

## **SUPPLEMENTARY MATERIALS**

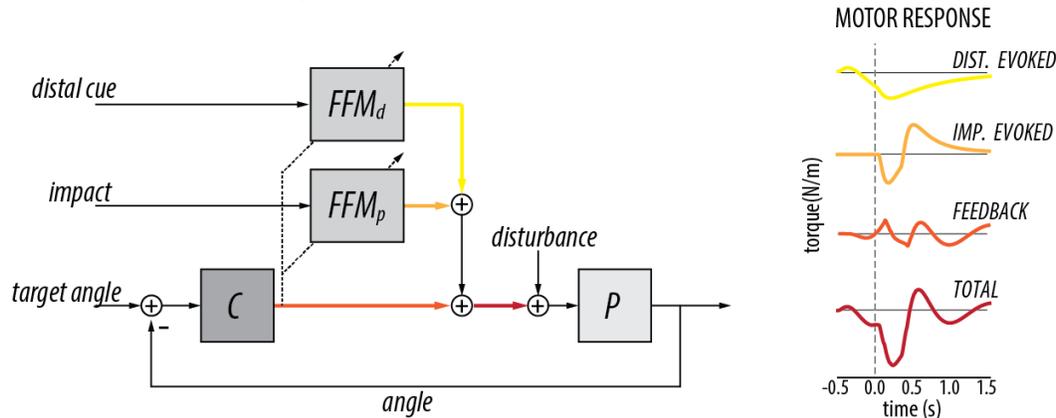
### The Perceptual Shaping of Anticipatory Actions

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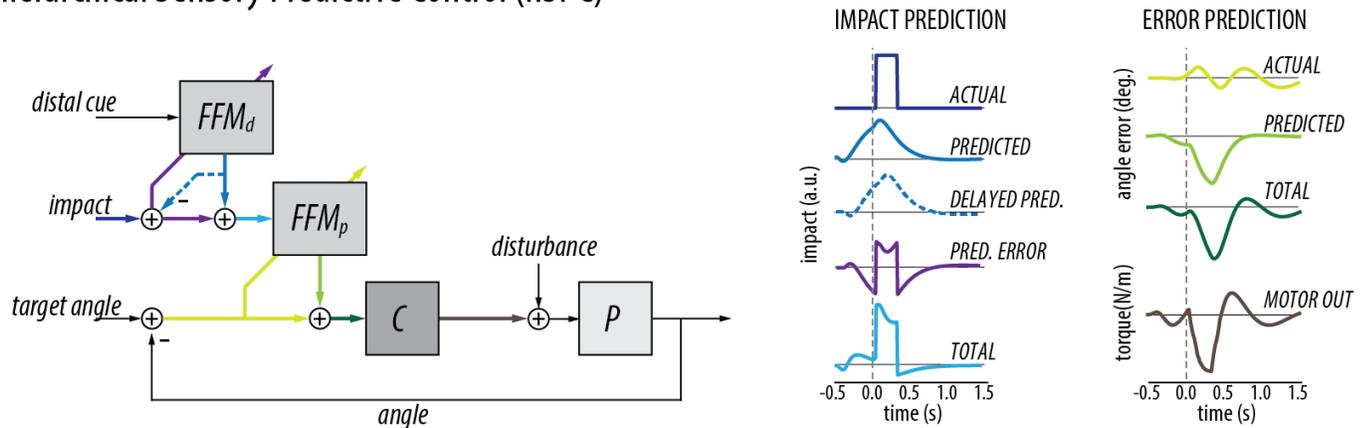
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## A Feedback Error Learning (FEL)



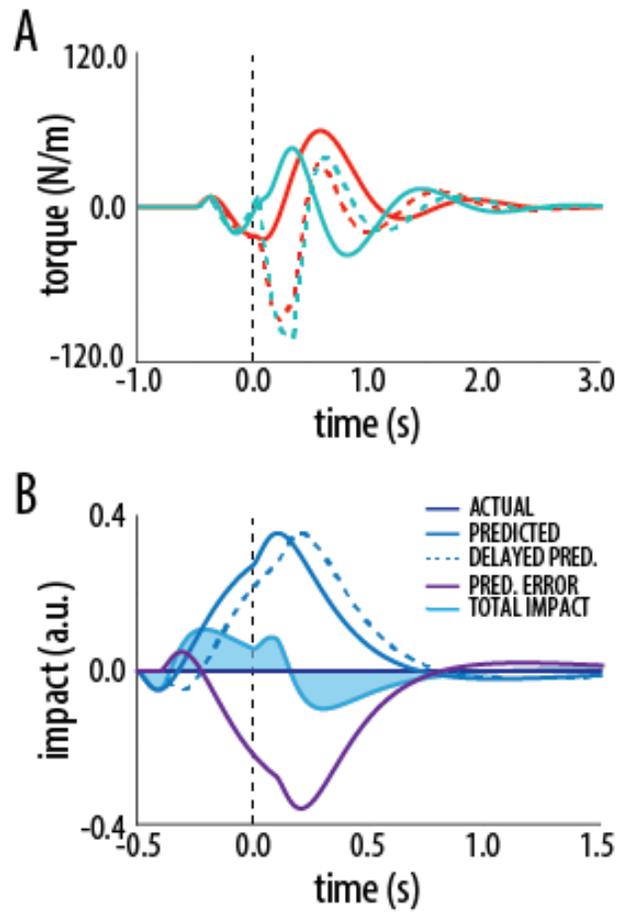
## B Hierarchical Sensory Predictive Control (hSPC)



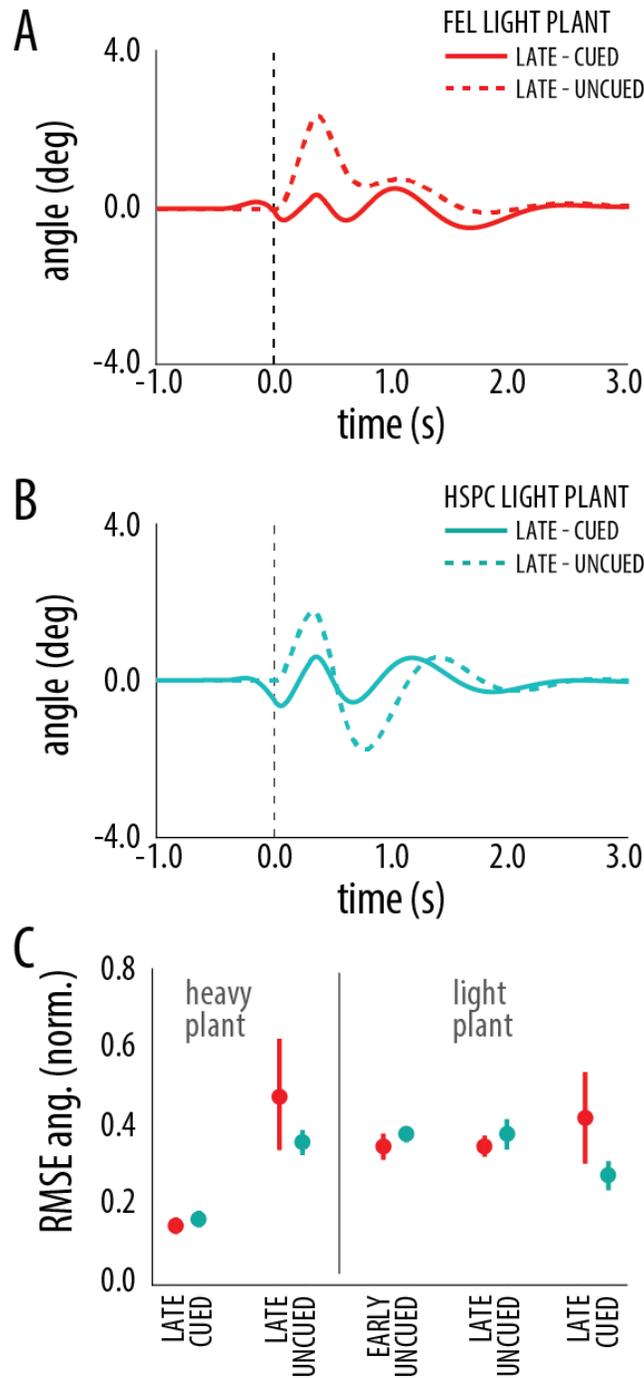
**Suppl. Fig 1. - Control Architectures and internal dynamics**

**A. Feedback Error Learning (FEL).** *Left. FEL Control scheme:* P indicates the plant, C indicates the feedback controller,  $FFM_d$  and  $FFM_p$  indicate the adaptive feed-forward controllers triggered by distal cue and proximal cue (impact) respectively. Colorcode of the arrows is described in the right panel. *Right. Decomposition of the motor response driving behavior in FEL after learning:* distal-evoked (yellow), impact-evoked (dark yellow) and feedback (orange) responses are integrated in a total motor command (red). All traces are aligned to the moment of the impact (gray dashed line).

**B. Hierarchical Sensory Predictive Control (hSPC).** *Left. hSPC Control scheme:* P indicates the plant, C indicates the feedback controller,  $FFM_d$  and  $FFM_p$  indicate the adaptive feed-forward controllers triggered by distal cue and proximal cue (impact) respectively. Colorcode of the arrows is described in the center and right panels. *Center. Decomposition of the impact sensory signal driving  $FFM_p$ :* the total impact signal (light blue) is obtained as the sum of the predicted impact signal (blue solid) and the prediction error (violet), which is computed by subtracting the delayed prediction (blue dashed) from the actual impact signal (dark blue). *Right. Decomposition of the angular error driving C:* the total error (dark green), obtained by summing the counterfactual (green) and the actual error (light green), is converted into a motor response (brown) by the feedback controller. Note that error and motor response refer to different scales. All traces are aligned to the moment of the impact (gray dashed line).



**Suppl. Fig 2. - Robustness experiment - A.** Mean motor response of FEL (red) and HSPC (cyan) during catch (N=10 – solid) and regular perturbed trials (N=10 – dashed). **B.** Online prediction error correction in HSPC: the prediction error, obtained as the difference between the delayed prediction and the actual impact signal is subtracted from the erroneously anticipated impact signal and generates a total response curtailed at the time the actual impact signal is perceived. Colorcode as in figure S1-B.



**Suppl. Fig. 3 - Generalization experiment. A. FEL:** Mean angular position before plant perturbation (N=10 –light plant) with (solid) and without the cue (dashed) **B. HSPC:** Same description as A. **C.** Root mean square error (RMSE) in angular position during *heavy-to-light* generalization phases for FEL (red) and HSPC (cyan). “Heavy plant” denotes the phase before plant perturbation. “Light plant” denotes the phase after plant perturbation.