Effects of immersive visual environment-change cues on motor learning during a virtual-reality target hitting task

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Internal model updating and switching during motor adaptation

When adapting to motor errors, the human motor system may update internal models of interactions, or in some cases create and switch to new internal models. Visual feedback of the consequences of movements, and of environmental changes prior to movements can inform the decision to update an existing internal model or to create and switch to a new model for a given interaction. In a ball rolling task, we tested if perturbations cued by immersive visual changes in the environment (i.e., a tilt in the surface) or different feedback properties of task errors determine whether motor adaptation is likely to occur via model updating or model switching.

Task

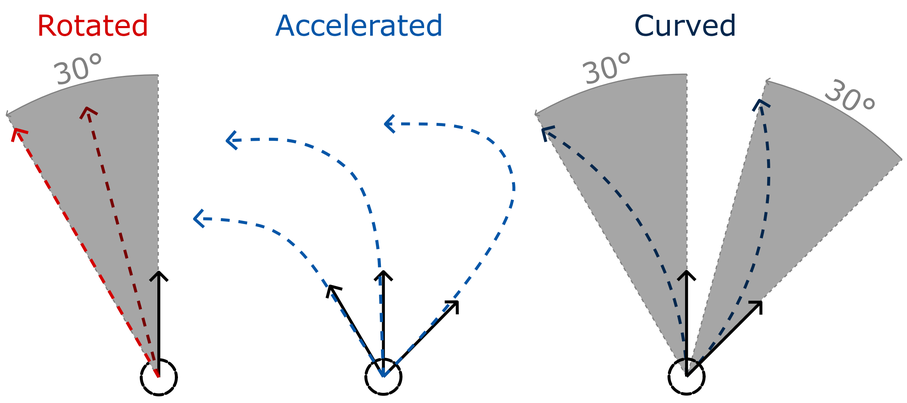
Participants made a throwing movement to roll a ball towards visual targets located 1 m away in an immersive virtual reality environment.

Groups

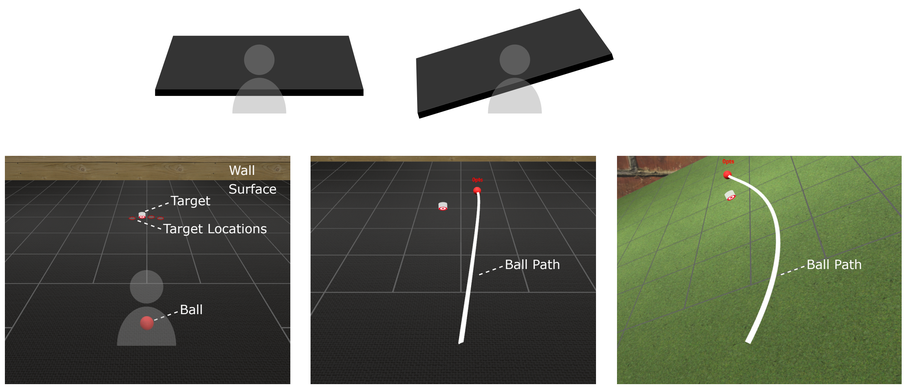
Perturbation	Visual Cue
Rotated - 30°	Cued
Rotated - 30°	Uncued
Accelerated	Cued
Accelerated	Uncued

Perturbation	Visual Cue
Rotated - 15°	Cued
Rotated - 15°	Uncued
Curved - 30°	Cued
Curved - 30°	Uncued

Perturbations

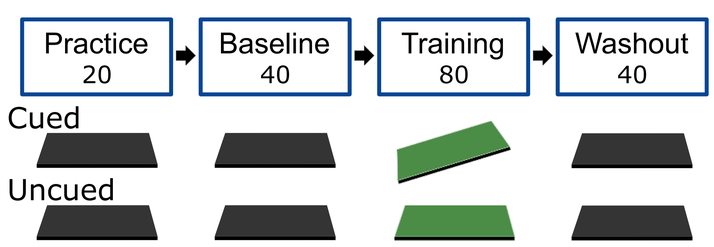


Visual Tilt Cues

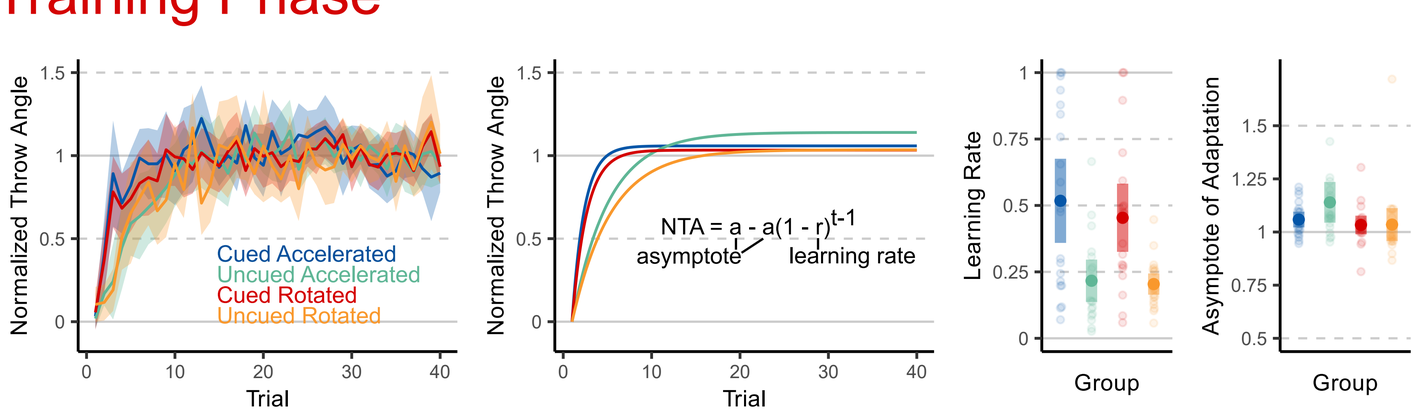


169 participants were split into 8 groups with differing perturbations and visual cues.

Task Schedule

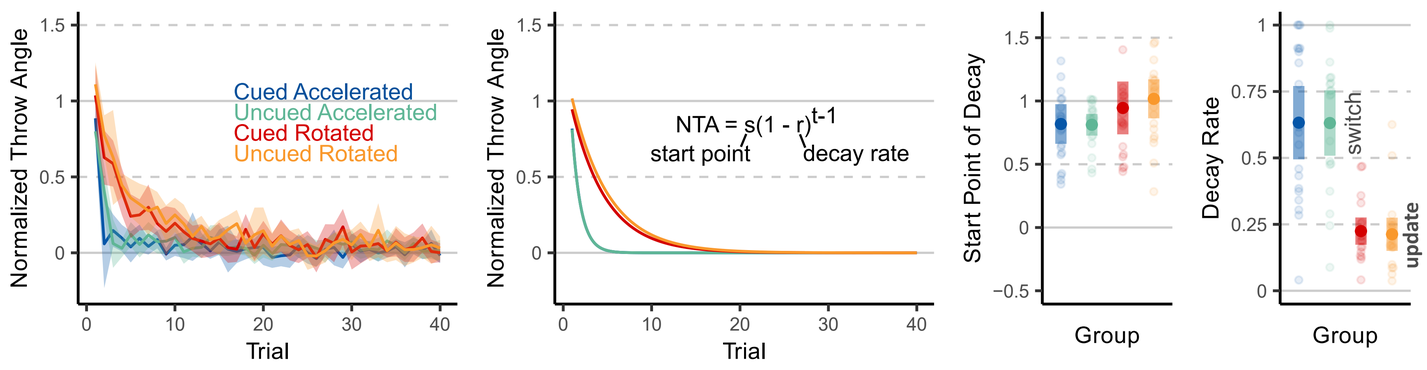


Training Phase



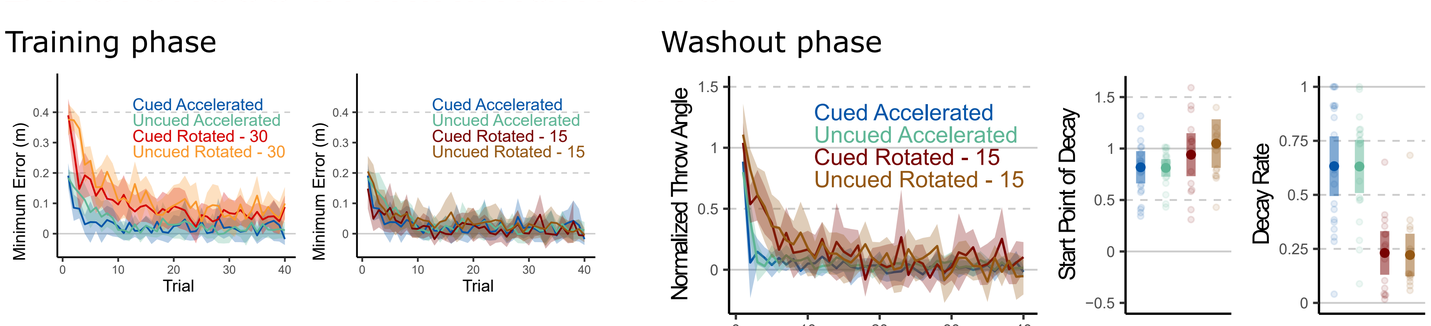
The visual tilt cue enabled faster adaptation.

Washout Phase

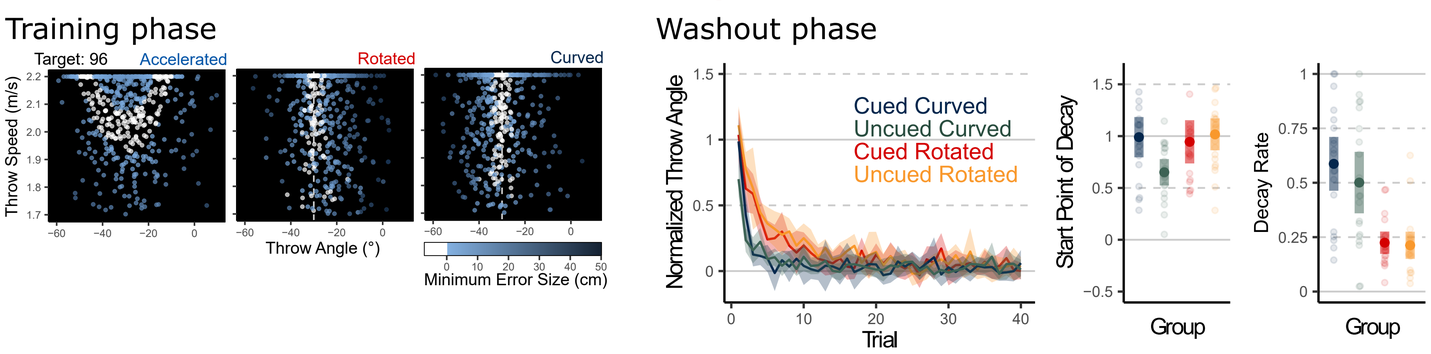


The perturbation type alone affected whether an existing internal model of motor control was updated, or a new internal model was created.

Differences in minimum error



Differences in the solution space



Our findings were not affected by either the size of the errors experienced during training, or the solution space of the task during training.

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