Differential feedback during adaptation impacts learning but not estimates of hand location

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Feedback, Adaptation and Hand Estimates

Motor Adaptation invovles at least two processes which are thought to utilize error based learning. Error based learning requires access to error information which can come from many sources. Here we focused on changing the visual error information provided to see how shifts in reaches and estimates of hand location emerge.

Two-Rate Model for Motor Learning

We also test if a two-rate model (Smith et al., 2006) can explain impacts of feedback during training and if shifts in estimates of hand location, match the slow process (McDougle et al., 2015). The two-rate model sets the motor output on trial t as the sum of a slow and fast process:

$$X_t = S_t + F_t$$

which are each determined by a learning rate L and retention rate R:

$$S_{t+1} = \text{Ls} \cdot e_t + \text{Rs} \cdot S_t$$

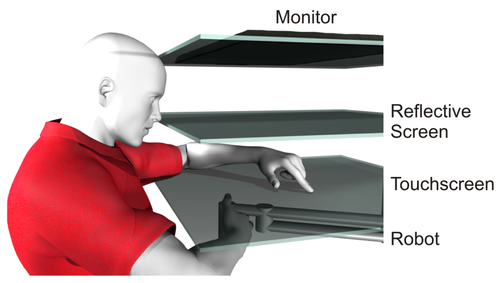
$$F_{t+1} = \text{Lf} \cdot e_t + \text{Rf} \cdot F_t$$

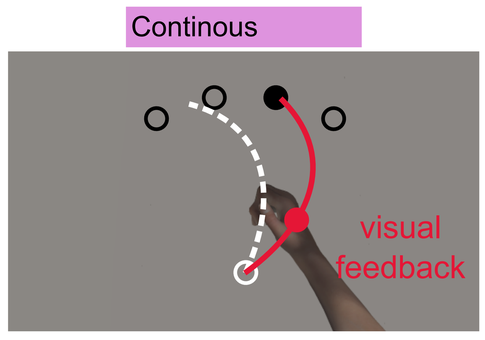
Both processes learn from errors on previous trials (e_t) and retain some previous adaptation (F_t, S_t). Constraints: Ls < Lf and Rs > Rf. The model explains a rebound after a brief reversal of the rotation.

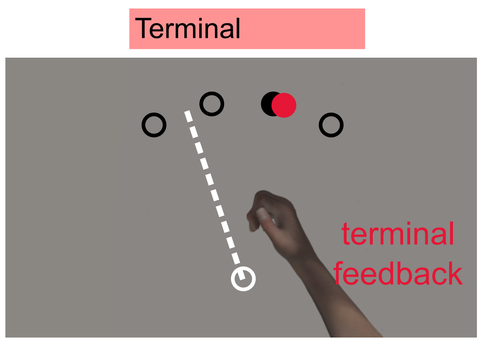
Experimental Procedure

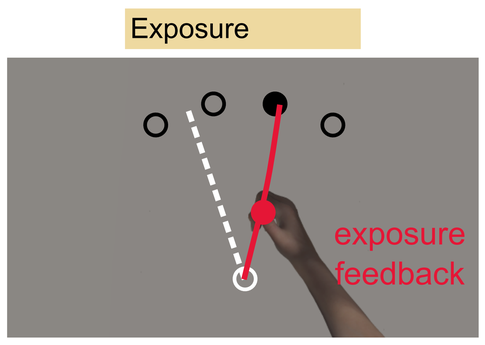
All groups experienced a visuomotor rotation following the two-rate model paradigm. Three different experimental groups were collected which varied on the type of training and all participants also completed a passive localization trial, where the robot dragged their unseen, right hand, to a location that they would then localize with their seen left hand. This localization trial was completed after every single training trial.

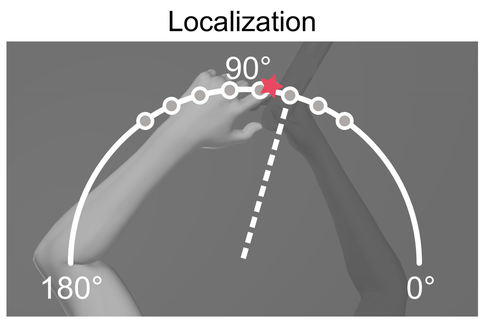
Continous	Active training with continous feedback and hand localizations.
Terminal	Active training with terminal feedback, hand cursor only visible at the end of the reach trial, and hand localizations.
Exposure	Exposure training with continous feedback and hand localizations. *During training participants' hand was deviated 30 degrees away from the target, while the cursor went directly to the target. Participants had no control over the direction they moved, only the distance.



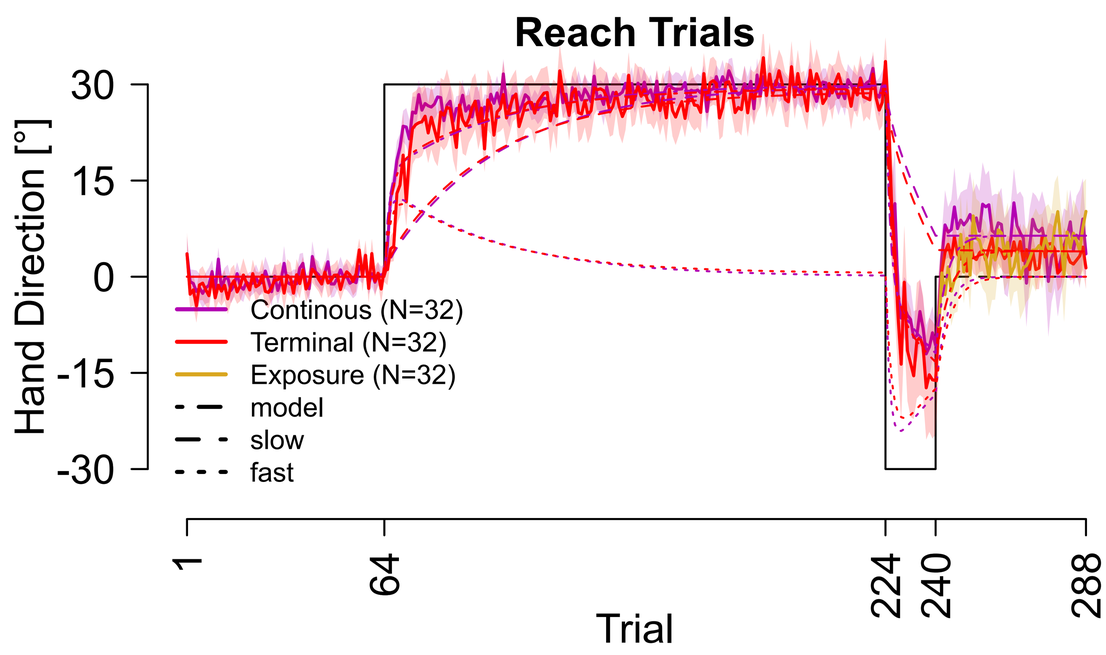




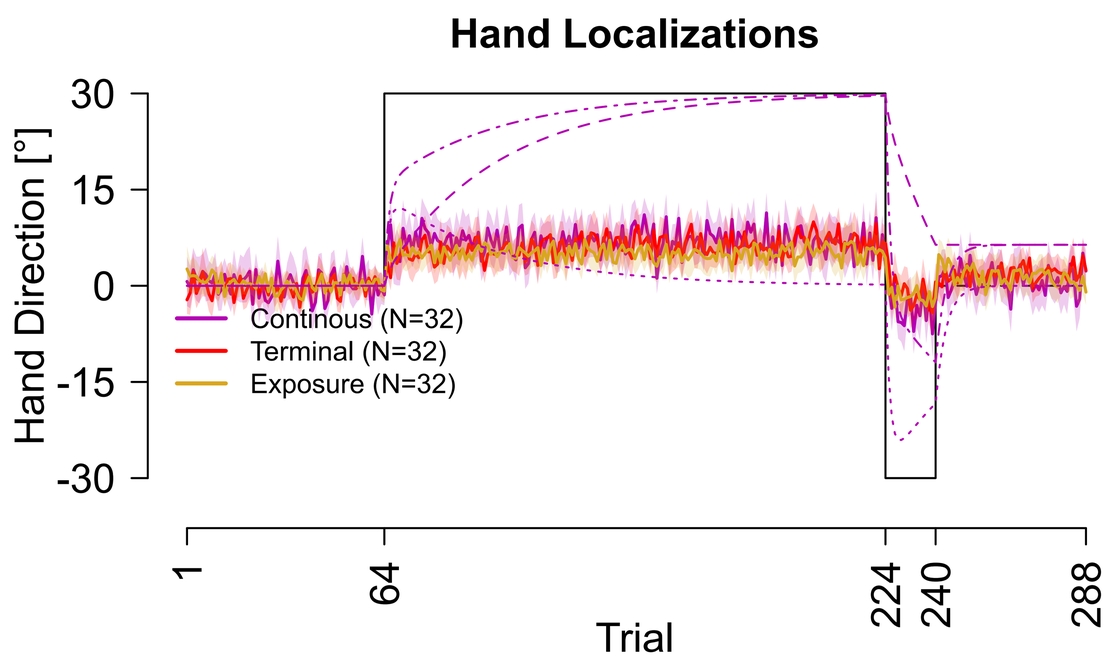




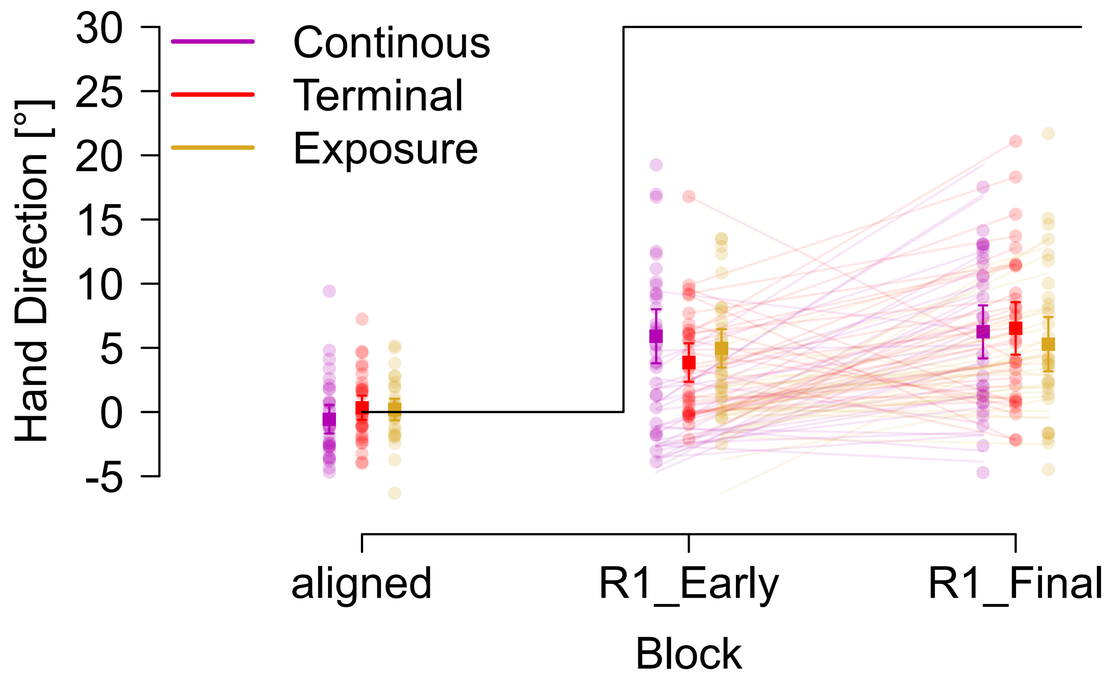
Two-Rate Model Predicts Reaches Well; Terminal Feedback Produces A Smaller Rebound



Hand Estimates are Similar Across Training Paradigms & Don't Match Pattern of Slow or Fast Process



With the model simulation and proposed fast and slow measures added to the above plot it is clear that the pattern of both the fast and slow pattern do not match that of the shift in estimates of hand location. The shift is virtually instantaneous, hitting asymptote at the same time. It is clear from the plot below that regardless of the feedback provided during training, participants shift their estimate of hand location.



Feedback during training has little impact on final adaptation

Shifts in estimates of hand location do not differ as a function of training feedback

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