Is Visuomotor Adaptation Classical Conditioning?
Guy Avraham¹, Jordan A Taylor², Richard B Ivry¹, Samuel D McDougle¹
1 Department of Psychology and the Helen Wills Neuroscience Institute, University of California, Berkeley, Berkeley, CA, USA
2 Department of Psychology and Princeton Neuroscience Institute, Princeton University, Princeton, NJ, USA

Introduction
- Two paradigmatic tasks for studying cerebellar-dependent learning processes:
  - Sensorimotor learning (e.g., prism adaptation [1]).
  - Classical / Pavlovian conditioning [2] (e.g., eyeblink conditioning).

- The two literatures have developed with minimal cross-fertilization, despite the fact that they share many key properties.
- Here, we take a look at sensorimotor adaptation through the lens of classical conditioning.

Methods

Experimental setup

<table>
<thead>
<tr>
<th>Task</th>
<th>CS (Plan/Tone/Light)</th>
<th>Reach</th>
<th>US (Clamp)</th>
<th>UR (Feedback correction?)</th>
<th>CR (Adapted response)</th>
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Clamp feedback

Time

Early/Late
Clamp Feedback

Assignments of CS+ (15° Clamp) and CS- (0° Clamp) counterbalanced across participants

Experimental protocols

Experiment 1: Differential Conditioning

Experiment 2: Compound Conditioning

\[ V_{x}^{n+1} = V_{x}^{n} + \Delta V_{x}^{n} \]

\[ \Delta V_{x}^{n} = \alpha \cdot \beta \cdot (\lambda - V_{tot}) \]

- We compare the Rescorla-Wagner model to a state-space model, the classic approach for modeling sensorimotor adaptation

Results – Experiment 1: Differential Conditioning

Simulation

Experimental results

Results – Experiment 2: Compound Conditioning

Simulation

Experimental results

Discussion

- We propose that implicit visuomotor adaptation may be understood as, fundamentally, an associative learning process.
- Consistent with this proposal, the Rescorla-Wagner model explains both the differential and compound conditioning effects. The conventional state-space model does not.
- However, neither model explains the non-zero steady-state hand angle during washout. This behavior could be driven by an additional gaze-dependent effect.
- With these and future experiments, we hope to bring theories of implicit visuomotor adaptation closer to established models of cerebellar learning in animal neurophysiology.

Acknowledgment

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References

[1] Helmholtz (1909), Treatise on Physiological Optics
[2] Pavlov (1927), Conditioned reflexes

Contact
Guy Avraham: guyavraham@berkeley.edu