The Feedback-Dependent Time-Course of Implicit Learning

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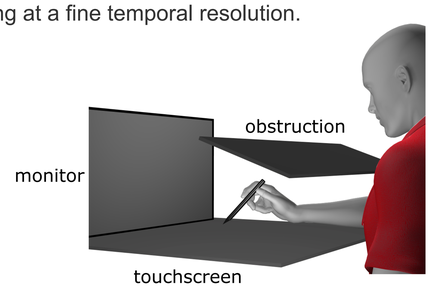
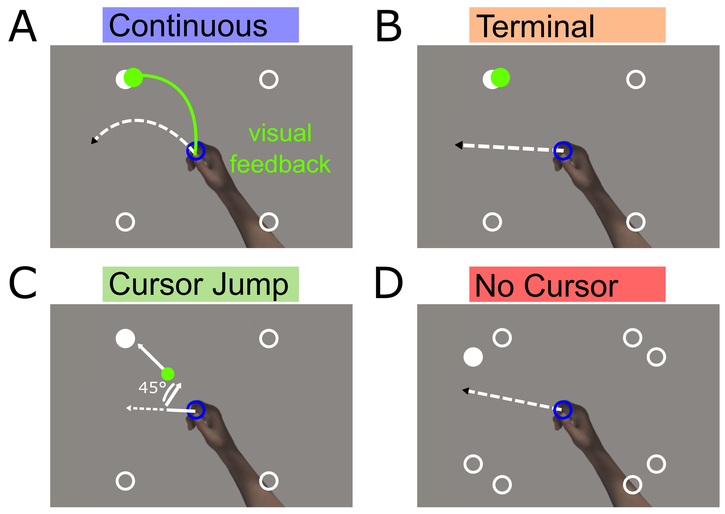
Is Implicit Learning Fast or Slow?

People constantly adapt their movements to their changing circumstances, which is mostly handled by our automatic, unaware, or implicit motor adaptation systems. While the time course of these implicit processes is thought to be slow, this is actually largely unknown. Motor adaptation is usually induced by having people reach to targets with a cursor whose motion is misaligned with respect to their unseen hand. Here, I have tested the effects of various kinds of feedback of the unseen hand motion on the speed of implicit learning.

Experimental Procedure

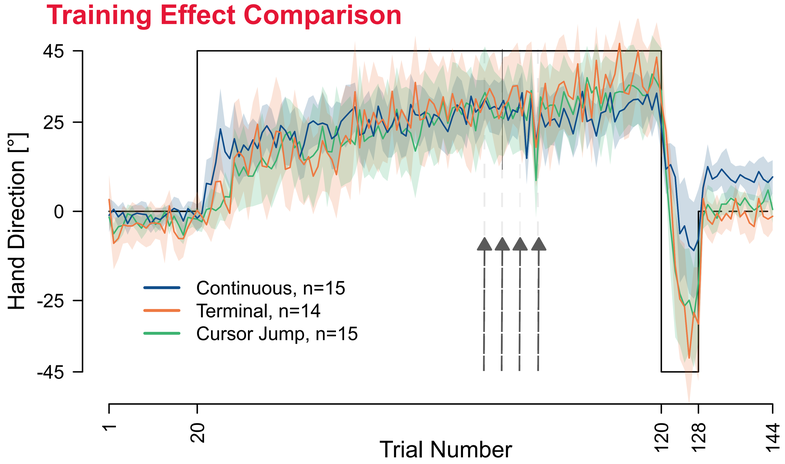
All groups completed the same rotation schedule with different visual feedback (see below) and all trained with a cursor rotated 45°. After every training trial participants completed a no-cursor trial to probe implicit adaptation. By alternating between training and testing trials, we could measure the rate of implicit learning at a fine temporal resolution.

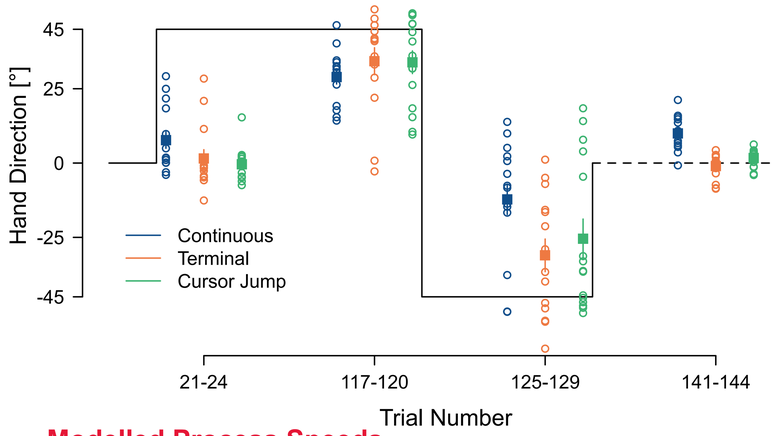




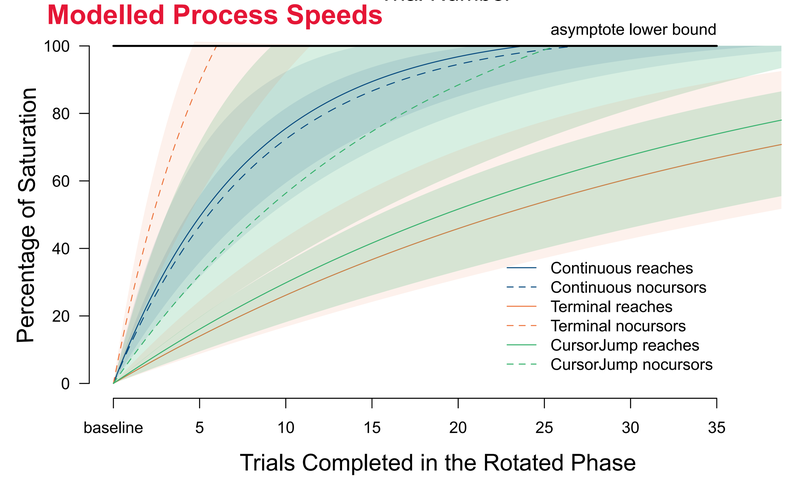
Continuous	Training with continuous rotated feedback
Terminal	Training with terminal rotated feedback; cursor only shown at end of reach trial
Cursor Jump	Training with cursor-jump feedback, cursor jumps 45° CW mid-reach on every trial
No Cursor	Aftereffect trial with no cursor feedback using targets ±15° relative to previous training target

Training Effect Comparison





Modelled Process Speeds



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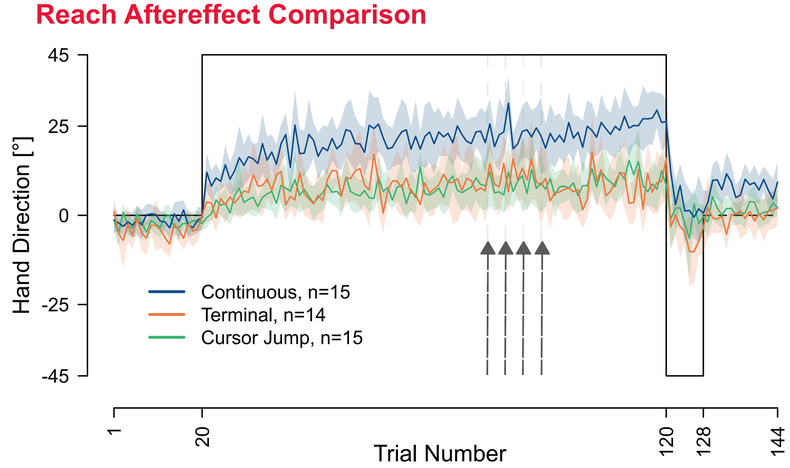
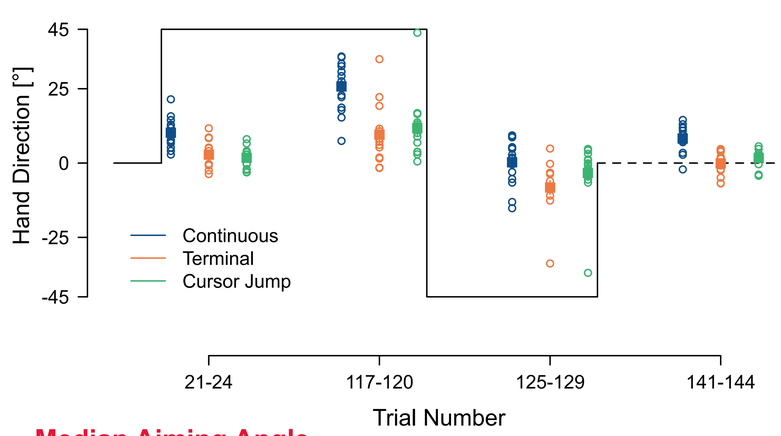
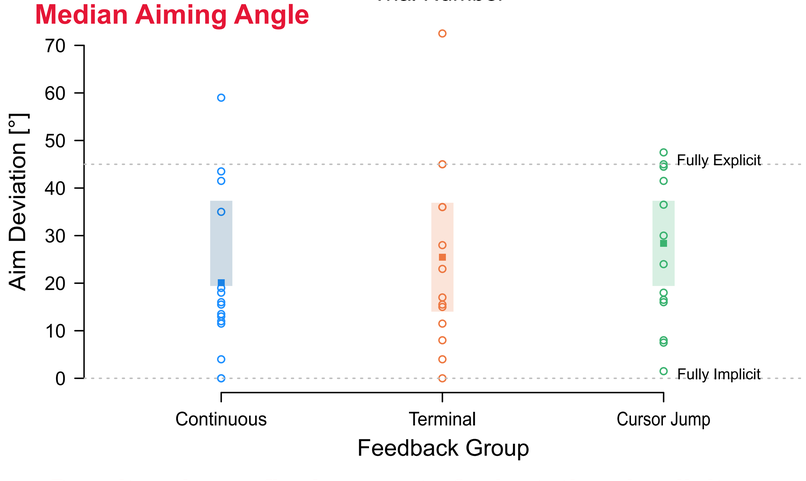
Reach Aftereffect Comparison





Median Aiming Angle



Despite a lower final amount of adaptation, implicit learning saturates faster with changed visual feedback