W24: Neural Modeling - HW 7 - Generalization & After Effect

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*Deadline: **23.01.2024 - 1:59 pm***

Savings - After-Effects while Learning Perturbations After Time Delay

1. *Re-run* first experiment with two sudden perturbations, repeat it after 30 minutes (all).
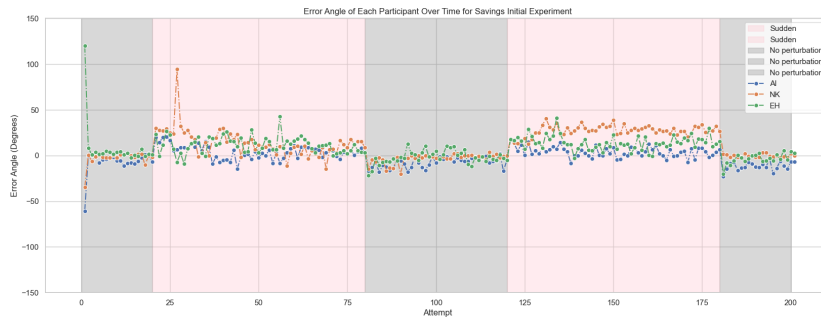

Figure 1: The plots show the savings results from multiple participants during Phase 0 of the experiment. In this phase, participants are shown target at an initial starting angle of 0. Phase 1 tests them after 30 minutes.
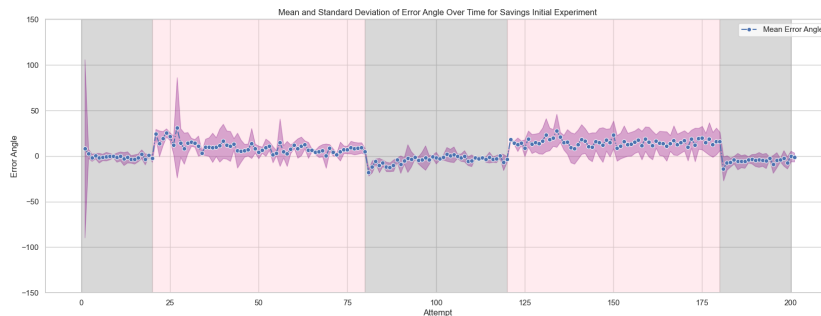

Figure 2: We plot the mean error angles and the cross-subject variance for Phase 0 of the experiment. We note that the variance of the second block is more consistent and smaller than the first perturbation block.
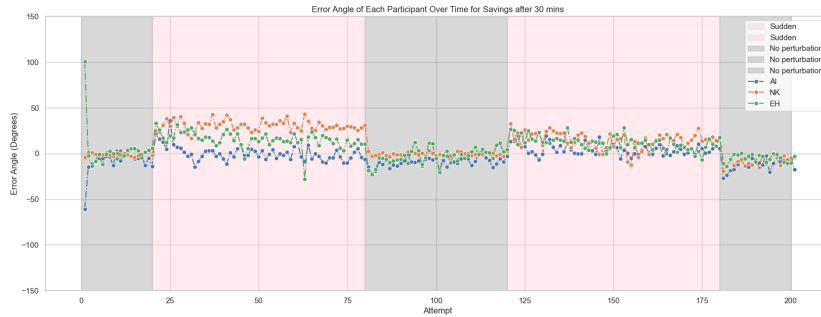
Figure 3: The same experiment was repeated after 30 minutes. The participants show better error angles, i.e., an adaption of motor control, especially in the sudden phase.
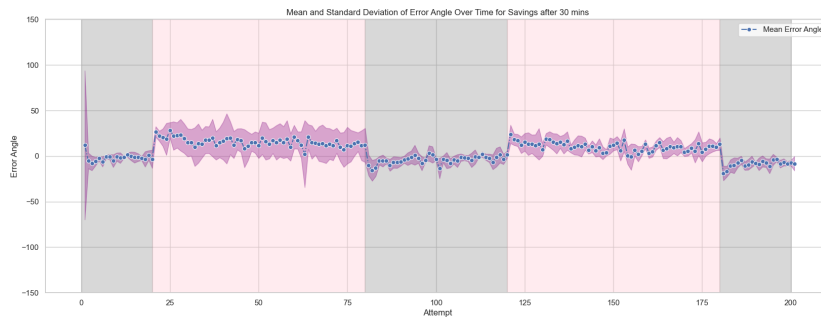

Figure 4: The mean error angles are also closer to zero than the first time. This indicates that subjects can adapt faster to the perturbation after 30 minutes. Moreover, the error variance for all subjects is lowest in the second block of Phase-1 vs all other blocks.

Answer: We compare the experiment's running after 30 min to look for the after-effects of savings. The main after-effect we note is that after 30 minutes, the sudden perturbation regions show a lower variance while learning after the delay. The second sudden phase in the experiment showed a very low variance, indicating better motor adaptation among participants.

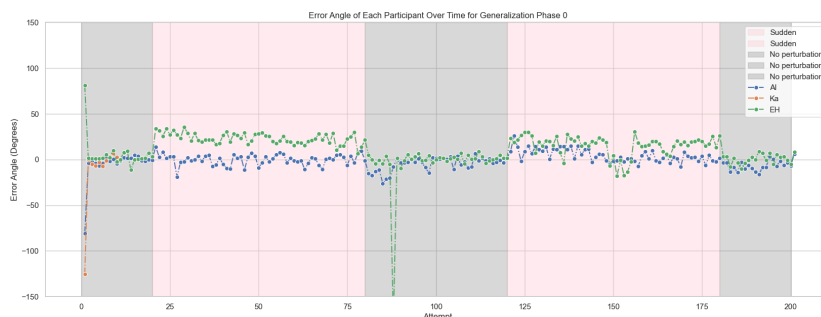*Generalization Experiment - Phase 0 - Learning and Initial Starting angle at 30 degrees.*

Figure 5: In Phase-0 of the generalization experiment, we show the participant a target at a starting angle of 30 degrees. Additionally, the participant is subjected to a perturbation of 30 degrees, which the participant adapts to. We note a lower variance in the second perturbation block compared to the first.
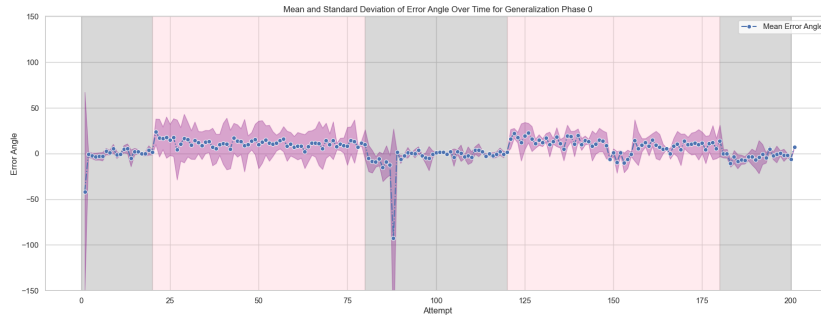
Figure 6: In Phase-0 of the generalization experiment, we show the participant a target at a starting angle of 20 degrees. Additionally, the participant is subjected to a perturbation of 30 degrees, which the participant adapts to. The shaded region shows the variance between participants of the experiment. We note the variance of the second block is lower than the first perturbation plot, suggesting subjects can adapt to the perturbation block.

Generalization Experiment - Phase 1 Generalization Close to First Learned Angle
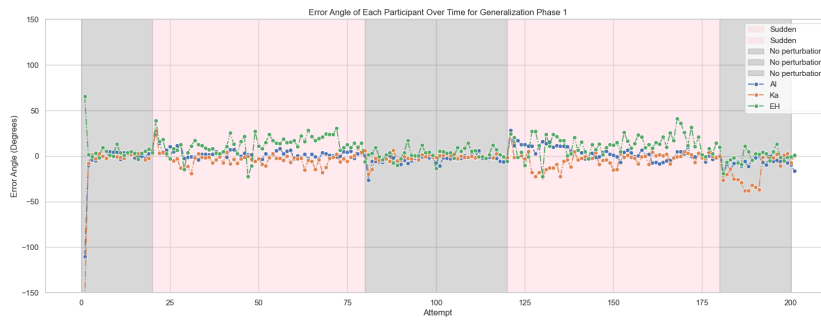

Figure 7: During Generalization Phase 1, participants were shown a target at 50 degrees. This was considered sufficiently close to the previous angle, allowing the subjects to adapt to the targets.

Generalization Experiment - Phase 2 - Target Angle Between Two Learned **Close** *Starting Angles*

Figure 8: Generalization Phase 2 shows a better motor adaptation among participants. The main reason is that the three angles in phases 0 (20-degrees), 1 (50-degrees), and 2 (35-degrees) are quite close. The phase-2 angle is between Phase-0 and and Phase-1 angles. Thus learning via-generalization is effective. We note that the error variance for Phase-2 is lower than Phase-1. We infer this to mean that data for both Phase-0, and Phase-1 is used to generalize for Phase-2

Figure 9: Phase-2 is shown to have least error variance of Phase-0, and Phase-1

Generalization Experiment - Phase 3 - Target Angle **far** from three previously Learned Starting Angles
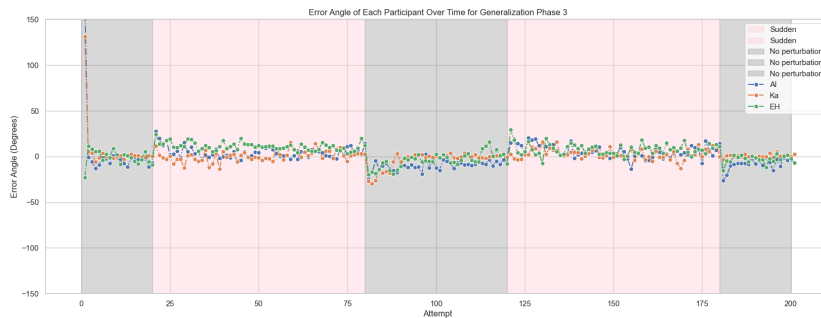

Figure 10: In Phase 3, The target angle is modified greatly to 135-degrees. The results vary among participants. The huge shift in the angle made the motor adaptation process slower, resulting in a larger variance.
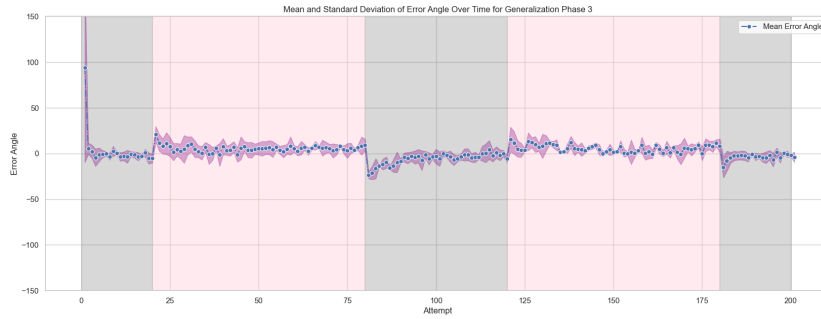
Figure 11: We note there is after effect on entering the no perturbation block after the first perturbation block. We take this as an indication that generalization for this error angle did not take place.

Task-4: Independent Experiments
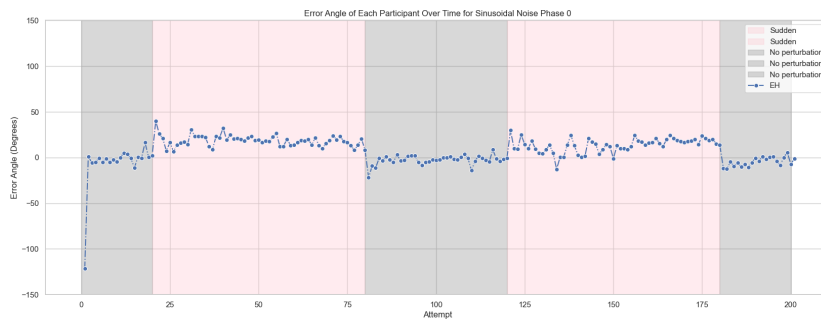
Sinusoidal Noise Phase 0:

Figure 12: Running the experiment with random sinusoidal noise in the mouse angle of the sudden perturbation period for the starting angle of 35 (Phase 2).
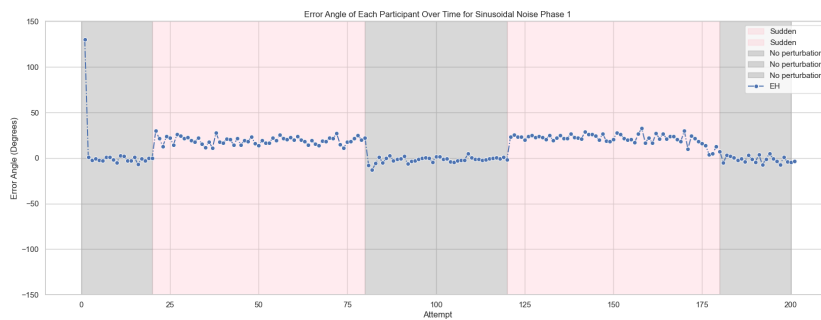
Sinusoidal Noise Phase 1:

Figure 13: Running the experiment with random sinusoidal noise in the mouse angle of the sudden perturbation period for the starting angle of 125 (Phase 3).

Answer: We added random sinusoidal noise to the mouse angle of the sudden perturbation phases for running independent experiments. We did this in the generalization experiment for two angles, 35 (Phase 2) and Generalization. We wanted to see if Generalization could still be achieved with the same participant (EH).

Observation: We don't see a significant difference in results. In both cases, motor adaptation is happening as expected.

Future Work: To better interpret results, the participant needs to do the whole generalization experiment to prove that the after-effects would be better in adjacent angles.