INTRODUCTION

- When practicing a new motor task performance errors and variability decrease.
- There is increasing evidence that amplification of the visually perceived error could lessen task errors. [1,2]
- Enlarging errors may encourage larger corrections, indicating that the learning rate or feedback gain will increase.

We aimed to investigate the mechanisms by which error amplification improves task performance. Our approach is based on the following assumptions:
- Subjects correct their errors with a specific feedback gain,
- There are several sources of noise in the human neuromuscular system,
- Performance error is a function of gain and noise.

H1: Error amplification causes subjects to decrease in their intrinsic motor noise.
H2: Stochastic error amplification has larger effect compared to deterministic error amplification.

EXPERIMENT

Experimental Method

- Subjects: 42 right-handed young healthy male and females
- Task: Subjects moved an instrumented lever arm to throw a virtual pendular ball to hit a target in the virtual task space.
- Ball trajectories determined by release angle $\theta$ and angular velocity $\dot{\theta}$.
- Execution Space: Solution manifold (SM) represents combinations of $\theta$ and $\dot{\theta}$ that give exact target hits (minimum distance error $\Delta_{TOT}$ is zero).
- Vertical SM means that $\Delta_{TOT}$ depends on $\theta$ only.

Deterministic Error Amplification (DEA)

- The release angle was manipulated:
  $\delta = \theta_0 + eA$

Stochastic Error Amplification (SEA)

- The release angle was amplified:
  $\delta = \theta_0 + e[1 + \epsilon(2A-1)]$

where $\epsilon$ is uniform noise ($0 - 1$). The gain factor $A$ represents the mean error amplification.

Experimental Protocol

- Subject Groups (Six Subjects Each Group)
<table>
<thead>
<tr>
<th>Control Group</th>
<th>DEA Group 1</th>
<th>DEA Group 2</th>
<th>DEA Group 3</th>
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</thead>
<tbody>
<tr>
<td>DEA-1.5</td>
<td>DEA-2.0</td>
<td>DEA-2.5</td>
<td>SEA-2.0</td>
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- Control & "Light" Error Amplification
- No error amplification

CONCLUSIONS

- Error amplification improved task performance.
- Performance improvement was brought about mainly by a reduction in the overall amount of intrinsic motor noise. H1 supported.
- Adding noise to the error amplification did not enhance this effect. H2 rejected.

REFERENCES