Using tools as cues for dual adaptation to opposing visuomotor rotations in virtual reality

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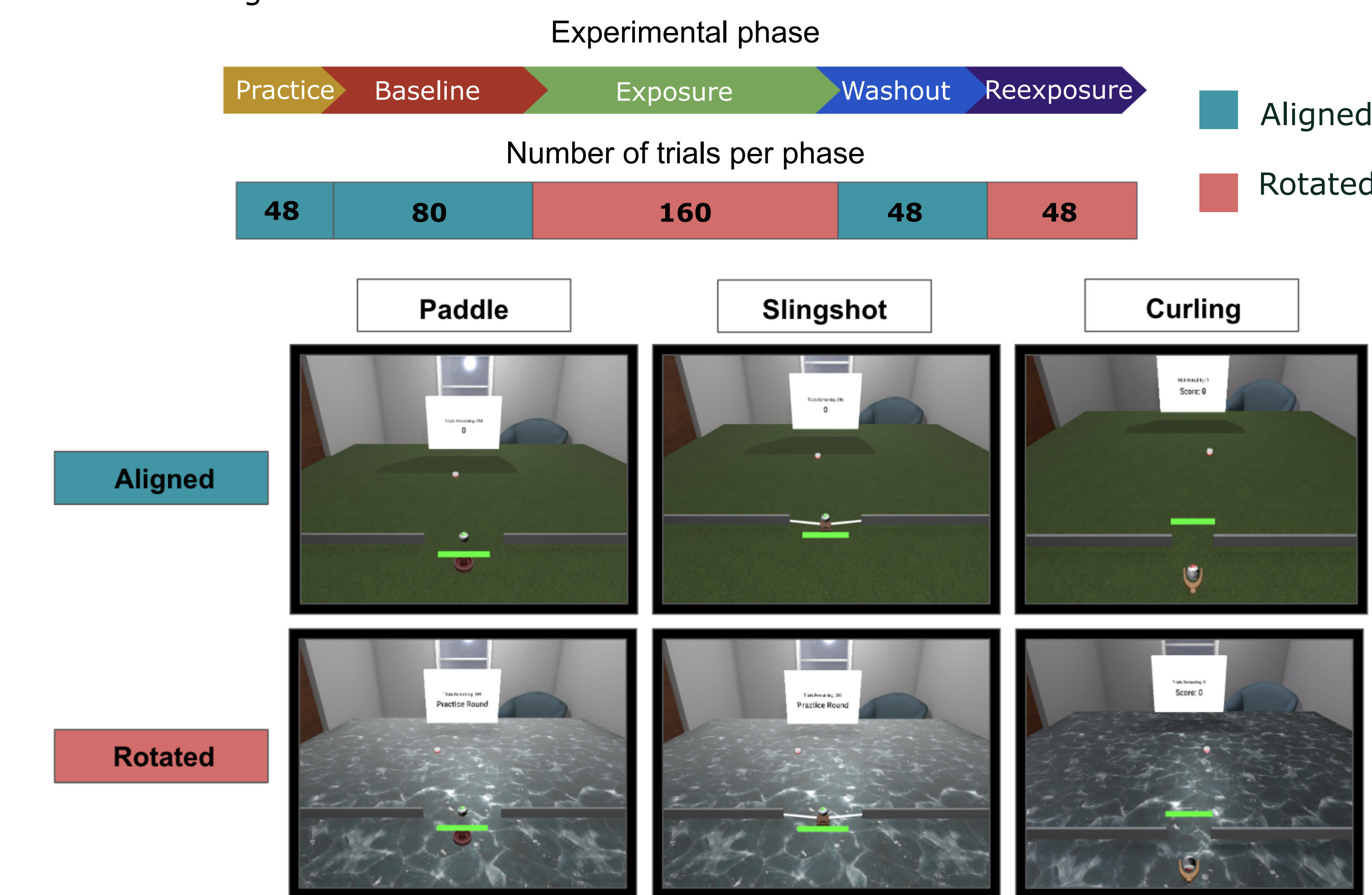## Contextual Cues are essential for learning how to use tools

Everyday tasks requires competent operation of different tool with separate movement types

Successful dual adaptation (concurrently learning two opposing pertubations) is reliant on extrinsic (shape of tool) or intrinsic (motor movement) cues
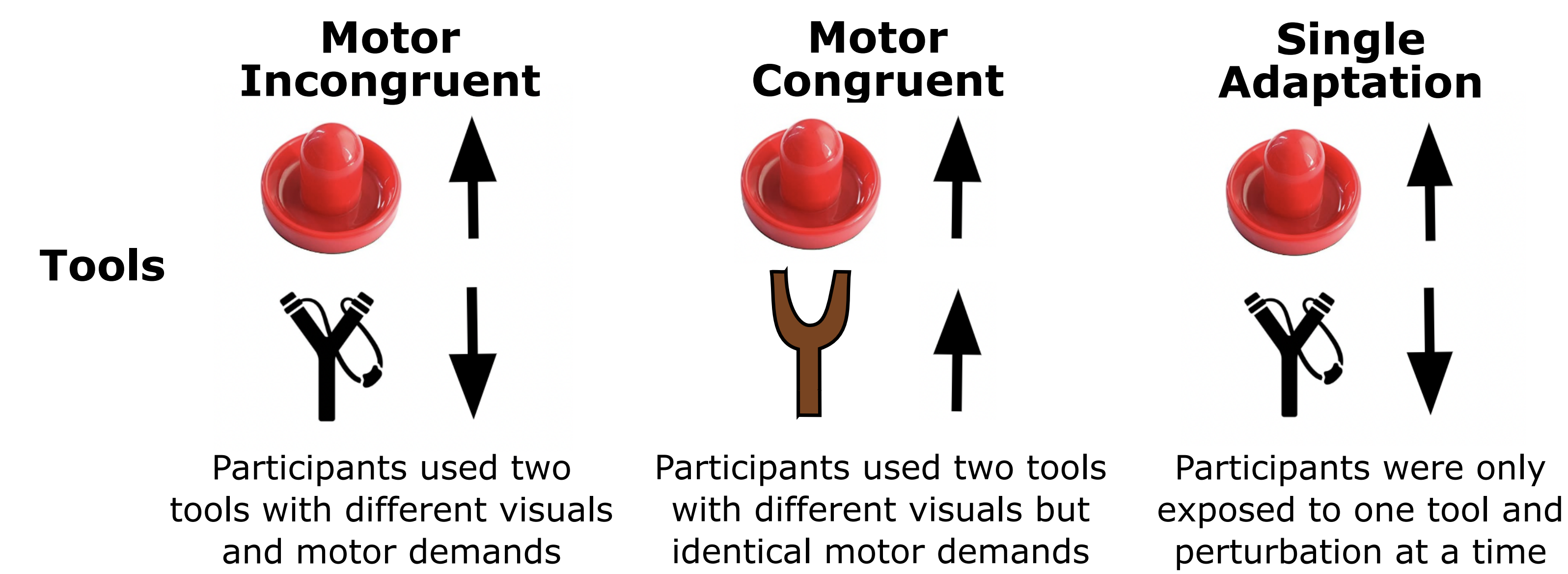
Can we use different tools to cue opposing rotations during dual adaptation in virtual reality?
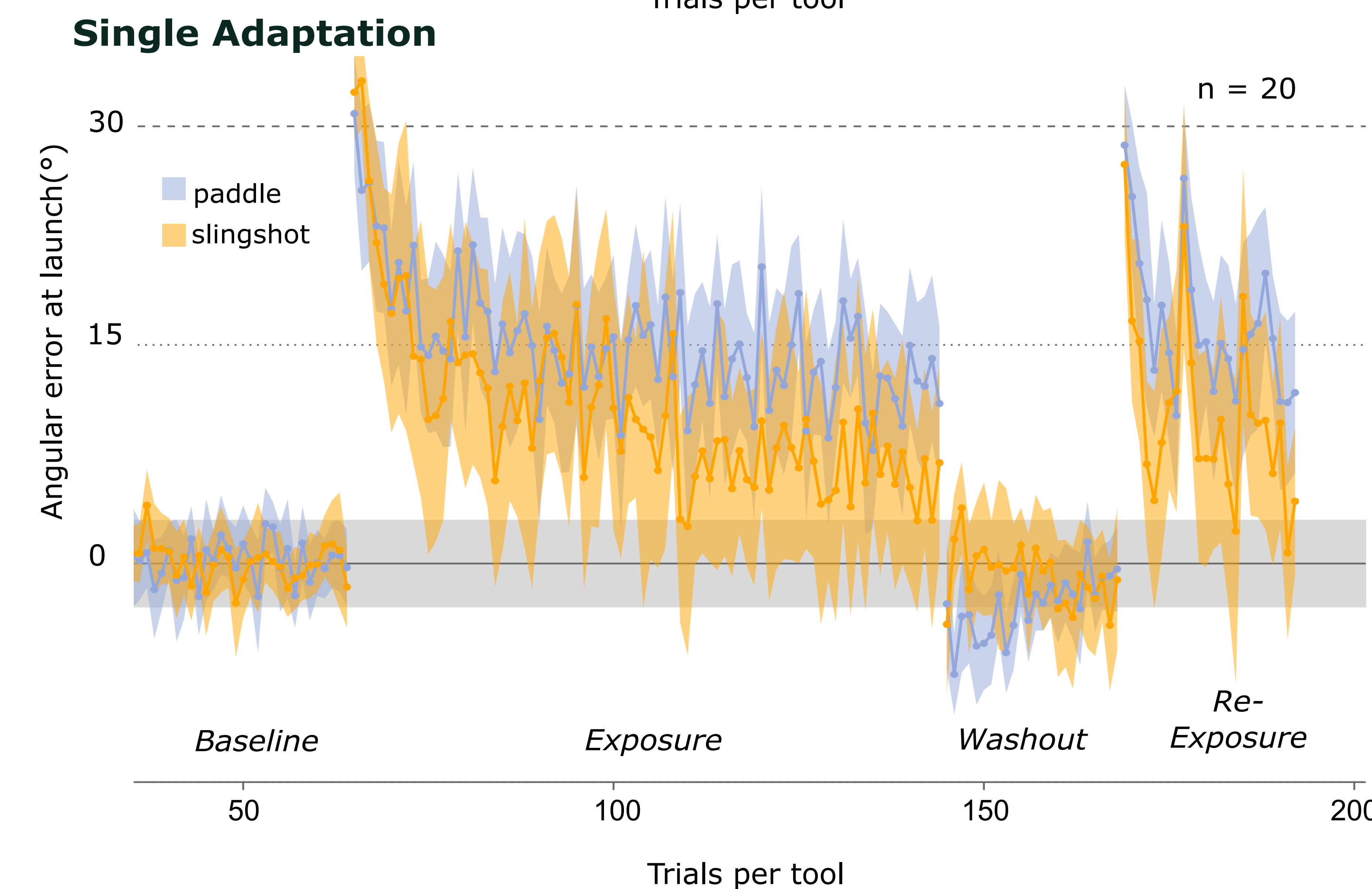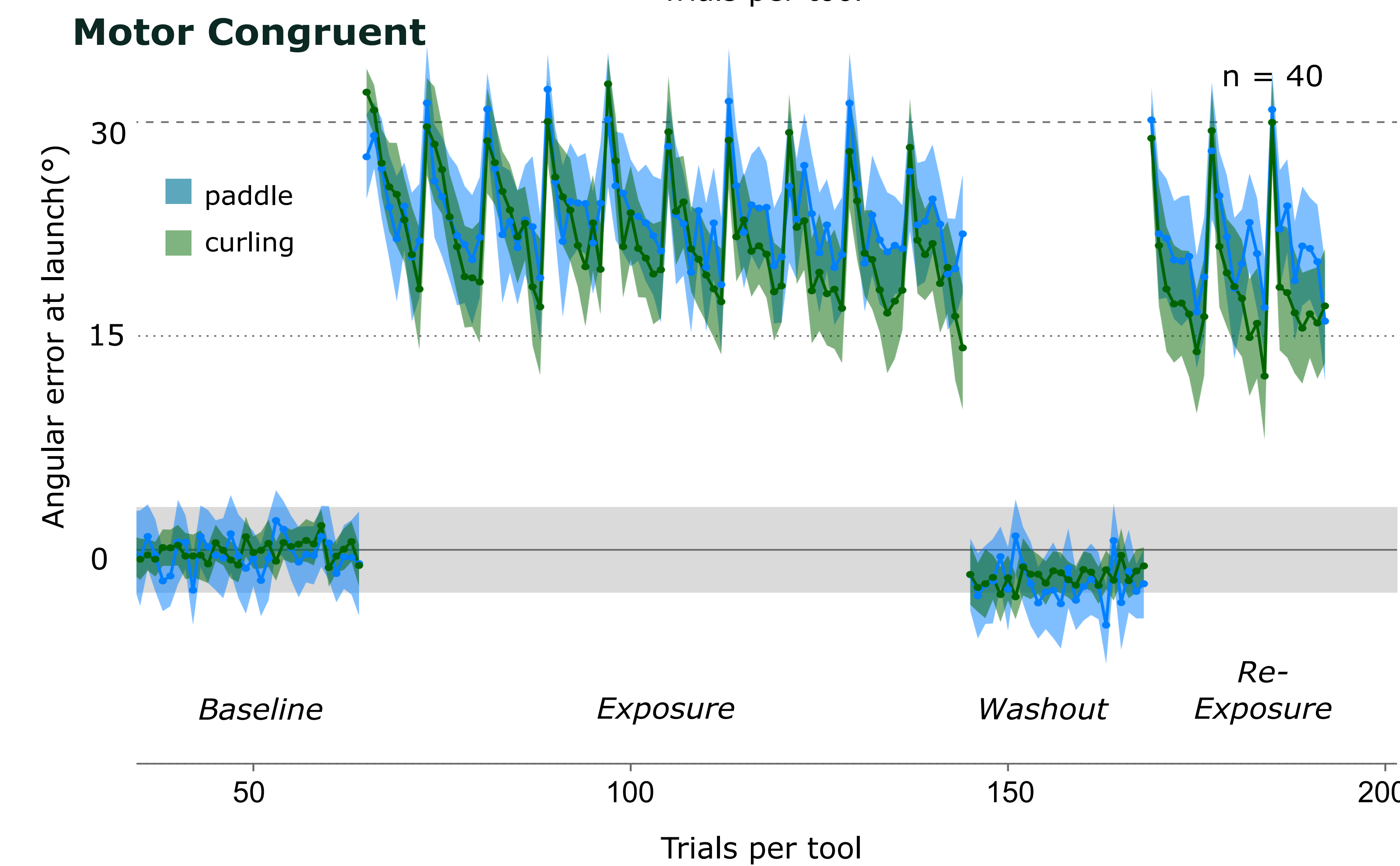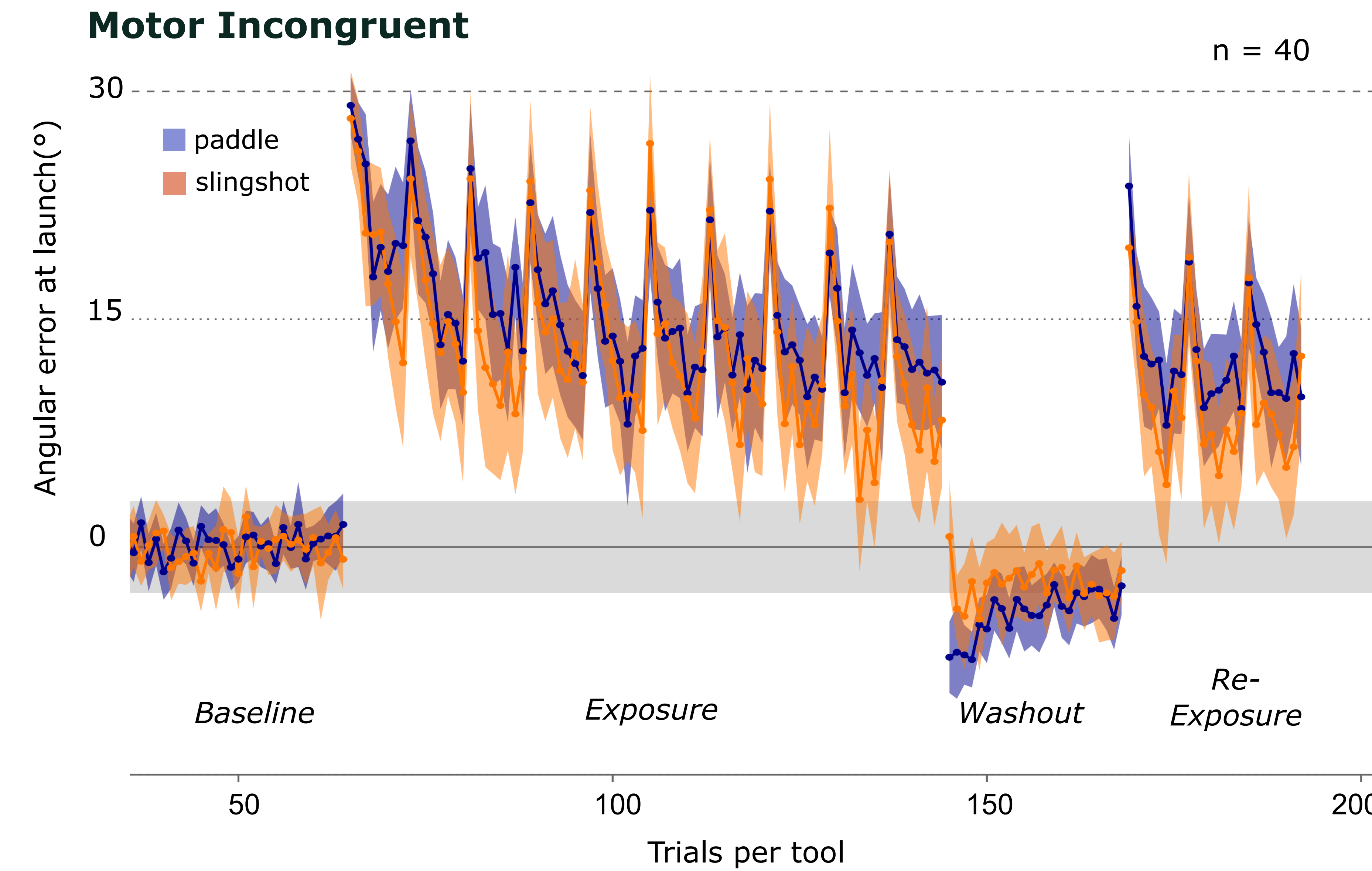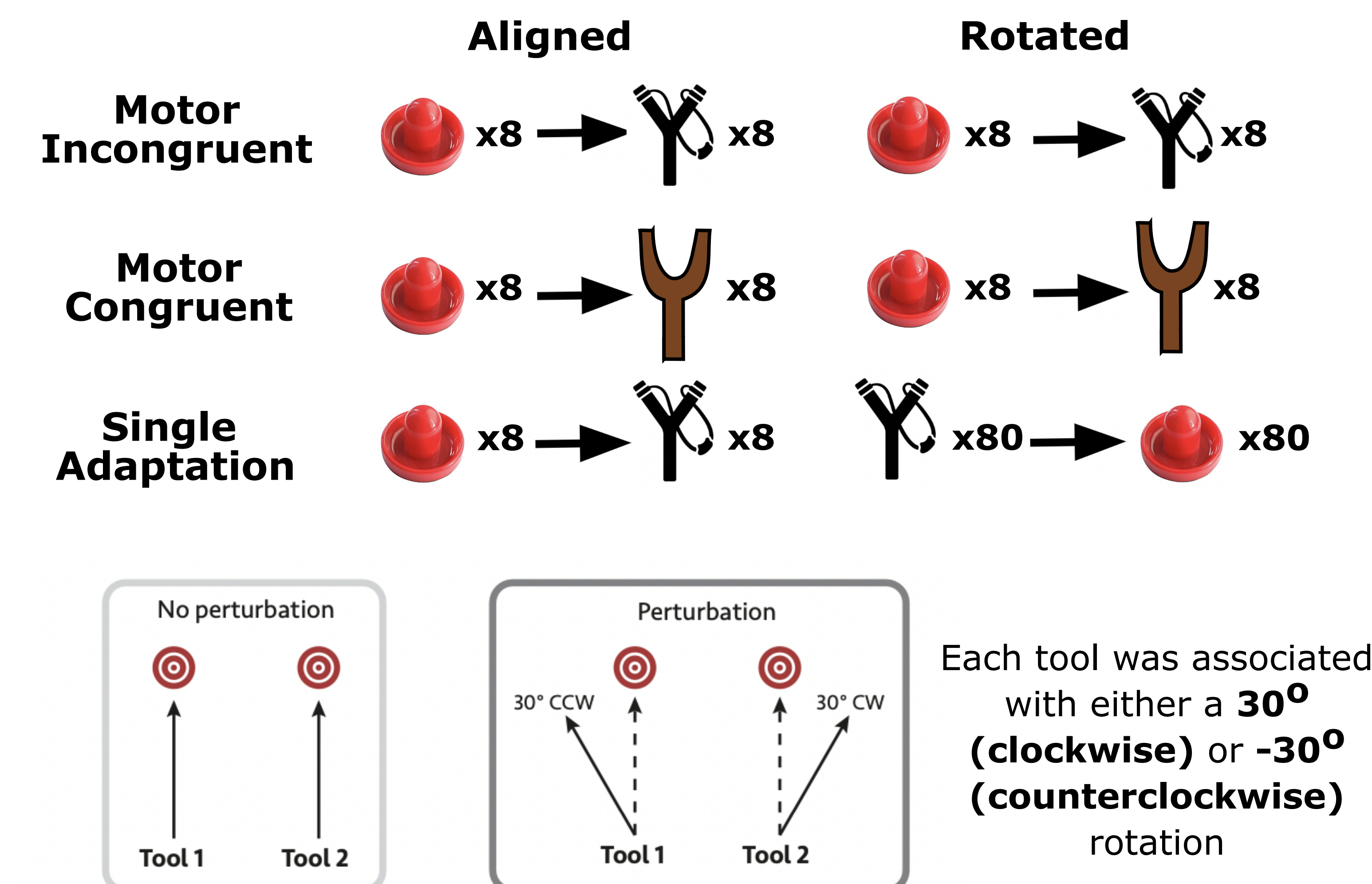
Virtual Paradigm

Participants (N = 124) used two tools in virtual reality to launch a ball toward a target

Conditions

Motor Incongruent
Participants used two tools with different visuals and motor demands

Motor Congruent
Participants used two tools with different visuals but identical motor demands

Single Adaptation
Participants were only exposed to one tool and perturbation at a time

Shot Procedure

Each tool was associated with either a **30°(clockwise)** or **-30° (counterclockwise)** rotation

Motor Incongruent

n = 40

Motor Congruent

n = 40

Single Adaptation

n = 20

Individual differences across experimental phase

Legend: paddle (incongruent), paddle (single), paddle (congruent), curling (single), slingshot (incongruent), slingshot (single), curling (congruent)

Exposure (First Block, Last Block), Washout (First Block, Last Block), Re-Exposure (First Block)
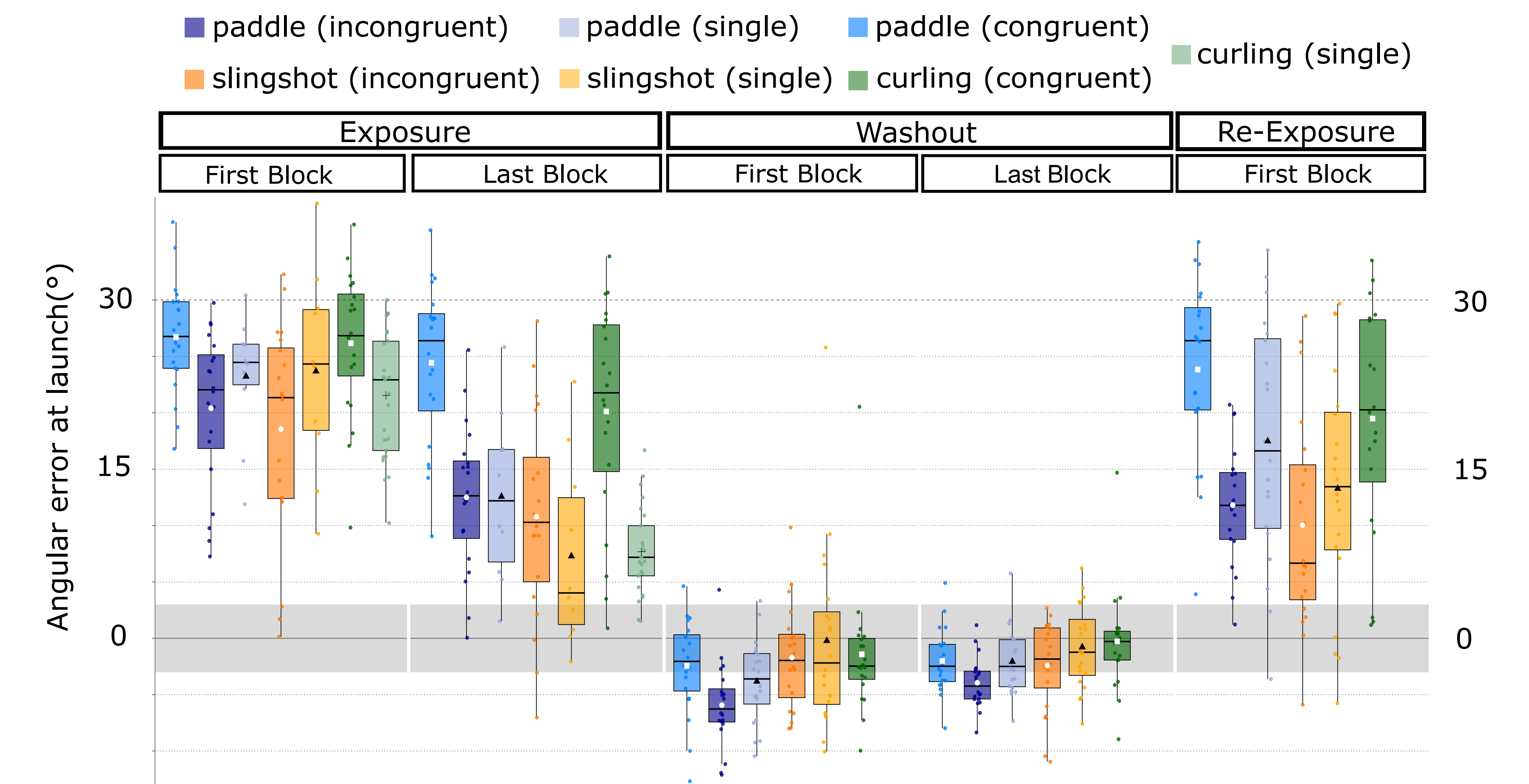
Paddle differences in angular error per block during exposure phase

Legend: paddle (incongruent), paddle (congruent), paddle (single)

Block 1, Block 2, Block 3, Block 4, Block 5, Block 6, Block 7, Block 8, Block 9, Block 10

Tool differences in angular error per block during exposure phase

First Block, Last Block
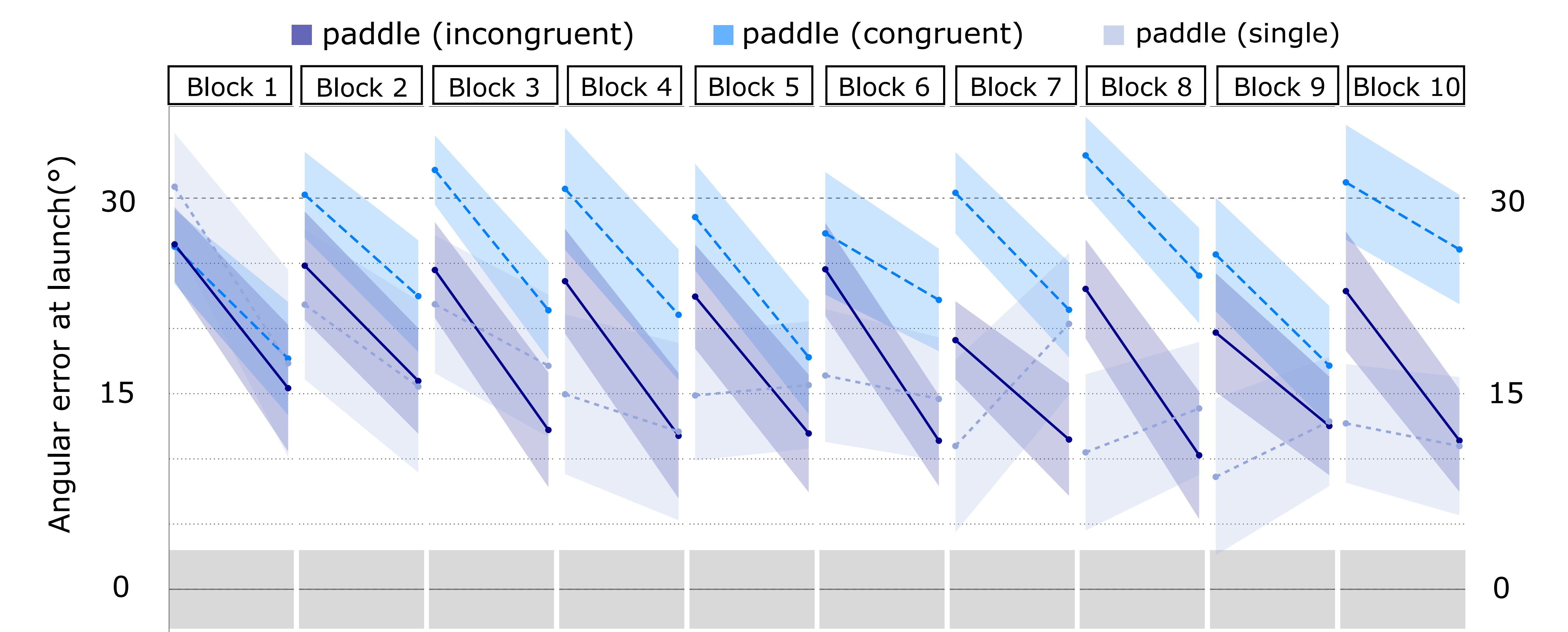
Legend: paddle (incongruent), slingshot (incongruent), paddle (congruent), curling (congruent), paddle (single), curling (single), slingshot (single); incongruent, congruent, single
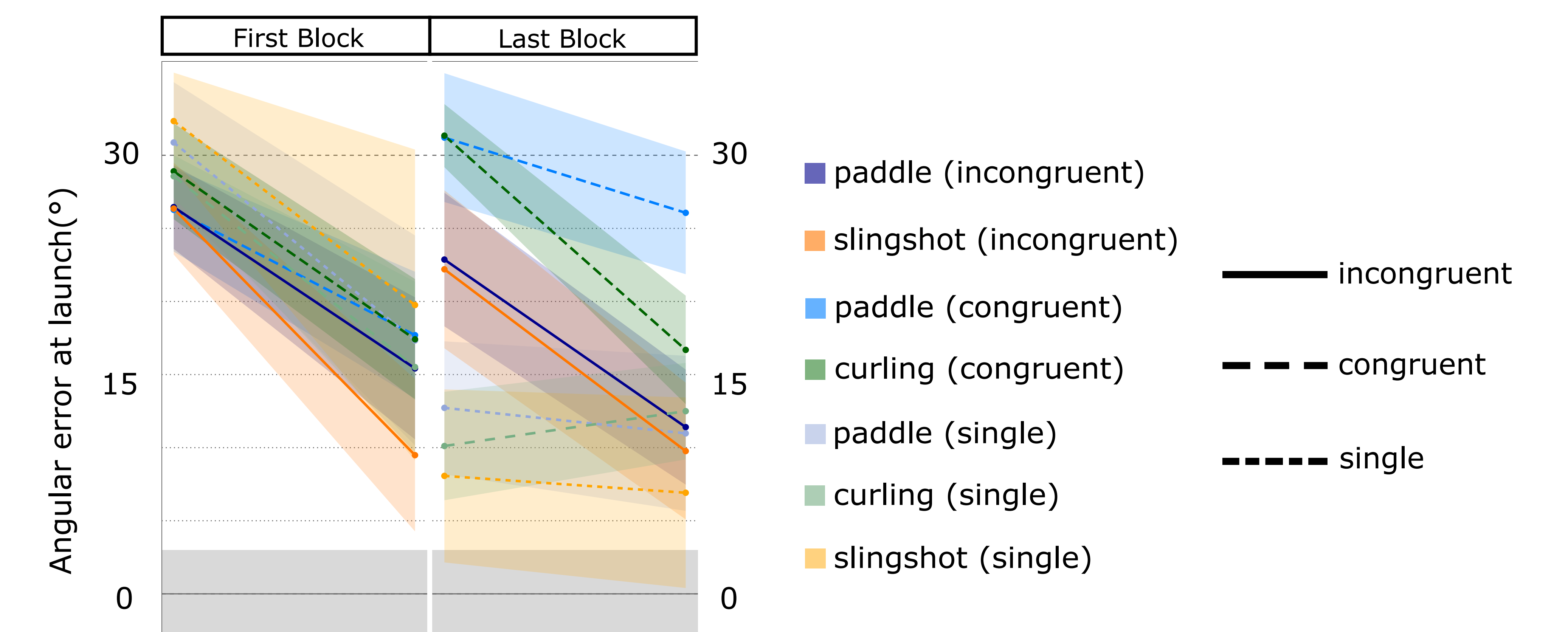
Main Takeaways

1) Greater learning when tools differed in both extrinsic and intrinsic cues
2) The extent of learning for tools was comparable between the incongruent and the single adaptation conditions.
3) Despite finding substantial within-block learning for both dual adaptation conditions, only the incongruent tools showed retention following block-switching