W24: Neural Modeling: HW-8 Tricking Cerebellum - Feedback

Aakarsh Nair & Ahmed Eldably

Deadline: ***30.01.2024 - 1:59 pm***

Code Availability

See the full code listing here: TheBavarianGame_ex3.py (GitHub permalink).

Experimental Design

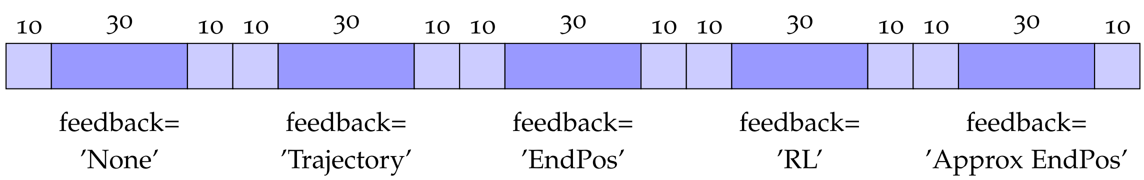

Figure 1: Experimental Setup: Experiment with different feedbacks. Each feedback consists of 10-steps unperturbed preceeding and succeeding a 30-step perturbed blocks.

Task-1: Implementation of Feedback Types

1. Implement the 4 different *feedback_types* : `trajectory`, `endpos`, `RL`.

   Answer:

   We implemented 4 different feedback types as per the specification.

   (a) `trajectory`: Feed back captures the trajectory of last shot. See Figure 11 for the final screen visible to the subject.

(b) `endpos`: Feedback captures the last position of the last shot. See Figure 3 for the final screen visible to the subject.

(c) `RL/Binary`: Feedback is only provided as a binary change in color of the target region. The subject.See Figure 5 for the final screen visible to the subject.

(d) `endpos_approx`: Approximate end position provides the approximate end position. The subject infers his end position by estimating the center of a scaled final position. See Figure 4 for the final screen visible to the subject.

2. Design your own experiment to test `feedback_types`.

   Answer: For our own experiment we use a variant of end position where we increase the size of the end position radius by a `scaling_factor` giving the subject only an approximate feedback of where the subject pint lands. See Figure 4.

TASK 2: Analysis of feedback on unbiased subjects

1. Record the subject performing your own experiment.
   Answer: We record two subjects performing in the different recording

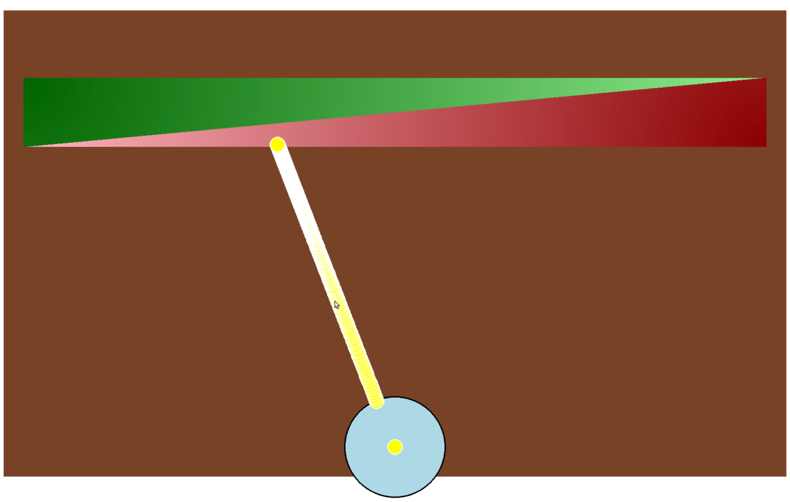

Figure 2: **Trajectory:** Trajectory of last action is provided as feedback

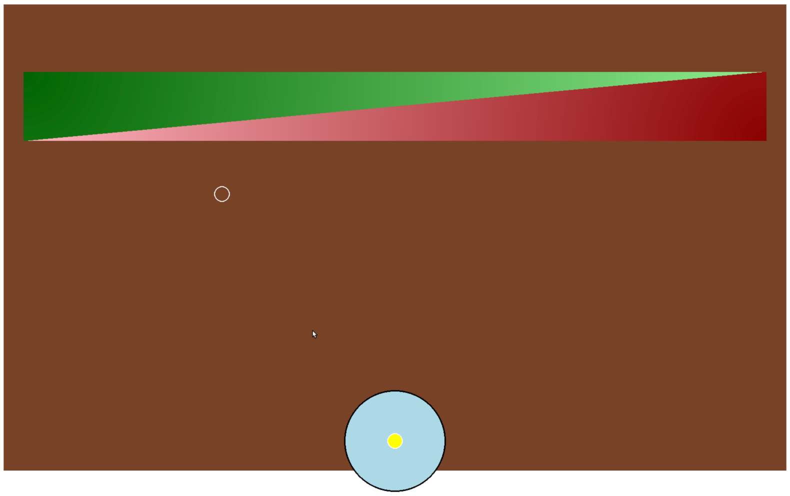

Figure 3: **End Position** Final End Position of Previous Action

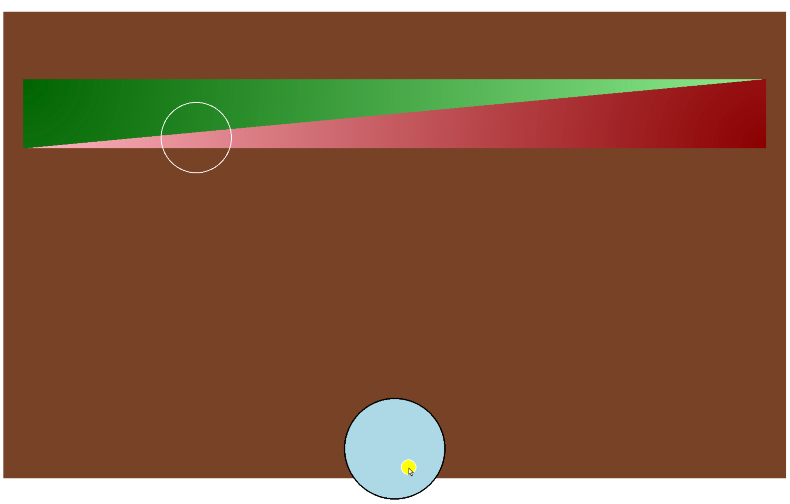

Figure 4: **End Position Approximate** The final end position of previous action is provided, however we introduce ambiguity using a scaling factor to the pint to make the final position slightly ambiguous.

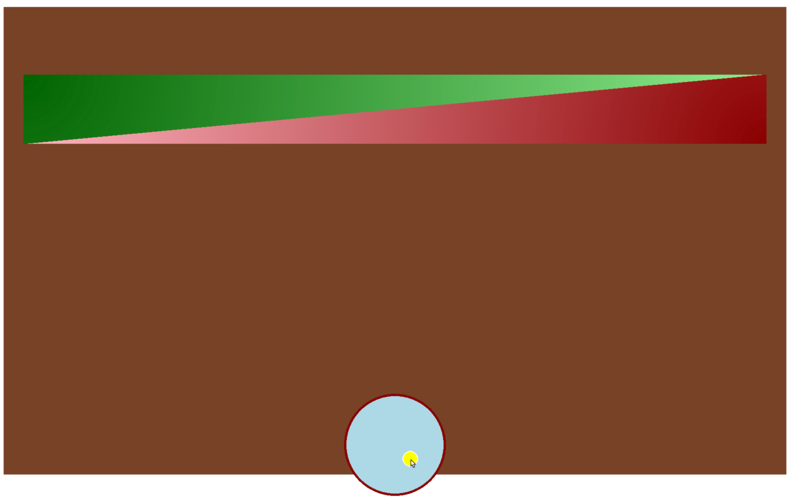

Figure 5: **RL:** Reinforcement Learning/Binary Feedback, Red circle indicates that previous action was unsuccessful.

2. Visualize the effect of different feedback on subject's performance.
   Answer:
   The two subjects are visualized under all feedback scenarios.

   (a)

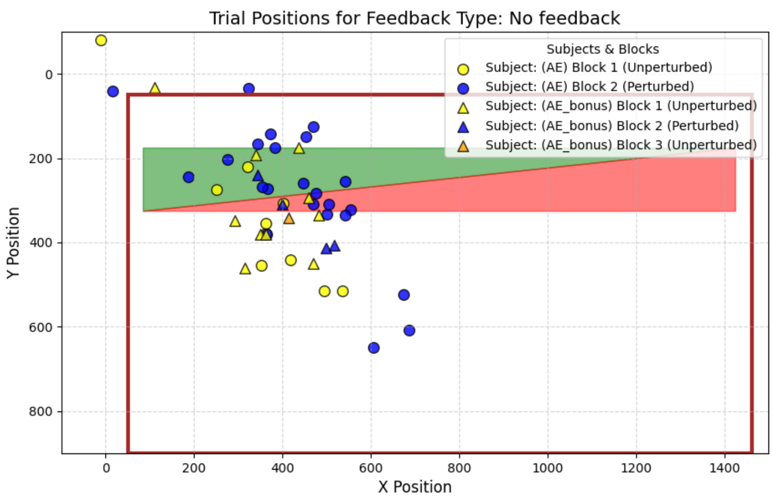

Figure 6: **No Feedback**: Feedback performance for subject AE. For subject not receiving feedback from previous trajectory except the observed behavior.

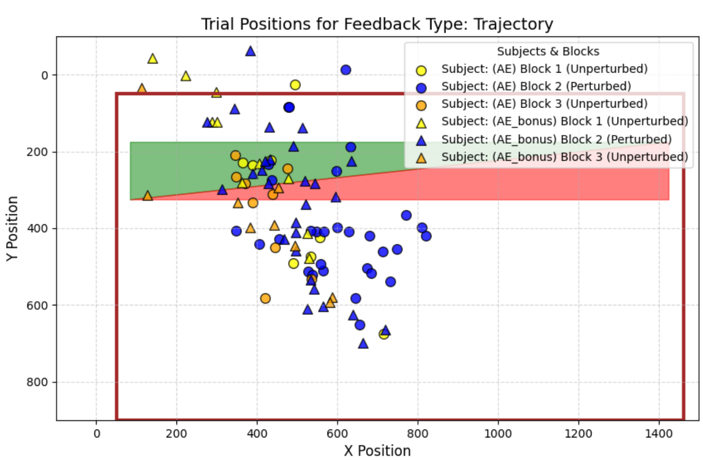

Figure 7: **Trajectory:** Feedback performance for subject AE. For feedback receiving only the end position. We note that the second unperturbed block show after effects of perturbation they tend to be more heavily biased leftwards than before the perturbed block

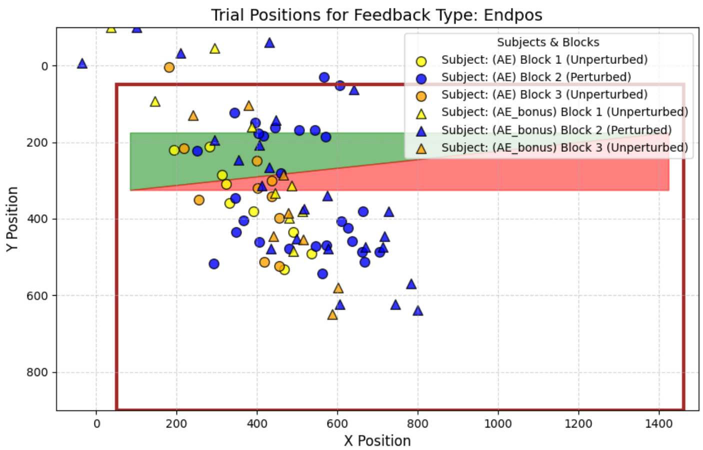

Figure 8: **End Position:** Feedback performance for two subjects. For feedback the subject receives only the end position as feedback. We note that a general trend for block three to be aligned in opposite direction of perturbing force, thus they are left skewed, indicating subject is experiencing *after effects*

.

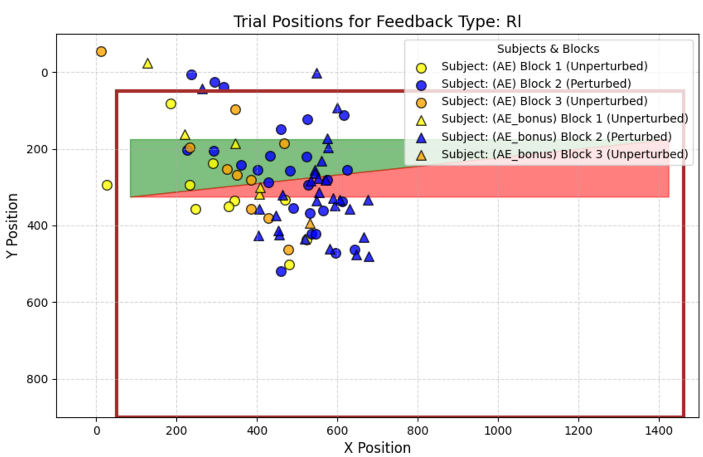

Figure 9: **Binary/RL:** Feedback performance for subject AE. For feedback receiving only hit or miss binary feedback.

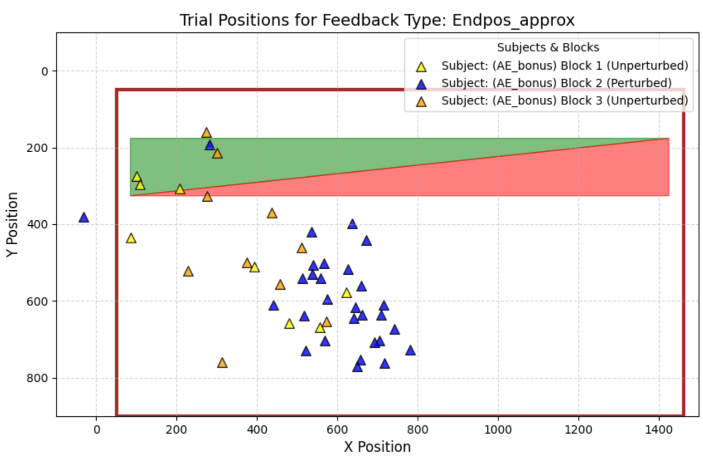

Figure 10: **End Position (Approx)** Feedback performance for subject AE. For subject receiving approximate end position feedback.

TASK 3: Discussion of your results

1. What's the effect on subject's performance of each `feedback_type` ?

   Answer:

   (a) `no-feedback`: The subject learns perturbation and faces a drop in accuracy. We aslo note that that subject accuracy adapts well under the standard feedback.

   (b) `trajectory` We note that subject is able to compensate for the perturbation while trajectory feedback, by noting its high Block-2 accuracy. However Lower Block-3 accuracy shows lingering *after-effect* from learning of Block-2. Leading to a lower accuracy.

   (c) `endpos:` The subject accuracy is low for most of the task. *After-Effects* indicates that the subject has learned the perturbations, in Block-2.

   (d) `RL/Binary`: The subject performs at the same level with RL feedback. The high block-3 accuracy indicates there is no *after-effects* , the subject has thus not learned about perturbation force and is able to perform well once he is able to see the pint again in Block-3.

   (e) `endpos-approx:` We note feedback is not sufficient to improve accuracy while perturbation is in effect. But *after-effect* indicates that perturbation were learned during phase-2.

2. Under which `feedback_type` was your subject able to adapt the best ?

   Answer: The subject is thus best able to adapt under *trajectory*, *endpos* variant feedbacks as he faces greater after effects after these feedback phases. For RL condition the increase in accuracy is largely unexplained, but is hypothesized to be due to not suffering from perturbation learning, and perhaps ease of unperturbed section due to greater feedback after the RL/Binary-feedback section finishes.

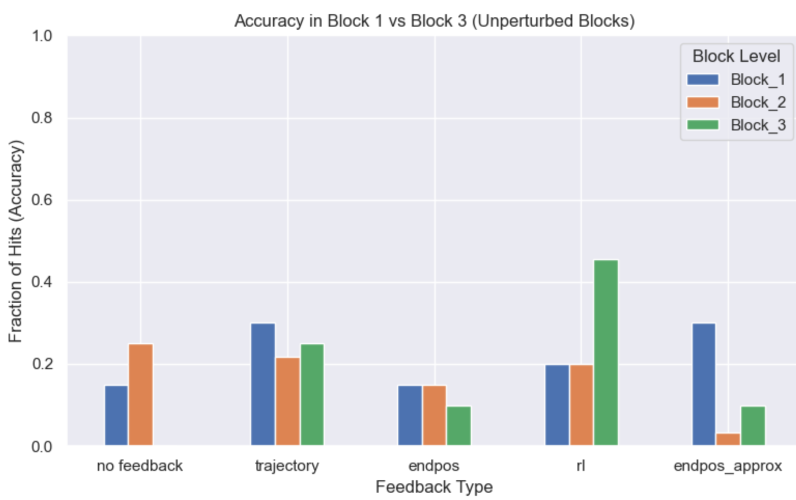

Figure 11: **Block Accuracy:** We compare the accuracy in the unperturbed sections before and after the perturbation blocks with various feedbacks. We note that accuracy drops, for trajectory, endpos, and endpos-approx, noting that this is hypothesized to be due to learning *after-effects*. This indicates that learning is taking place under these conditions. For RL the feedback block after the RL block does not show a drop in accuracy thus the subject is not facing *after effects* from learning the perturbation force, and the task is easier in the unperturbed section.