The Effect of Error-Sensitivity and Perturbation Schedules on the Slow and Fast Processes in Reach Adaptation

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Does gradual learning change the slow process?

Previous research has mapped the fast and slow processes onto explicit and implicit learning, respectively (McDougle et al. 2015). Since adapting to an abrupt perturbation is more explicit, and a gradually introduced perturbation is more implicit, can the two-rate model explain the differences between abrupt and gradual motor learning?

The Two-Rate Model of Motor Learning

The two-rate model (Smith et al., 2006) demonstrates that at least two processes are involved in motor learning.

The motor output is the sum of the slow and fast processes:

$$X_t = X_{s,t} + X_{f,t}$$

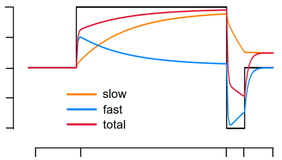
determined by a learning rate 'L' and retention rate 'R':

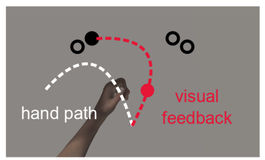
$$X_{s,t+1} = L_s \bullet e_t + R_s \bullet X_{s,t}$$

$$X_{f,t+1} = L_f \bullet e_t + R_f \bullet X_{f,t}$$

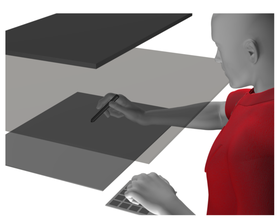
Both processes learn from the error on the previous trial (e_t), and retain part of the previous adaptation ($X_{s,t}$, $X_{f,t}$).

Constraints: $L_s < L_f$, $R_s > R_f$

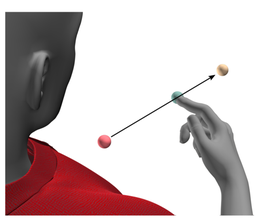




Tablet and Stylus Setup



Virtual Reality Setup



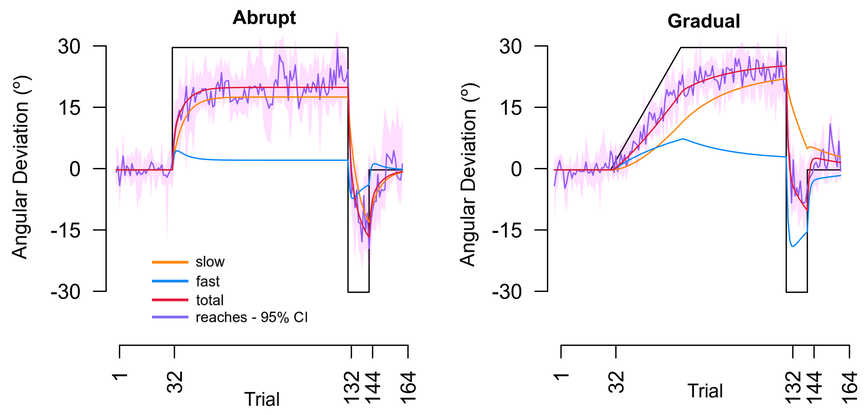
For both setups, we used a within-subjects design where all participants (N=32) adapted to rotated visual feedback of their hand introduced once gradually and once abruptly.

Desktop and Mouse Setup

In another experiment, participants (N=35) did two out of four conditions where we varied the duration (4 or 12 trials) and magnitude (0 or 30 degree) of the reversal period.

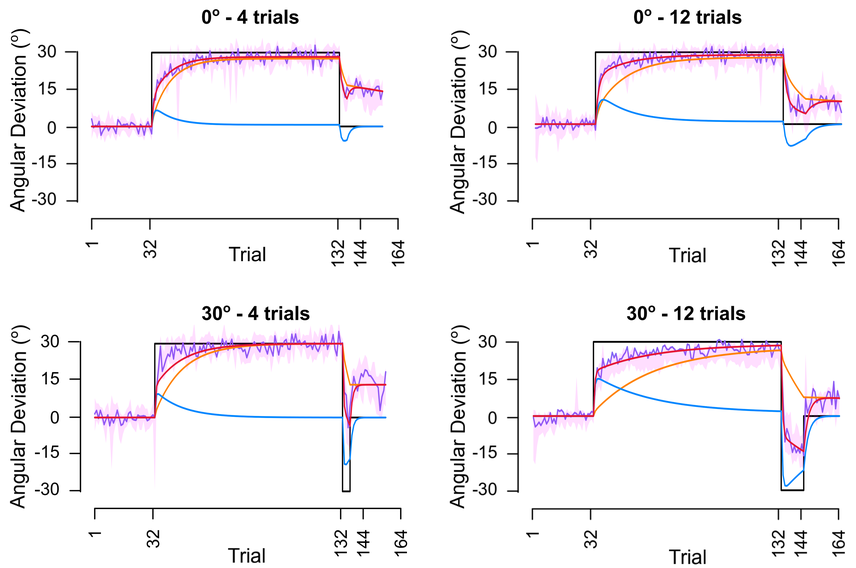
Virtual Reality Setup

There was no decrease in performance when adapting to a visuomotor adaptation in Virtual Reality



Desktop and Mouse Setup

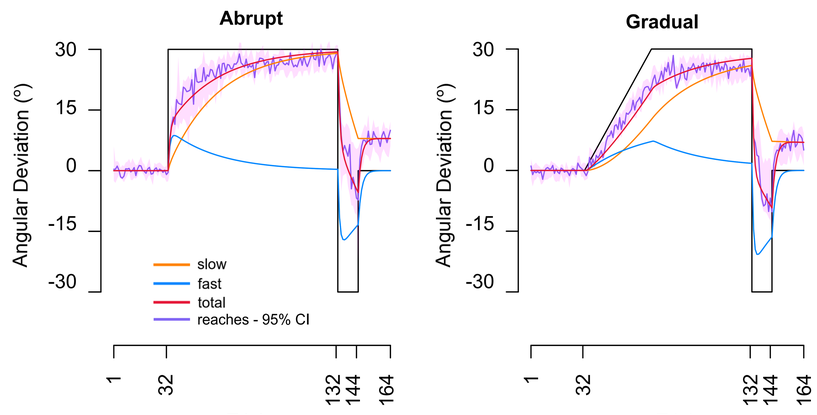
The reversal magnitude affects the rebound, but the reversal duration does not

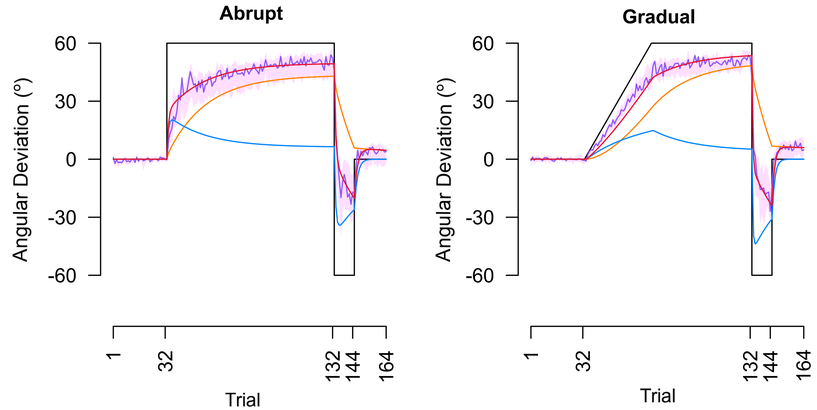


The slow rate predicts the magnitude of the reversal

Tablet and Stylus Setup

There is no difference in rebounds when a perturbation is introduced either abruptly or gradually for both a 30 and 60 degree visuomotor rotation





- **The way the perturbation is introduced does not affect the rebound**
- **This visuomotor adaptation paradigm can be tested across different experimental setups**

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