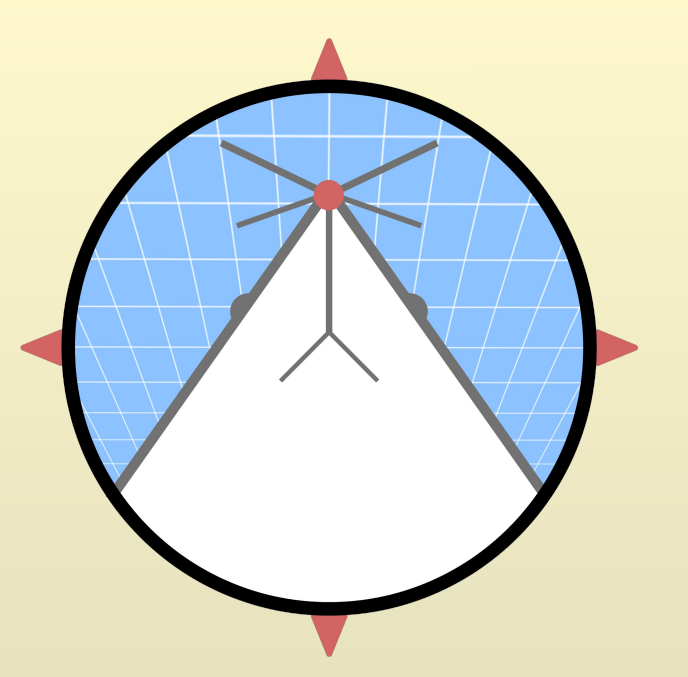# Teaching Rats to Drive: A Novel Method for Spatial Navigation Research in Rats

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Background

Spatial Navigation

Spatial learning is a popular assessment of cognitive abilities in rodents models. However, previous research tends to consider spatial navigation in the natural context of using its limbs as the primary means of locomotion and typically either let rats have the freedom to navigate and run at the same time (Tolman, Ritchie, & Kalish, 1946) or restricted their running ability and navigation together (Stackman, Golob, Bassett, & Taube, 2003).

A New Approach

The current study aims to separate spatial navigation from running on foot and explores the necessity of running in spatial navigation by introducing rats to a car they can drive. Using a specialized protocol utilizing principles of operant conditioning, six female Long-Evans rats were taught to operate a car in order to reach an intended destination with reinforcers.
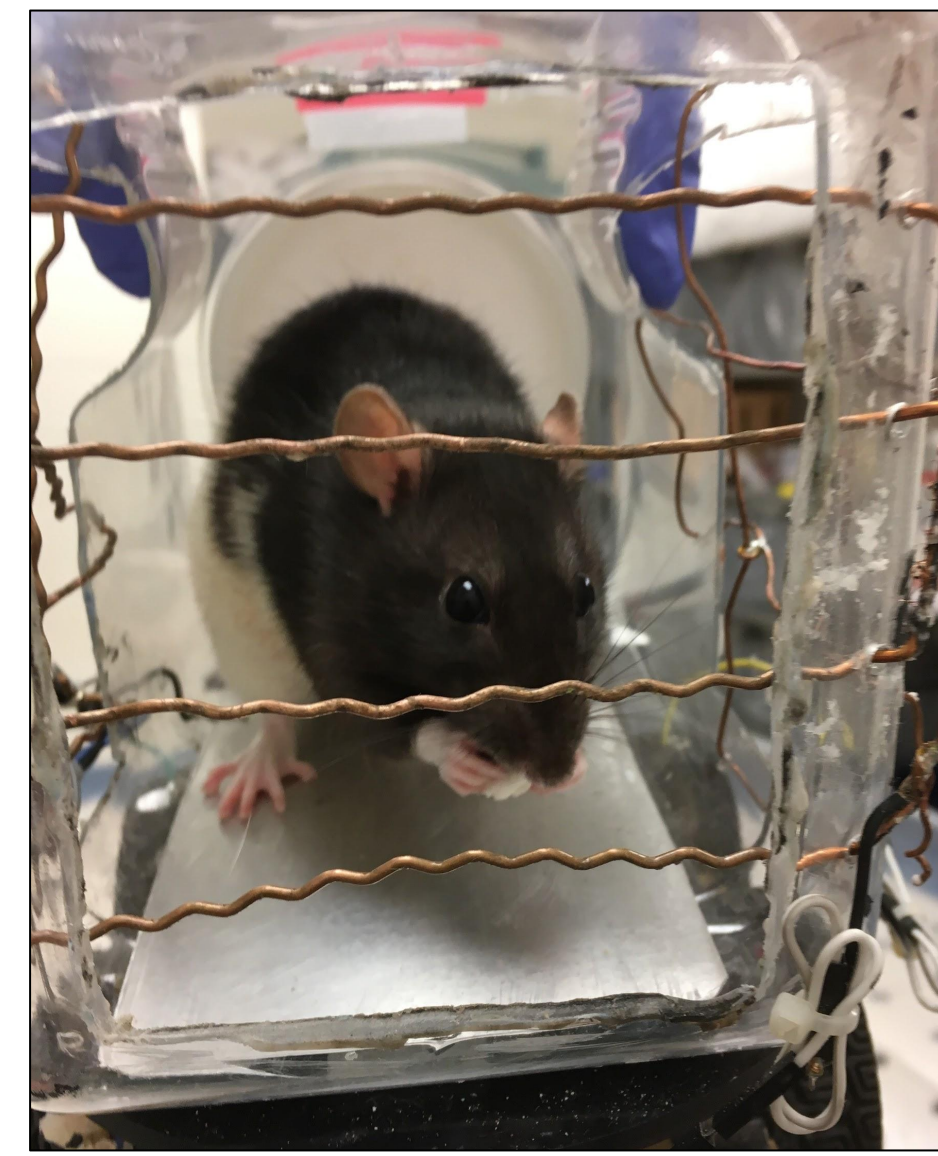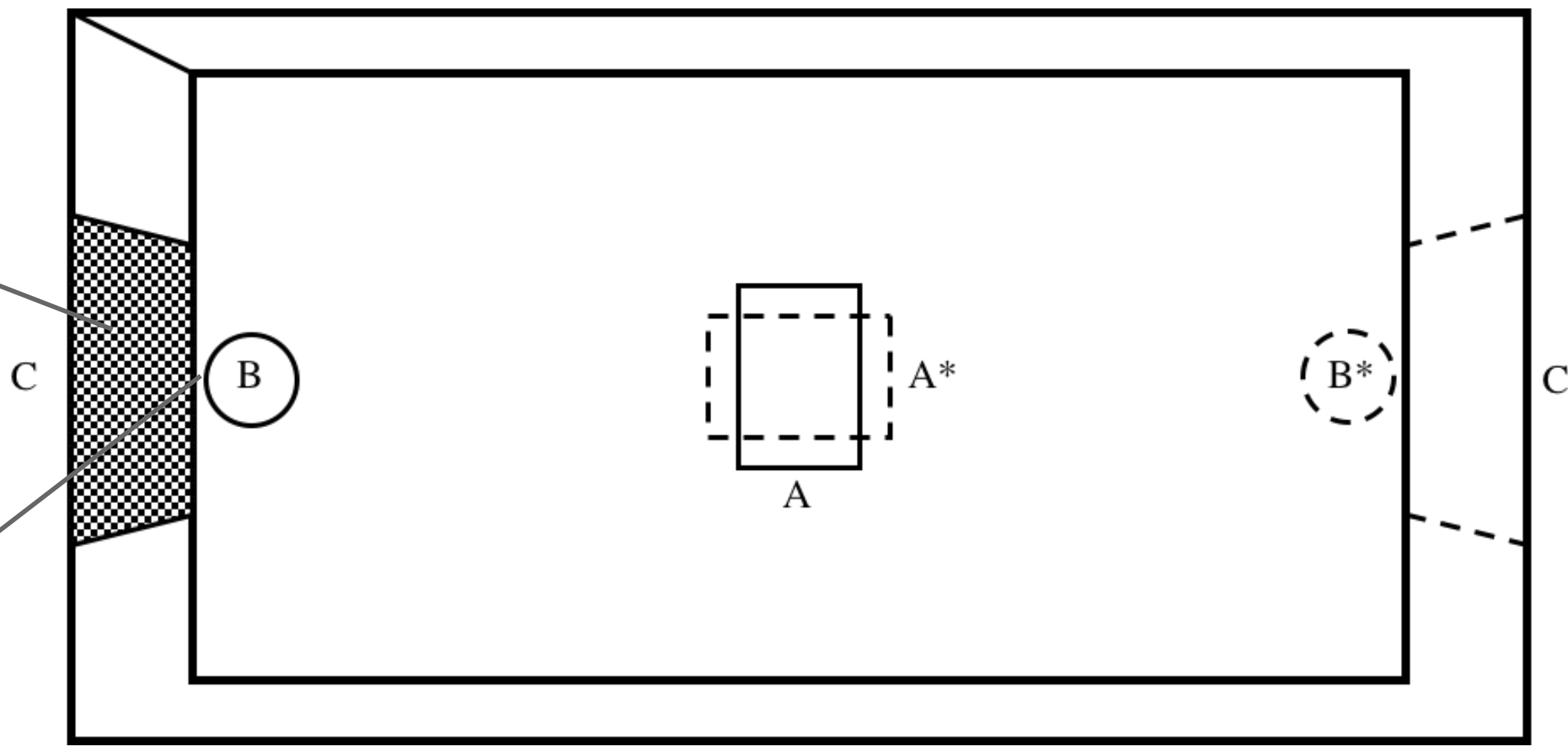
Rat Car Design

Joystick Design
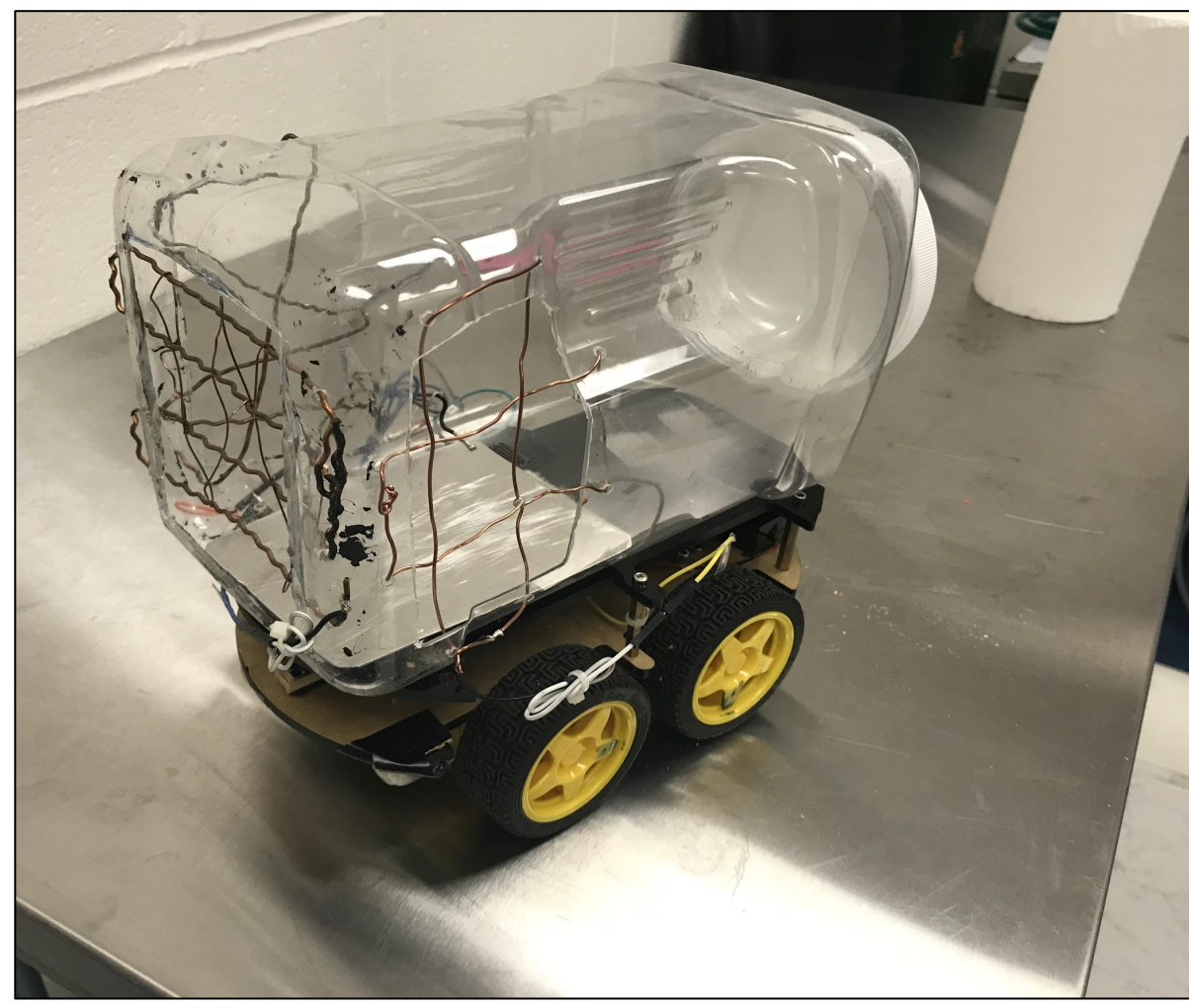
Current Design

Environment and Equipment

Checkerboard Visual Cue

Treat Tree Destination: with olfactory cue

Steering arena : Dimensions: 140cm width, 280 cm length, 51 cm height. A indicates the front of the car for standard trials,; A* indicates the front of the car for trials with an orientation manipulation; in all trials, the center of the car was aligned with the center of the arena.
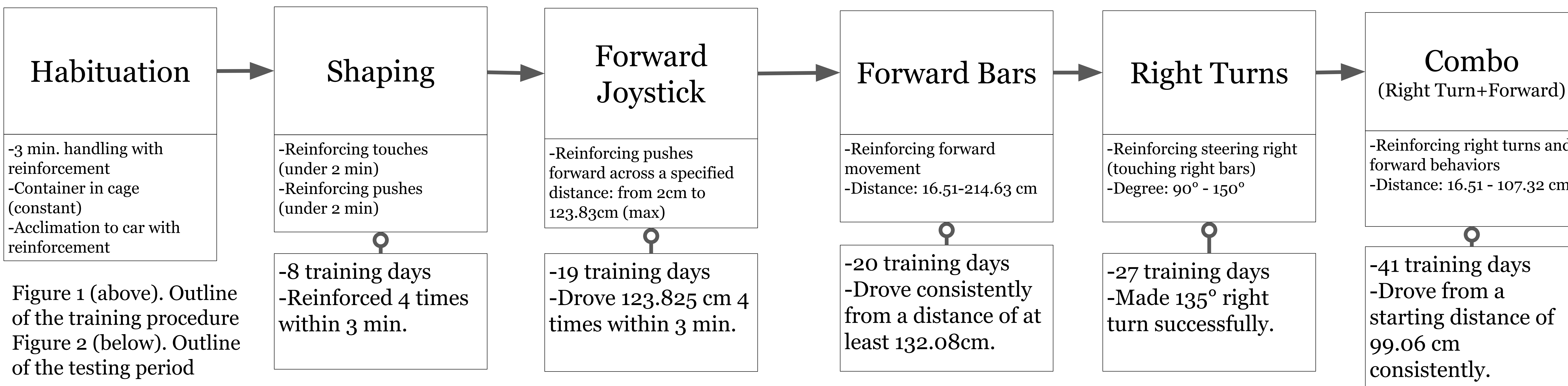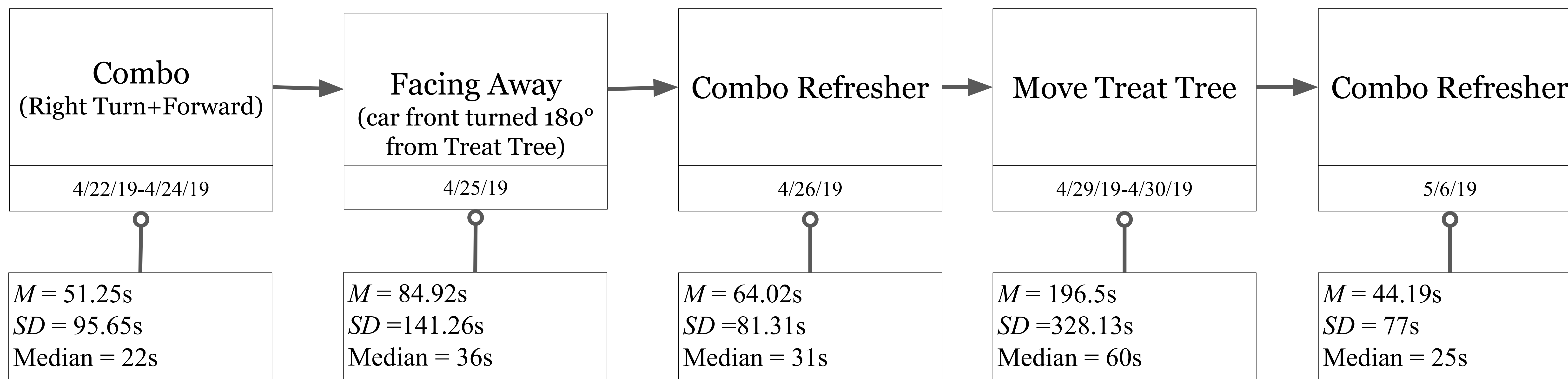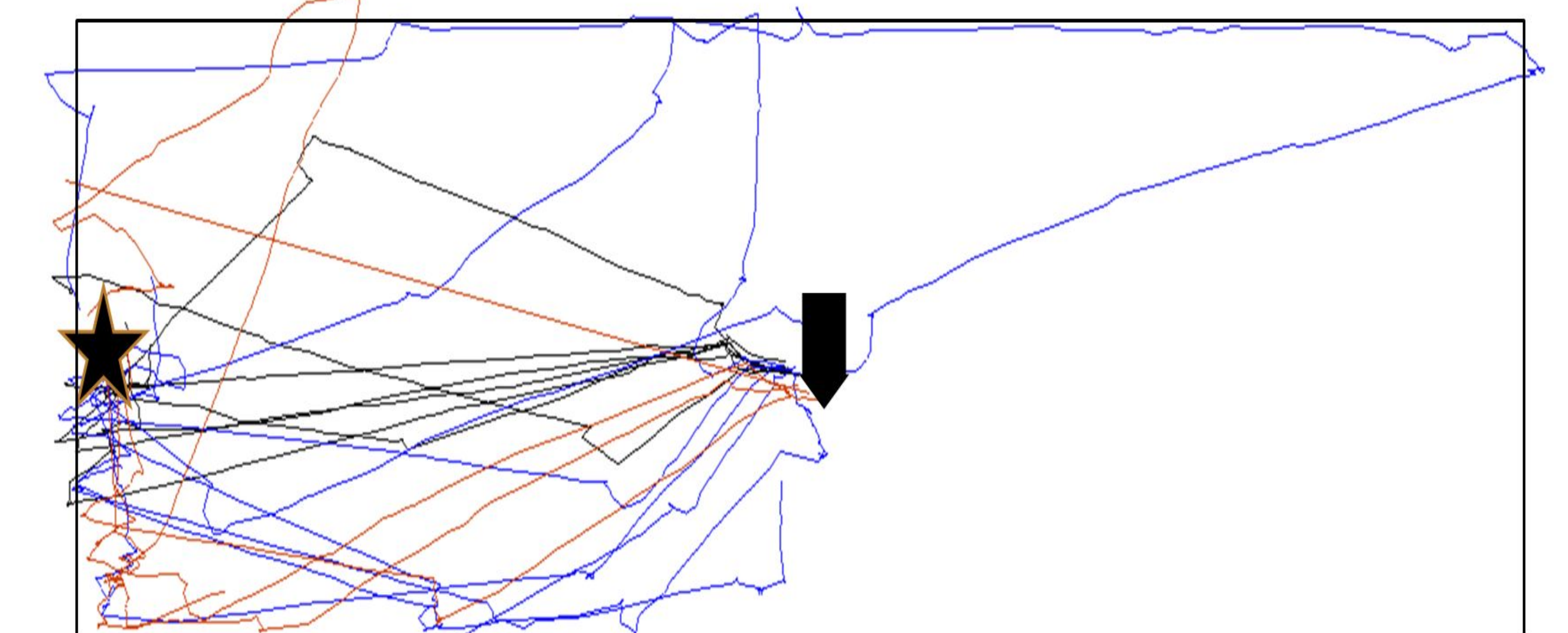
Training Outline

Habituation
- 3 min. handling with reinforcement
- Container in cage (constant)
- Acclimation to car with reinforcement

Shaping
- Reinforcing touches (under 2 min)
- Reinforcing pushes (under 2 min)
  - 8 training days
  - Reinforced 4 times within 3 min.

Forward Joystick
- Reinforcing pushes forward across a specified distance: from 2cm to 123.83cm (max)
  - 19 training days
  - Drove 123.825 cm 4 times within 3 min.

Forward Bars
- Reinforcing forward movement
- Distance: 16.51-214.63 cm
  - 20 training days
  - Drove consistently from a distance of at least 132.08cm.

Right Turns
- Reinforcing steering right (touching right bars)
- Degree: 90° - 150°
  - 27 training days
  - Made 135° right turn successfully.

Combo (Right Turn+Forward)
- Reinforcing right turns and forward behaviors
- Distance: 16.51 - 107.32 cm
  - 41 training days
  - Drove from a starting distance of 99.06 cm consistently.

Figure 1 (above). Outline of the training procedure
Figure 2 (below). Outline of the testing period

Testing Outline

Combo (Right Turn+Forward)
4/22/19-4/24/19
- *M* = 51.25s
- *SD* = 95.65s
- Median = 22s

Facing Away (car front turned 180° from Treat Tree)
4/25/19
- *M* = 84.92s
- *SD* =141.26s
- Median = 36s

Combo Refresher
4/26/19
- *M* = 64.02s
- *SD* =81.31s
- Median = 31s

Move Treat Tree
4/29/19-4/30/19
- *M* = 196.5s
- *SD* =328.13s
- Median = 60s

Combo Refresher
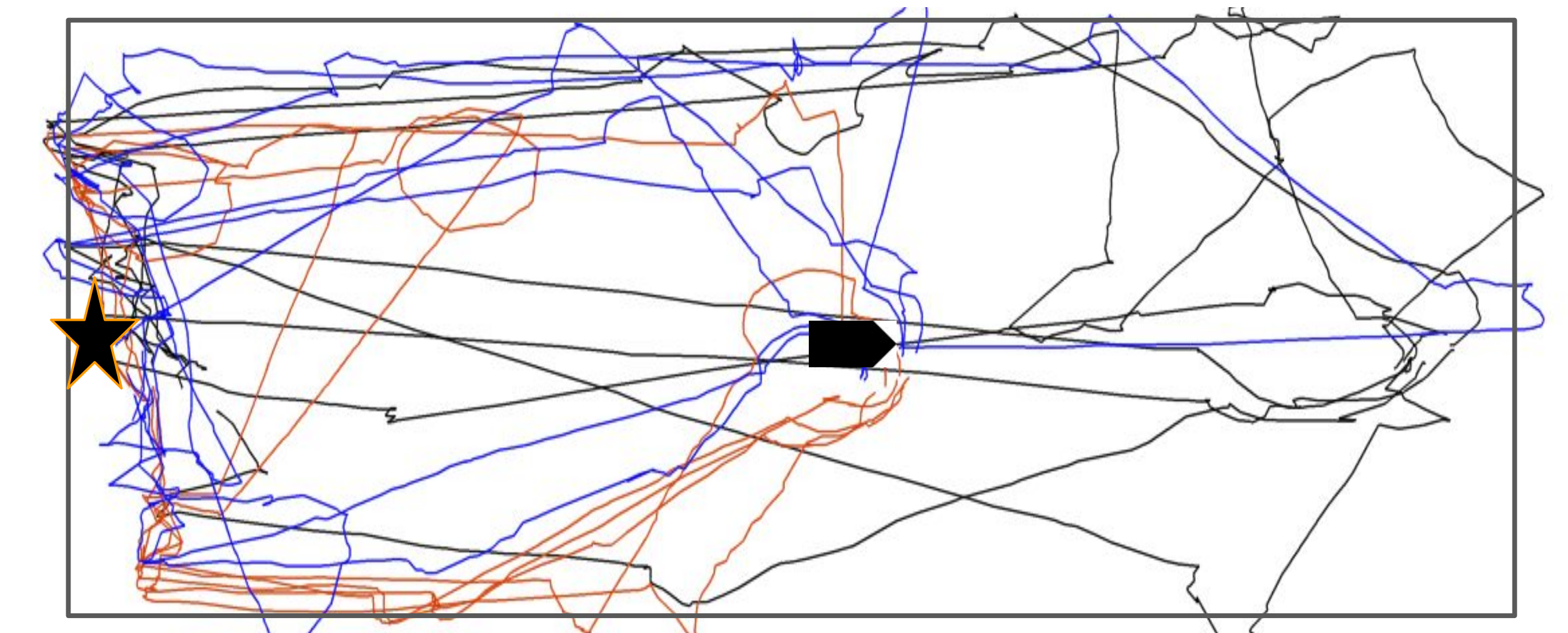5/6/19
- *M* = 44.19s
- *SD* = 77s
- Median = 25s

Paths Traveled (for three rats)

Turn & Forward: 100% success

Facing away: 100% success

Moved treat tree:
100% success for 4 rats
87% success for 1 rat
0% success for 1 rat