Effects of immersive visual cues and perturbation types on adaptation to internal and external errors
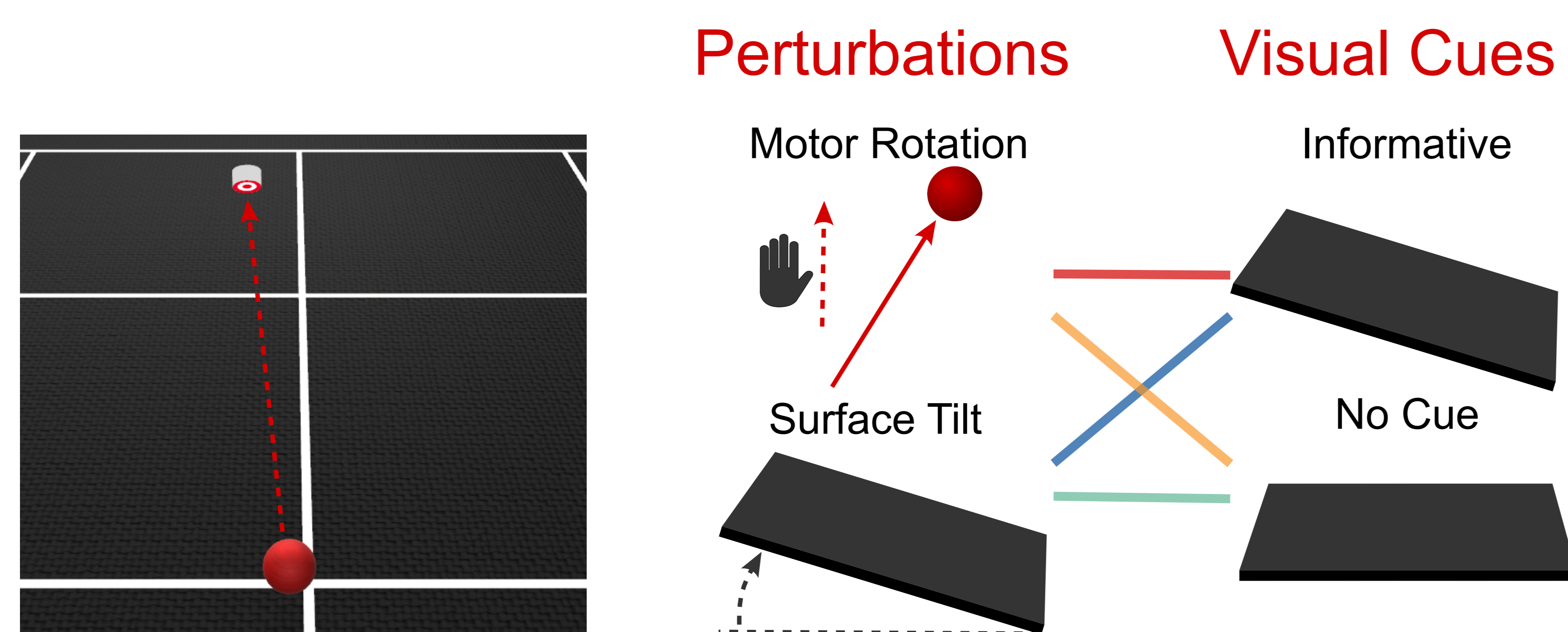
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Error attribution during motor adaptation

During human motor adaptation, information about the source of motor errors is valuable and our motor system differently adapts to internal and external sources of error. Internal and external error attribution cannot be directly measured and in the past, has been difficult to disambiguate. In a ball rolling task, we tested whether perturbations due to surface properties (i.e. tilt) or visual indications of perturbations can elicit external error attribution during adaptation.

Participants rolled balls towards visual targets in an immersive virtual reality environment

Perturbations

Motor Rotation

Surface Tilt

Visual Cues

Informative

No Cue

Task schedule

The experiment included 5 blocks of rolling tasks: 2 blocks of non-perturbed rolls, 1 adaptation block where rolls were perturbed, 1 block of non perturbed rolls to determine the aftereffects of adaptation, and finally one block of perturbed rolls to explore learning transfer to the opposite hand.

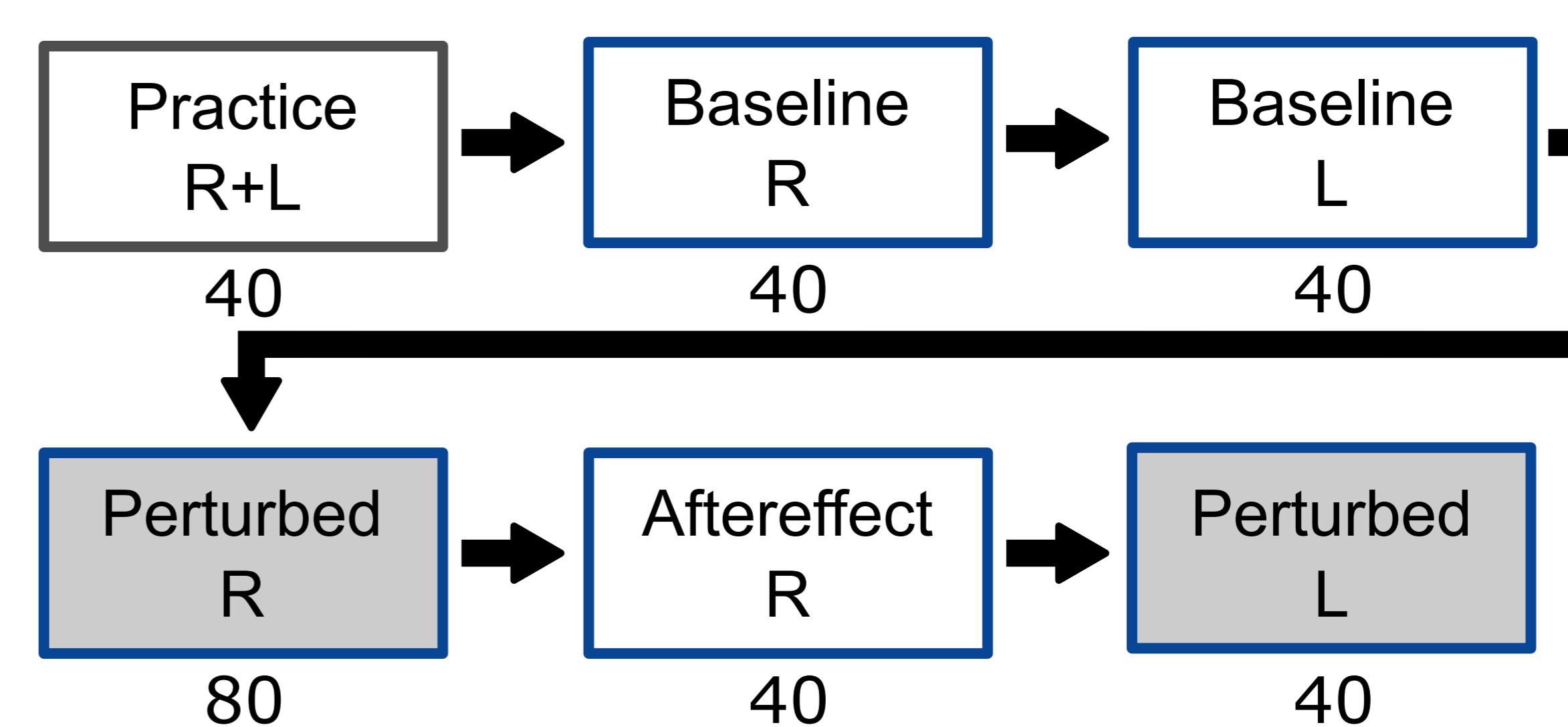Participants (N = 84) were split into 4 groups with differing perturbations and visual cues

Rotation + informative cue: 30° visuomotor rotation for all Perturbed trials.
Rotation + no cue: 30° visuomotor rotation for all Perturbed trials.
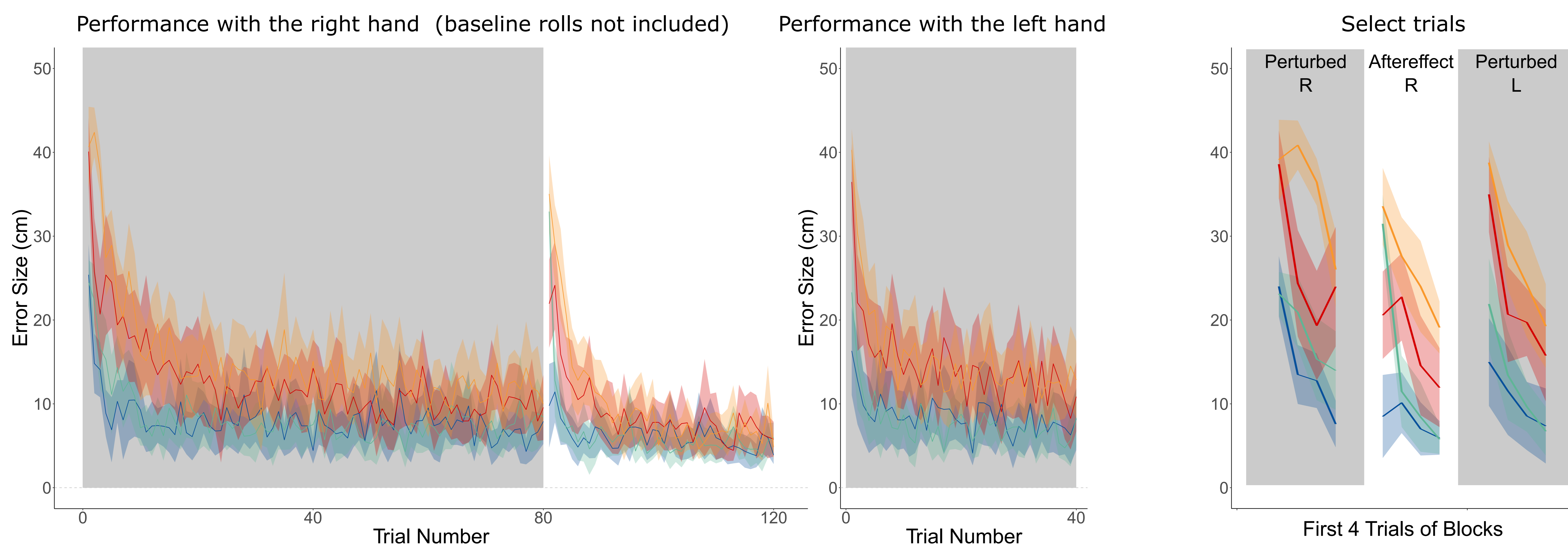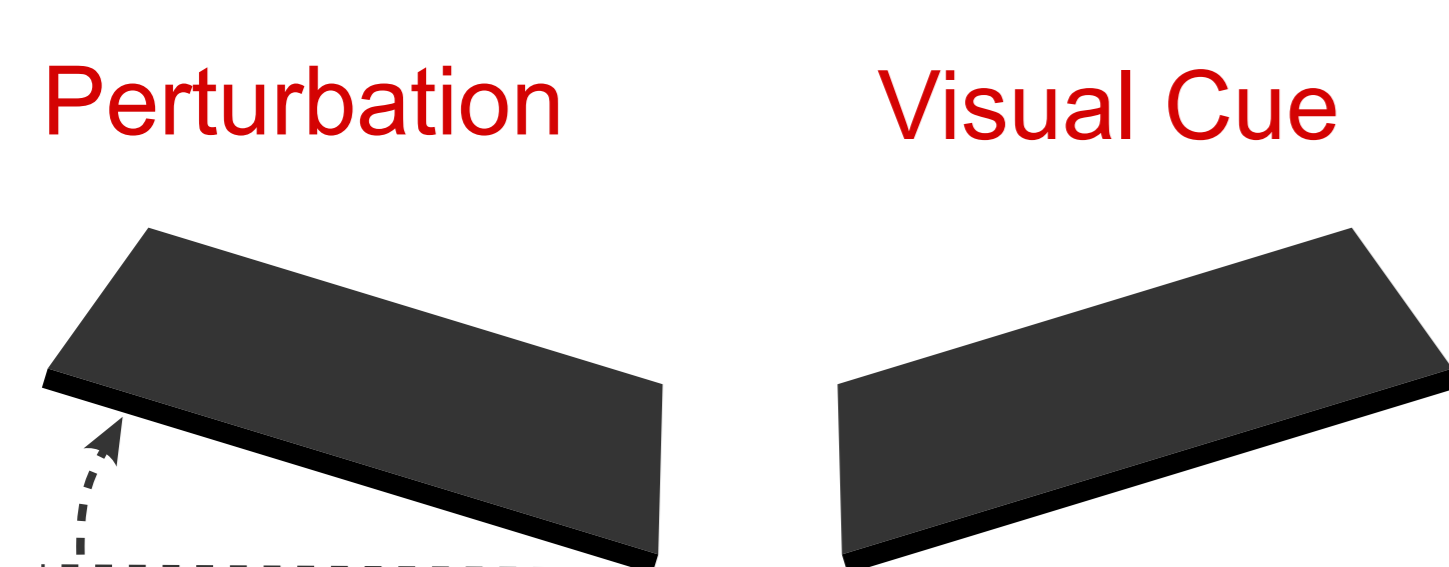**Plane tilt + informative cue**: 25° surface tilt for all Perturbed trials.
Plane tilt + no cue: 25° surface tilt for all Perturbed trials.

Surface-tilt perturbations elicited external error attribution while visual cues did not

Performance with the right hand (baseline rolls not included)

Performance with the left hand

Select trials

Next steps

Non-informative cues

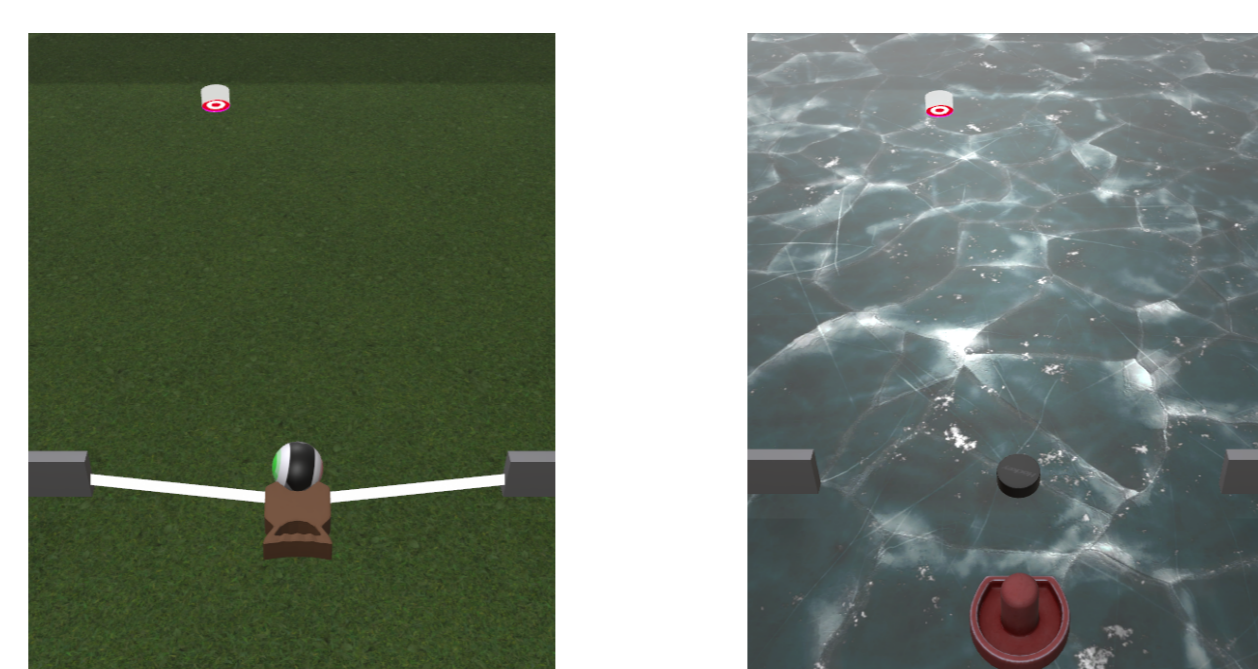Perturbation   Visual Cue

Tools and environments

Conclusions

Groups adapting to surface-tilt perturbations learned faster and were able to quickly return to baseline-like performance in the absence of a perturbation. Adaptation to surface tilts, regardless of visual cues, was also better transferred to the opposite hand.

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