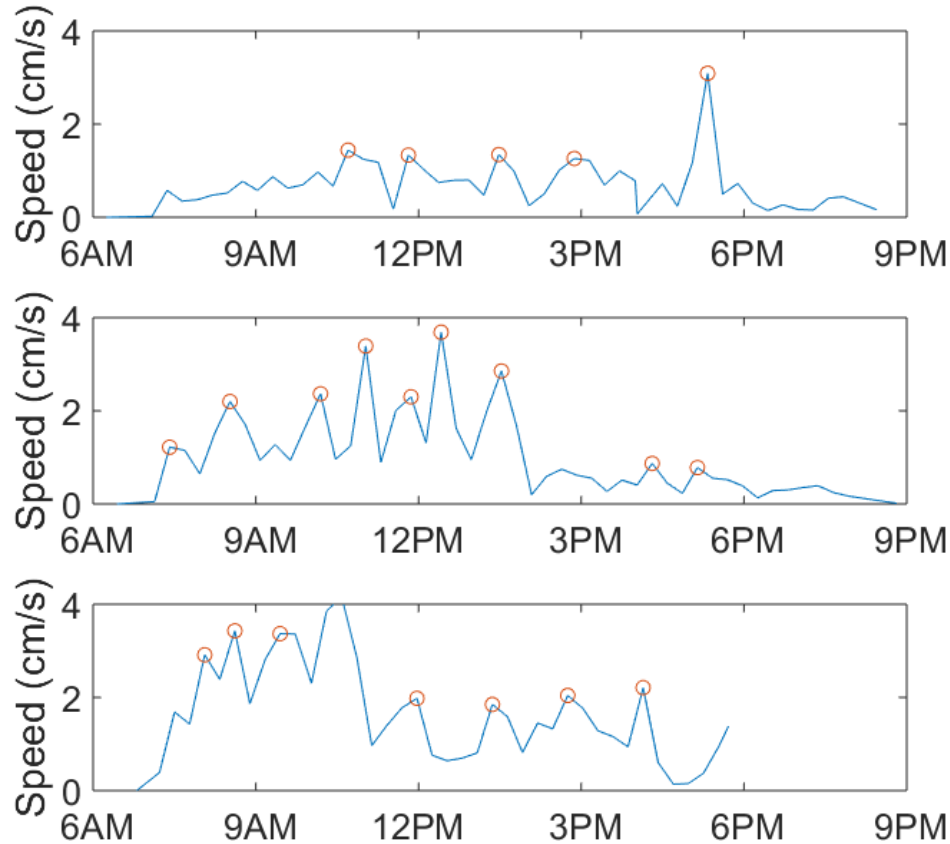
Dark coloration
Hyperactivity
Decrease in density of myelin and
abnormal formation of myelin sheath

How can we measure finch activity?

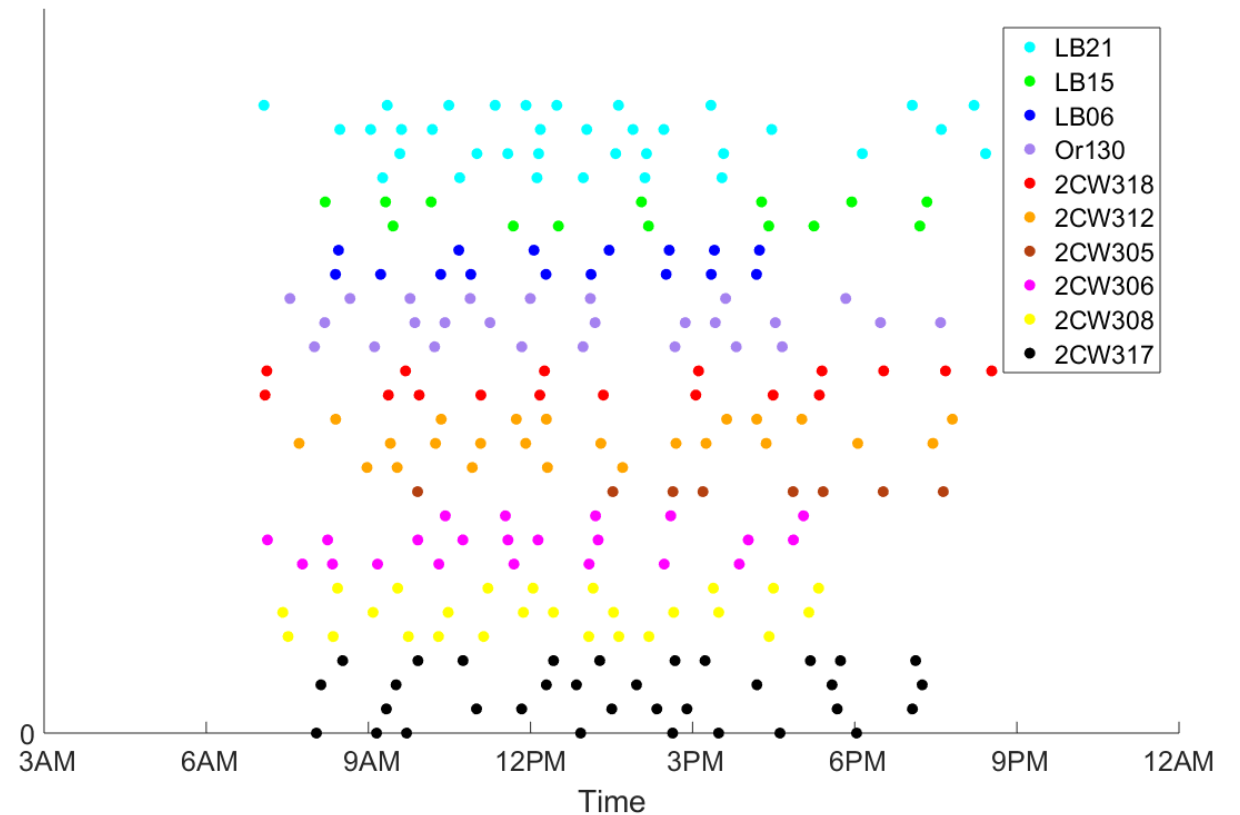


Demonstration of the output of the tracking algorithm

Results – activity levels

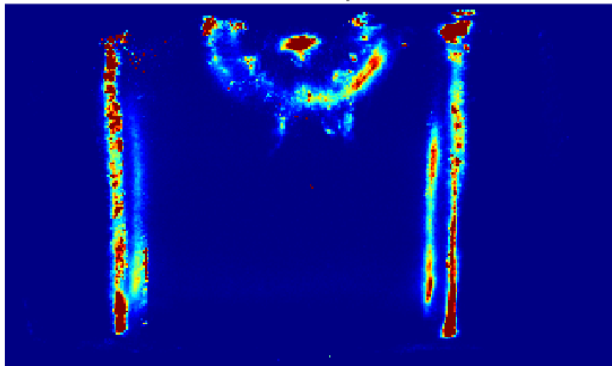


Example activity profile across 3 days

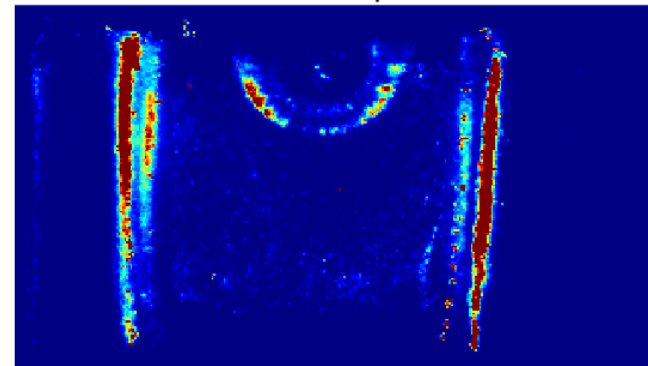


Bouts of activity of different animals

Heat maps

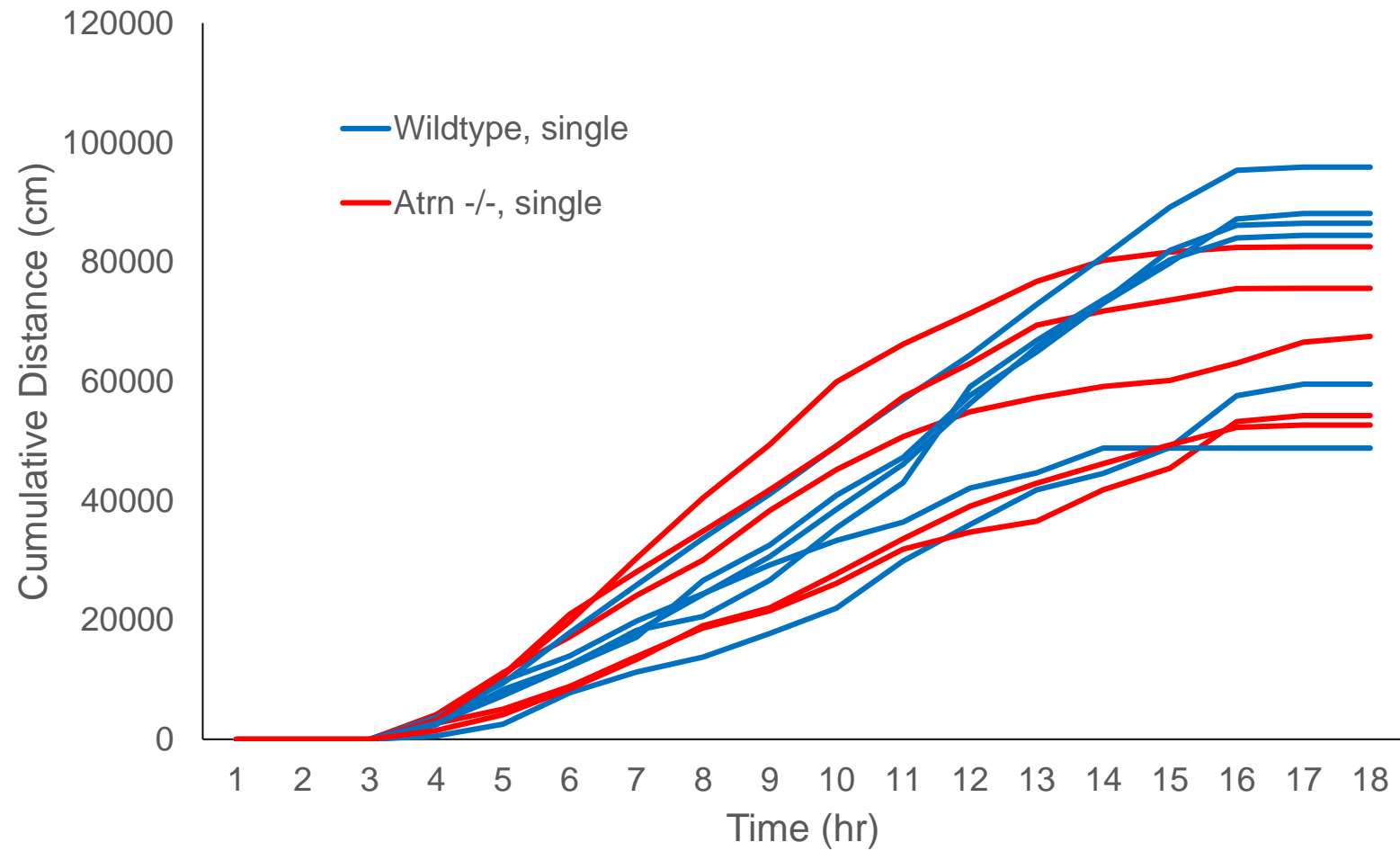


Wild-type



Atrn^{-/-}

Cumulative distance



Summary

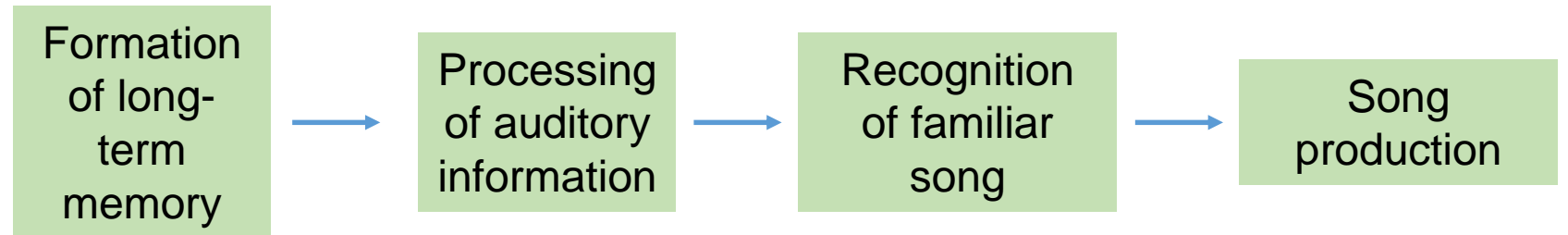
1. **Do Atrn mutants exhibit other behavioral abnormalities?**
2. What causes the song-learning deficit in Atrn mutants?



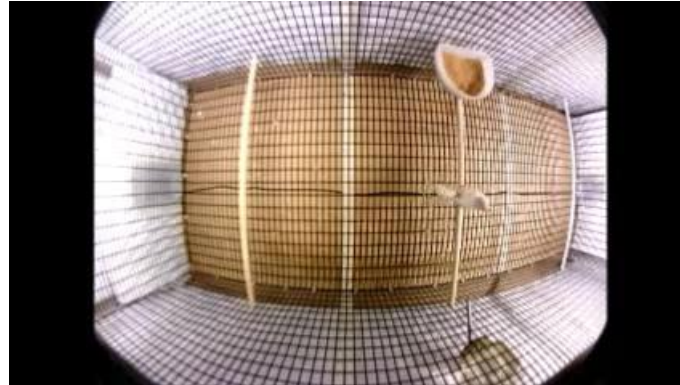
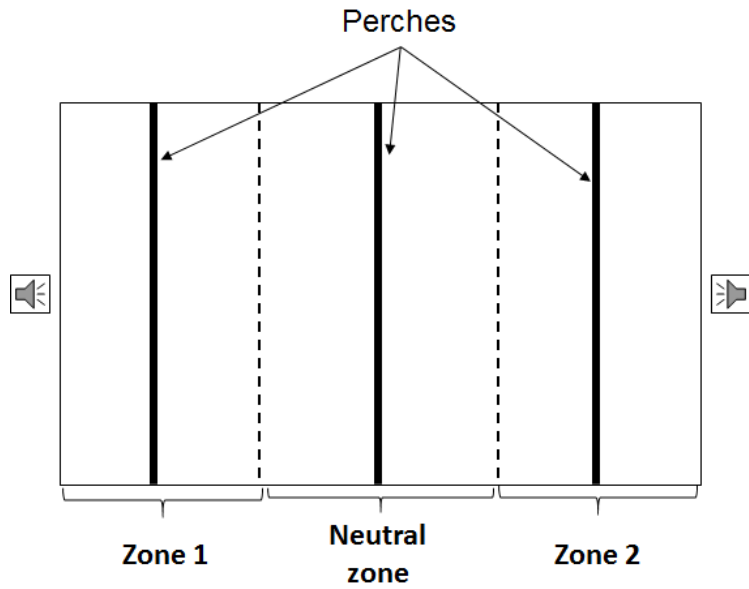
- **No hyperactive behavior** when singly-housed.
- However, could be hyperactive when paired with a companion female (study in progress).

Questions

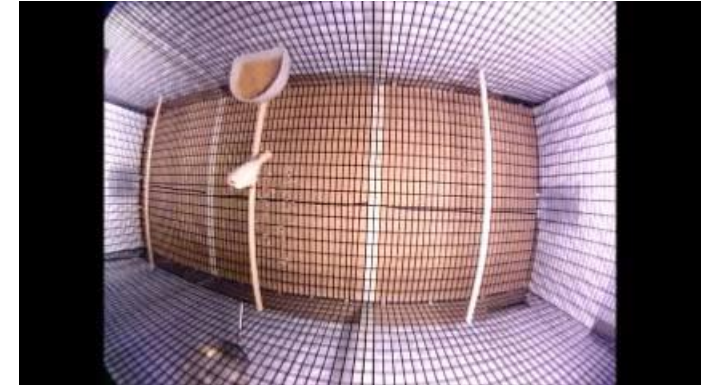
1. Do Atrn mutants exhibit other behavioral abnormalities?
- 2. What causes the song-learning deficit in Atrn mutants?**



Song preference test

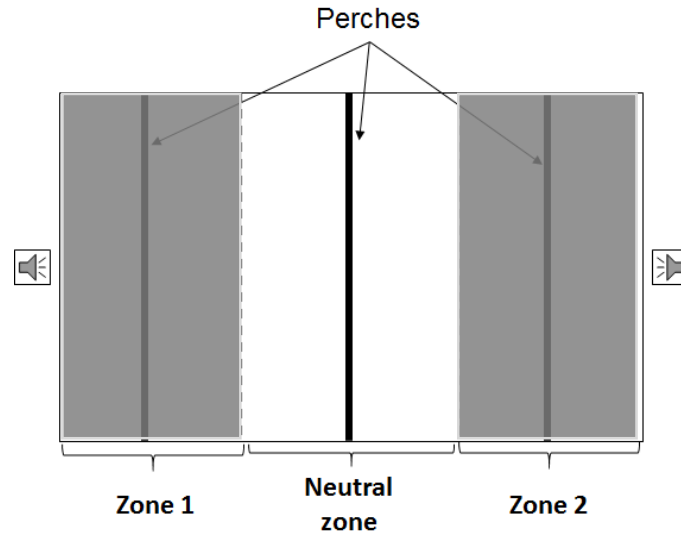


Wild-type response to
tutor's song

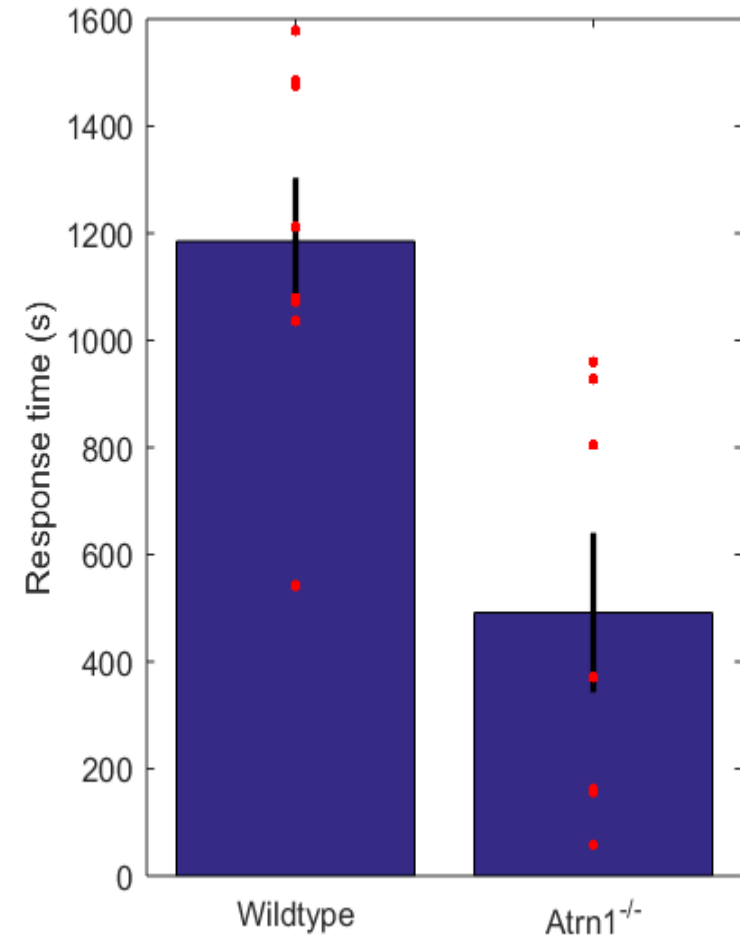


Wild-type response to
novel song

Song preference test – results



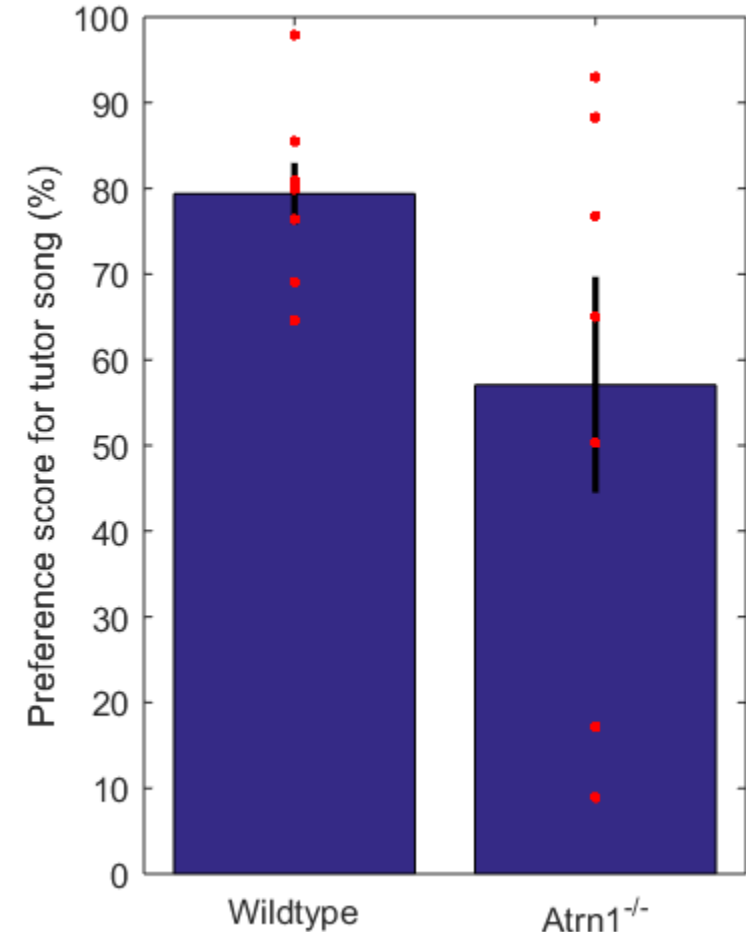
- **Response time**: total time spent in the approach zones.
- Attractin mutants showed a **significant decrease** in response time ($p < 0.01$)



Song preference test – results

$$\text{Preference score} = \frac{\text{Time spent in tutor's zone}}{\text{Response time}}$$

- **Wild-type animals** showed *moderate preference for the tutor song* (65 – 80% preference)
- **Attractin mutants** showed a wide spread of preference scores (10% - 90% preference)



Summary

1. Do Atrn mutants exhibit other behavioral abnormalities?
2. **What causes the song-learning deficit in Atrn mutants?**



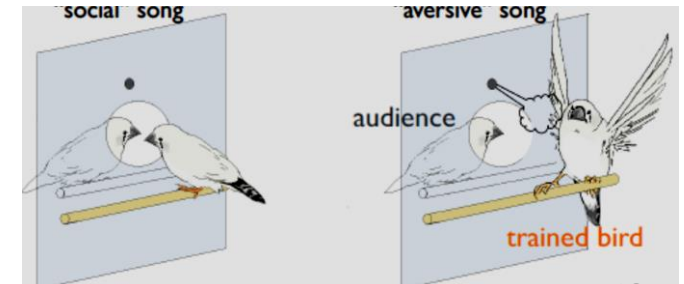
Significant deficit in song-preference behavior

Possibility 1: Failure to recognize familiar song

?

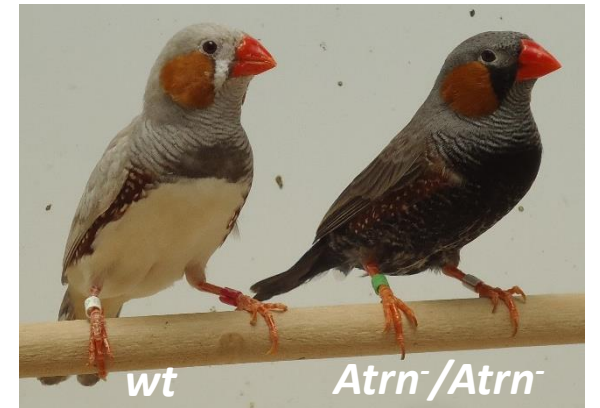
Possibility 2: Failure to express a preference

In progress: Dissociate these two causes by a **conditioning experiment** (avoid aversive stimulus associated with a song)



Conclusion

1. **Attractin mutants** offer a unique opportunity to study the circuits involved in vocal learning.
 2. **Novel computational methods** developed:
 - Automated motion-tracking
 - Semi-automated song preference test
 3. Attractin mutants:
 - Did not show hyperactive behavior when singly housed.
 - Displayed deficits in song-preference behavior
- Promising first steps towards a better understanding of the mutants' song-learning deficit.



Acknowledgement

Many thanks to

- My mentors, Carlos Lois and Tarciso Velho
- Caltech Student-Faculty Program
- Named SURF donor, Mrs. Maria Chan

