Visual Search

For most animals, survival depends on rapid detection of rewarding objects, but search for an object surrounded by many others is known to be difficult and time consuming. However, there is neuronal evidence for robust and rapid differentiation of objects based on their reward history in primates (Hikosaka et al., 2014).We hypothesized that such robust coding should support efficient search for high-value objects, similar to a pop-out mechanism. To test this hypothesis, we let subjects view a large number of complex objects with consistently biased rewards with variable training durations (1, 5, or 30 days). Following training, subjects searched for a high-value object (Good) among a variable number of low-value objects (Bad) (Ghazizadeh et al., 2016).

Search task consisted of target present and target absent trials that were intermixed with equal probability. A single Good object was present in target present trials while all objects were Bad in target absent trials.

Experiment Settings:

For each group 48 fractals in total consist of:

- 24 for value group:
    - 12 good
    - 12 bad
- 24 for perceptual group:
    - 12 good
    - 12 bad

Search phase:
Subjects have to find the sole high-value objects among low-value distractors in each target present (TP) trial and reject the target absent (TA) trials.

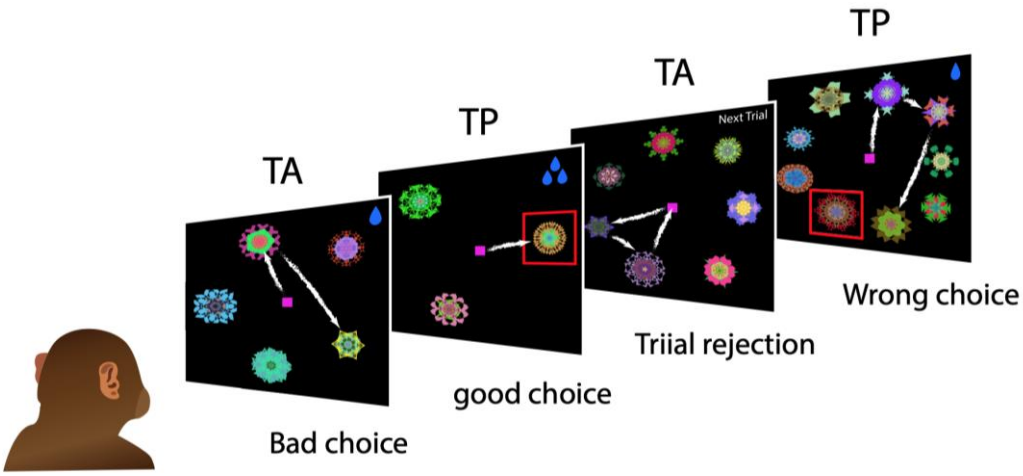
- 4 sessions for each subject
- Equal TP and TA trials for each good fractal
- Each session last about 12 minutes:
    - Half of the trials are TA and half TP
    - Half of the trials are from perceptual group and the other half from value group
    - 6 trials on average for each good fractal in each session (total of 144 trials per session)

Search Steps:

1. Fixation at the center
2. Fixation point disappears, objects onset
3. Select an object or reject the trial
    - Select: fixating on the object and press space button

- Reject the trial: press X button

4. Display off
5. Delivering the corresponding reward
   - value group: 1 unit for bad, 3 unit for good
   - perceptual group: 1 unit for bad, 3 unit for good



6. Go to the next trail (step 1)

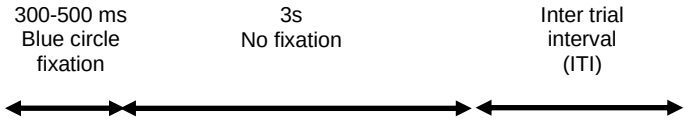
Display Size (DS):

3, 5, 7, 9 random assignment

Rotation:

1-360 deg random assignment

Each Trial:



1. No press: error beep, 1.5s ITI
2. Reject press (TA): low reward delivery after each 2-4 random correct rejection
   - ITI for reward delivery: 1.5s
   - ITI for no reward delivery: 200ms
3. Reject press (TP): same as above(2) without reward
4. Accept press:
   - No fractal selection: error beep, 1.5s ITI
   - Fractal selection: associated reward delivery, 1.5s ITI

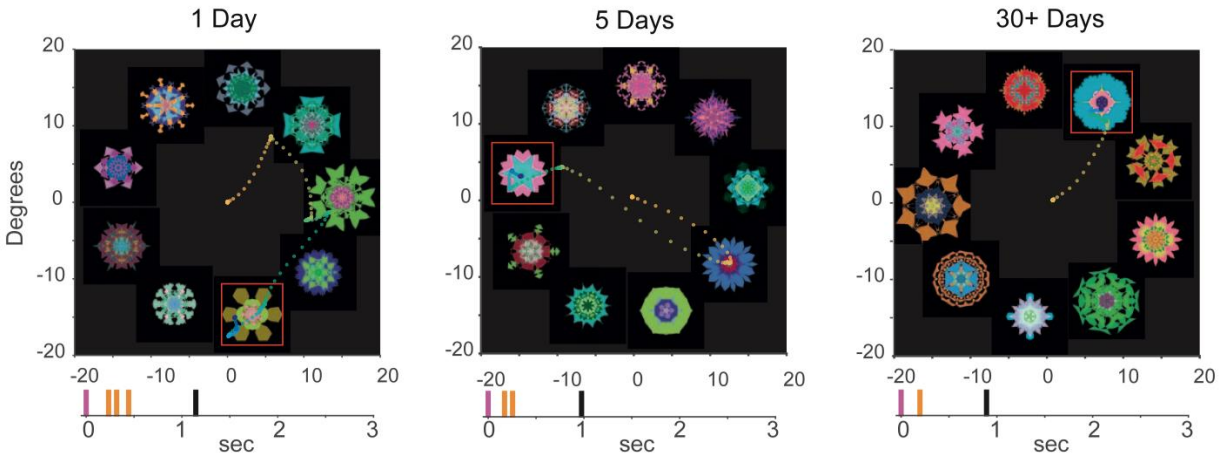


Fig3. Example search performance of monkey after different training amounts. Eye position is shown by time-dependent color-coded dots (2/ms dot, from orange to blue). Red square indicates Good object (not shown to the monkey). Tick marks at bottom show the timings of saccades (orange) and reward (black) relative to display onset (purple).

Tasks

1. Draw state diagram for every state and condition.

2. We want to use different combinations of fractals for each subject in a way that each fractal appears equally in each of the 4 aforementioned categories (Value/Perceptual, Good/Bad) in order to control the bias of low-level guiding features and recognition difficulties among fractal objects. Implement random assignment as described above. How many subjects do we need for equal appearance?

3. fractals should appear equally at each conditions in all 144 Trials. Half of the trials are TA and half TP. Half of the trials are from perceptual group and the other half from value group. Fractals placement in each Trial should be equal and random according to several conditions(TA/TP, Value/Perceptual and DS). Implement random assignment as described above.

4. Implement Search Phase as described in Experiment structure. In the beginning of script we should collect subject ID and session number. Use mouse position to simulate eyes movement. Use keyboard for key pressing (Accept: Space, Reject: X). Draw green and red rectangle for good and bad fractals as shown in Assignment2.mov. Prepare Recorded video of your final search task in the same way as Assignment2.mov. Recorded video should include occurrence

of different situation (No press beeping, Reject press (TA), Reject press (TP), Accept press, No fractal selection).

5. Draw information box in some corner of recorded video for each trial. information box should contain key pressed, value/perceptual group and reward amount.

6. Proper output data at the end of script as will describe below. Save it to a single .mat file.
   - Subject ID, session number, fractal size in degree, peripheral circle degree, screen size
   - At each trial: button pressed, fractals name, fractals position on display, DS, value/perceptual group, TA/TP, mouse position in time.

7. Explain the reason for selection different ITI in TA and TP? Looking at below paper would be helpful.
   Ghazizadeh, A., Griggs, W., & Hikosaka, O. (2016). Object-finding skill created by repeated reward experience. Journal of Vision, 16(10):17, 1–13, doi:10.1167/16.10.17.

Bonus

Find proper tools (Matlab script or other tools) for real-time detection eye gaze position on the display using webcam. Replace mouse simulation with real eyes movement in the experiment and prepare Question 4 with real eyes data. Draw eye position as described in Fig3 in recorded video.