How to do radial maze testing
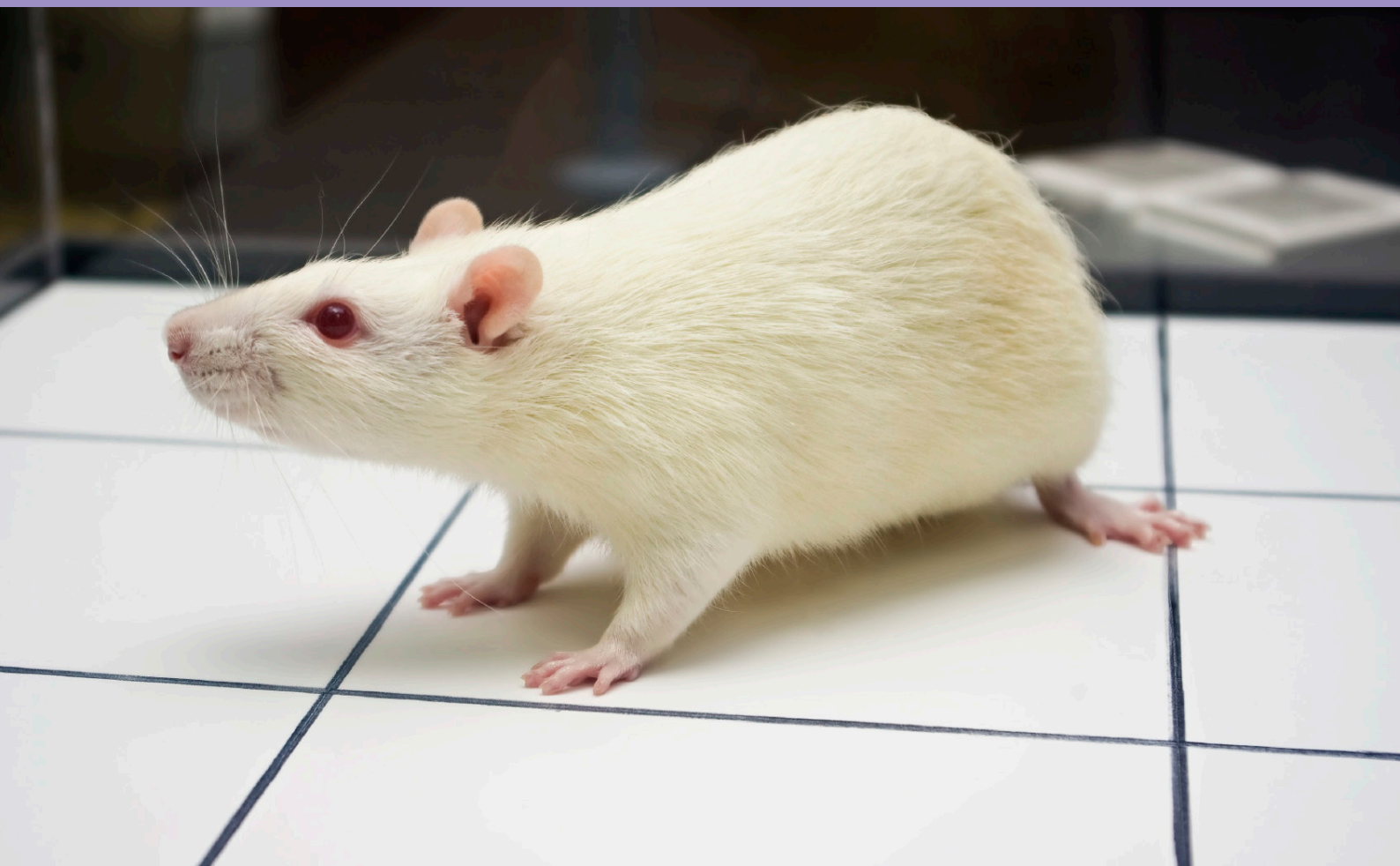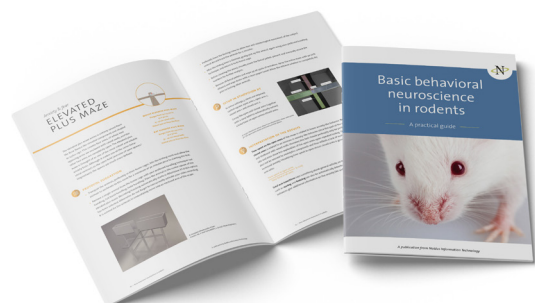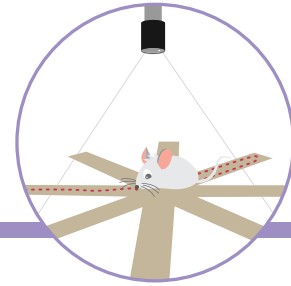
This is a chapter from the e-book:

Basic behavioral neuroscience in rodents.

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THE RADIAL MAZE

In 1976, Olton and Samuelson devised a classic task for assessing **working memory** and **spatial memory** in rodents: the radial arm maze. This maze has eights arms, which radiate from a central platform. To test working memory, all arms of the maze are baited (food reward), the animal is placed on the center platform and is allowed to explore freely. Retrieving the food reward from each arm, and not re-entering a previously visited arm is a key readout for this. Re-entering a previously visited arm is considered a working memory error. To test spatial memory, one arm (or multiple) can be baited, and the animal is trained in multiple sessions to this location. In each following session the speed to reach the arms should increase, indicating healthy spatial memory. Removing the food reward (or placing it in another arm) can subsequently be used to also test spatial memory and **cognitive flexibility** (how fast it will test new locations, or adapt, to find the reward).

MOUSE RADIAL ARM MAZE
8 Equal arms: 35 cm length
15 cm raised walls

RAT RADIAL ARM MAZE
8 Equal arms: 52 cm length
30 cm raised walls

PROTOCOL SUGGESTION

Pre-training (can be done across several days prior to the experiment)

- Transport the animals, preferably in their home cages, into the testing room and allow the animals to acclimate to this room for a minimum of 30 minutes prior to starting the test.

- Allow animals to acclimatize to the maze and encourage exploration: place multiple animals (preferably cage mates) on the maze and let explore freely for 20 minutes with food rewards scattered throughout the maze.

- On the subsequent days only place food rewards at the ends of the arms.
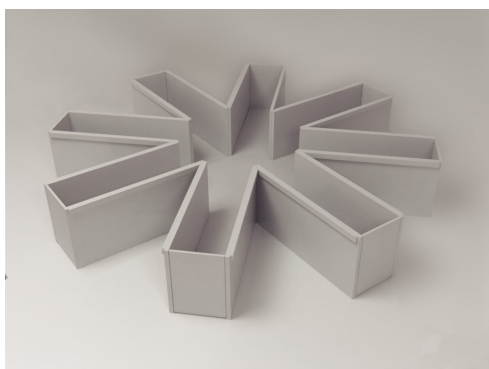
A standard radial arm maze.
Credits: He, S. and Corscadden, L. (2022). Maze Engineers.
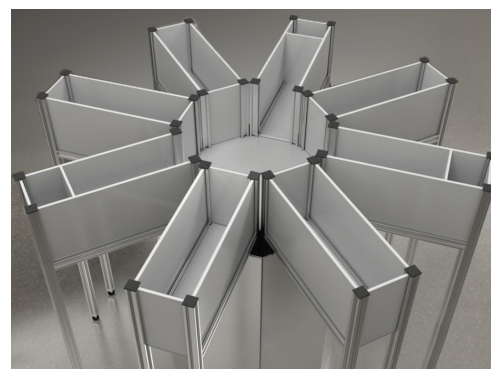
An elevated radial arm maze with sliding doors to seal off specific locations can also be used. Credits: He, S. and Corscadden, L. (2022). Maze Engineers.

Training phase (this can be repeated over the course of 10 to 20 days)

- Transport the animals, preferably in their home cages, into the testing room and allow the animals to acclimate to this room for a minimum of 30 minutes prior to starting the test.

- Bait all arms of the maze (in the end of the arms).

- Remove a single animal from the home cage with your preferred handling technique: tail handling, full hand handling, tube handling. Place the animal in in the center of the maze and allow the animal to move freely through the maze. The session is terminated when the subject has visited all 8 arms and has eaten the reward after 16 arm visits are made (regardless of which arms) or after a maximum of 15 minutes. Recording/tracking automatically starts in Etho-Vision XT if this option has been selected. Otherwise, do not forget to concurrently activate your video recording.

Testing phase

- Transport the animals, preferably in their home cages, into the testing room and allow the animals to acclimate to this room for a minimum of 30 minutes prior to starting the test.

- Bait some of the arms of the maze, while the remaining arms remain un-baited.

- Remove a single animal from the home cage with your preferred handling technique: tail handling, full hand handling, tube handling. Place the animal in in the center of the maze and allow the animal to move freely through the maze. The session is terminated when 8 minutes have passed or until all baited arms are entered. Recording/tracking automatically starts in EthoVision XT if this option has been selected. Otherwise, do not forget to concurrently activate your video recording.

- After the testing time is finished, gently pick up the animal, again using your preferred handling technique, and return it to its home cage.

- Before cleaning the arena, visually count the faecal pellets present and manually record the numbers for further analysis.
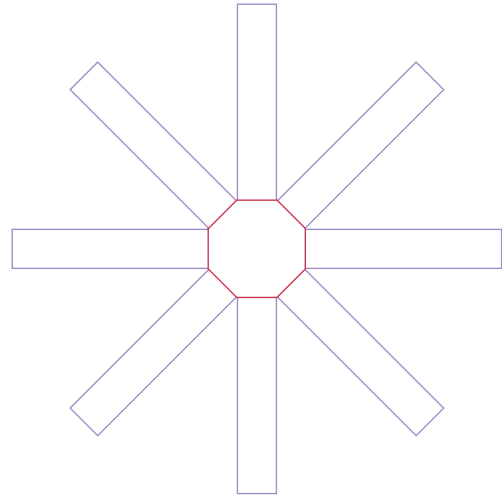
This protocol is adapted from Maze Engineers:
https://conductscience.com/maze/portfolio/radial-arm-maze/

SETUP IN ETHOVISION XT

In EthoVision XT, an arena with 8 arms (or more/less depending on the size of the maze) should be drawn, and a center zone.

A simple EthoVision arena setup in the radial arm maze: all arms are defined, as well as the central area of the arena.

INTERPRETATION OF THE RESULTS

The following parameters are essential to measure from the radial arm maze:

- Total numer of arm entries (all four paws in an arms)
- Total correct arm entries (a novel arm that has not previously been entered)
- Total wrong arm entries/errors (a previously visited or un-baited arm)

With this you can create a so-called **memory score**:

$$\text{Memory score} = \frac{(\text{correct arm entries}) - (\text{incorrect arm entries})}{(\text{correct arm entries}) + (\text{incorrect arm entries})}$$

A memory score of 1 reflects a perfect memory score of entering only novel arms. This score is likely to improve over several tests.
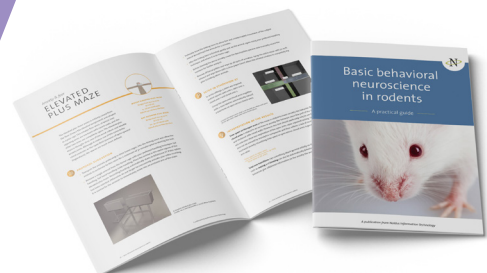
Also **the time between retrieving food rewards** can be scored as a measure of activity and willingness to explore.