

# Effect of Error Feedback on Implicit Adaptation

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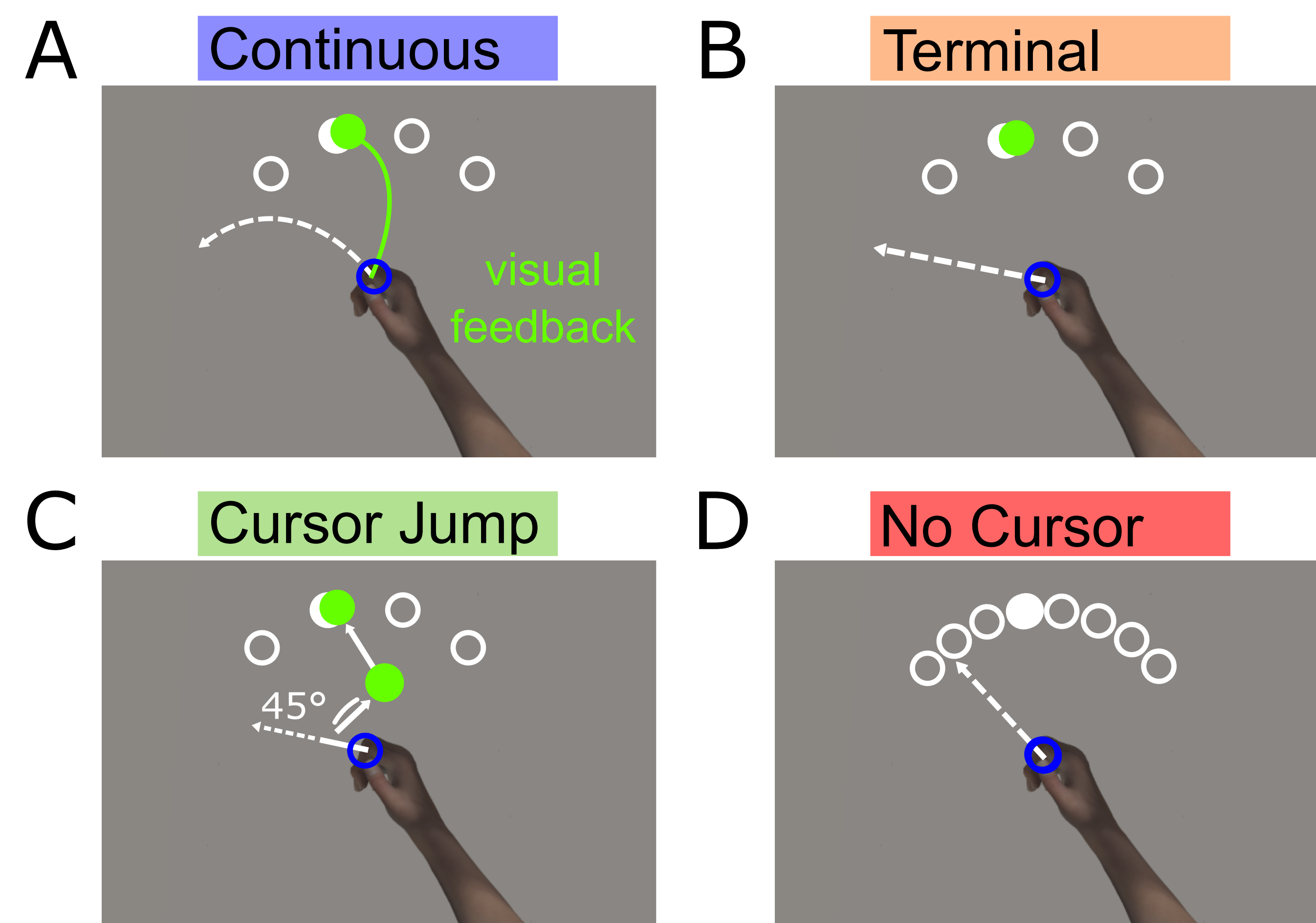
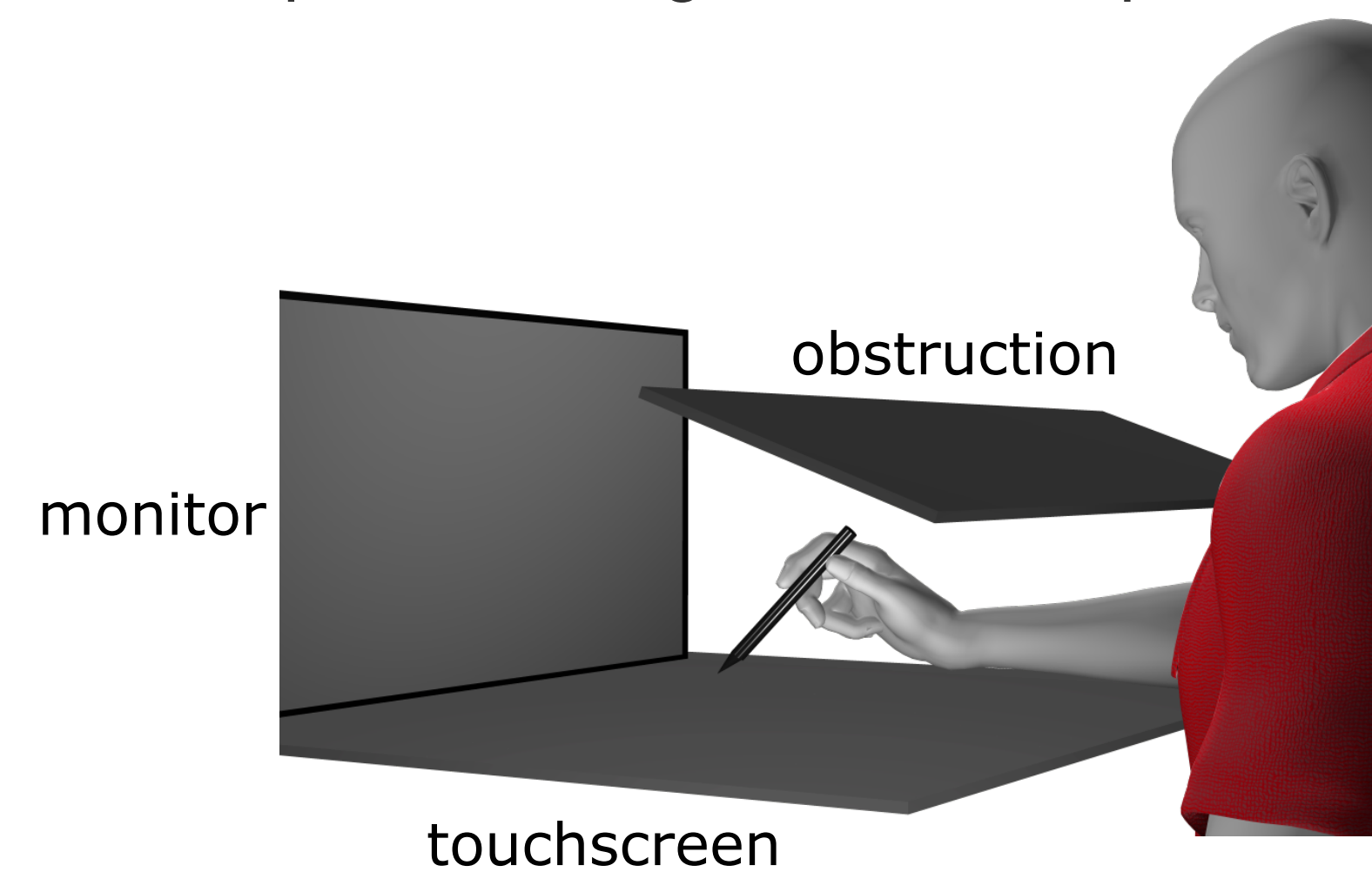
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## How is Implicit Learning Influenced by Feedback?

People constantly adapt their movements to their changing circumstances, which is mostly handled by our automatic, unaware, or implicit motor adaptation systems. While the time course of these implicit processes is thought to be slow, this is actually largely unknown. Motor adaptation is usually induced by having people reach to targets with a cursor whose motion is misaligned with respect to their unseen hand. Here, I have tested the effects of various kinds of feedback of the unseen hand motion on the speed of implicit learning.

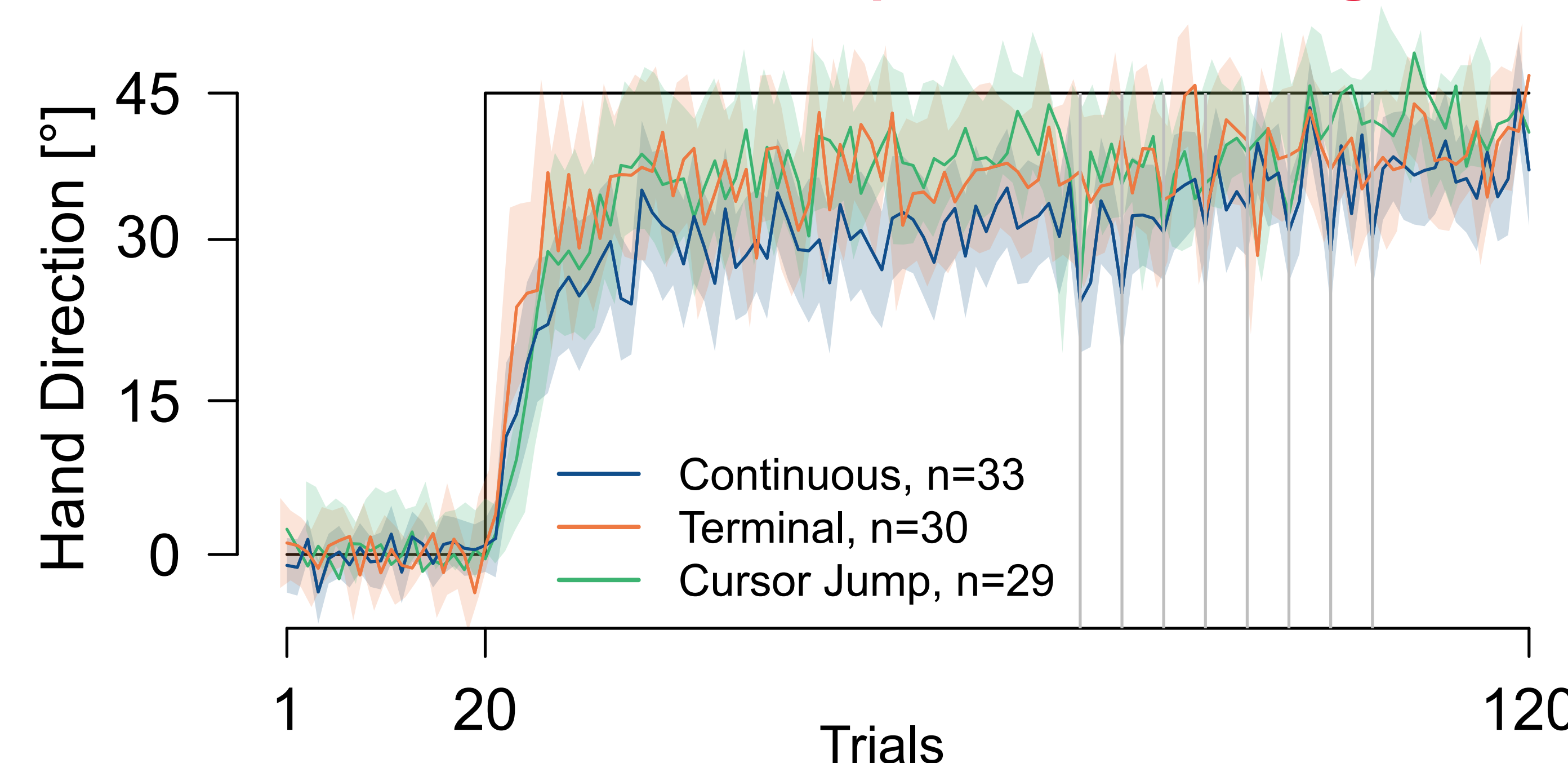
## Experimental Procedure

All groups completed the same rotation schedule with different visual feedback (see below) and all trained with a cursor rotated 45°. After every training trial participants completed a no-cursor trial to probe implicit adaptation. By alternating between training and testing trials, we could measure the rate of implicit learning at a fine temporal resolution.

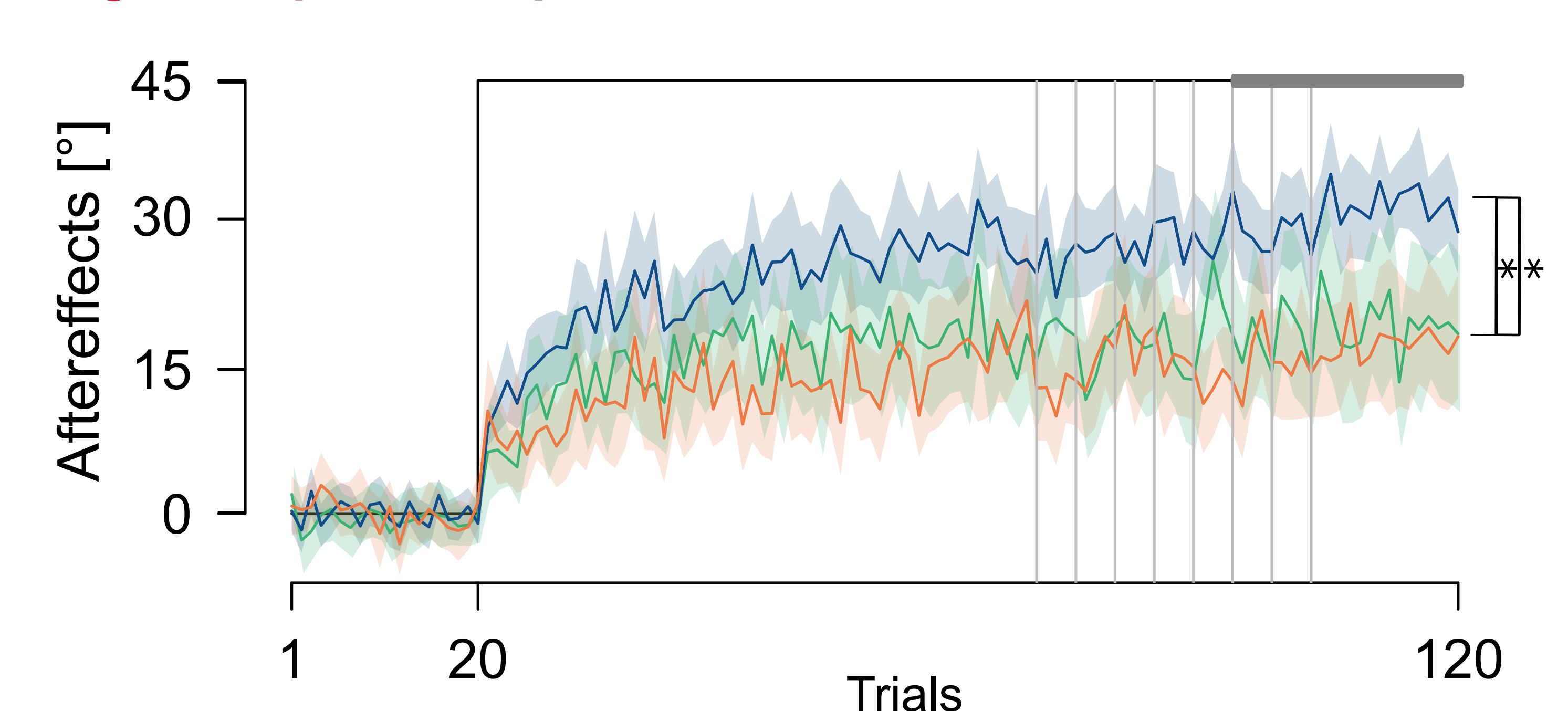


- Continuous** Training with continuous rotated feedback
- Terminal** Training with terminal rotated feedback; cursor only shown at end of reach trial
- Cursor Jump** Training with cursor-jump feedback, cursor jumps 45° CW mid-reach on every trial
- No Cursor** Test trial with no cursor feedback using targets which are ±15° relative to previous training target

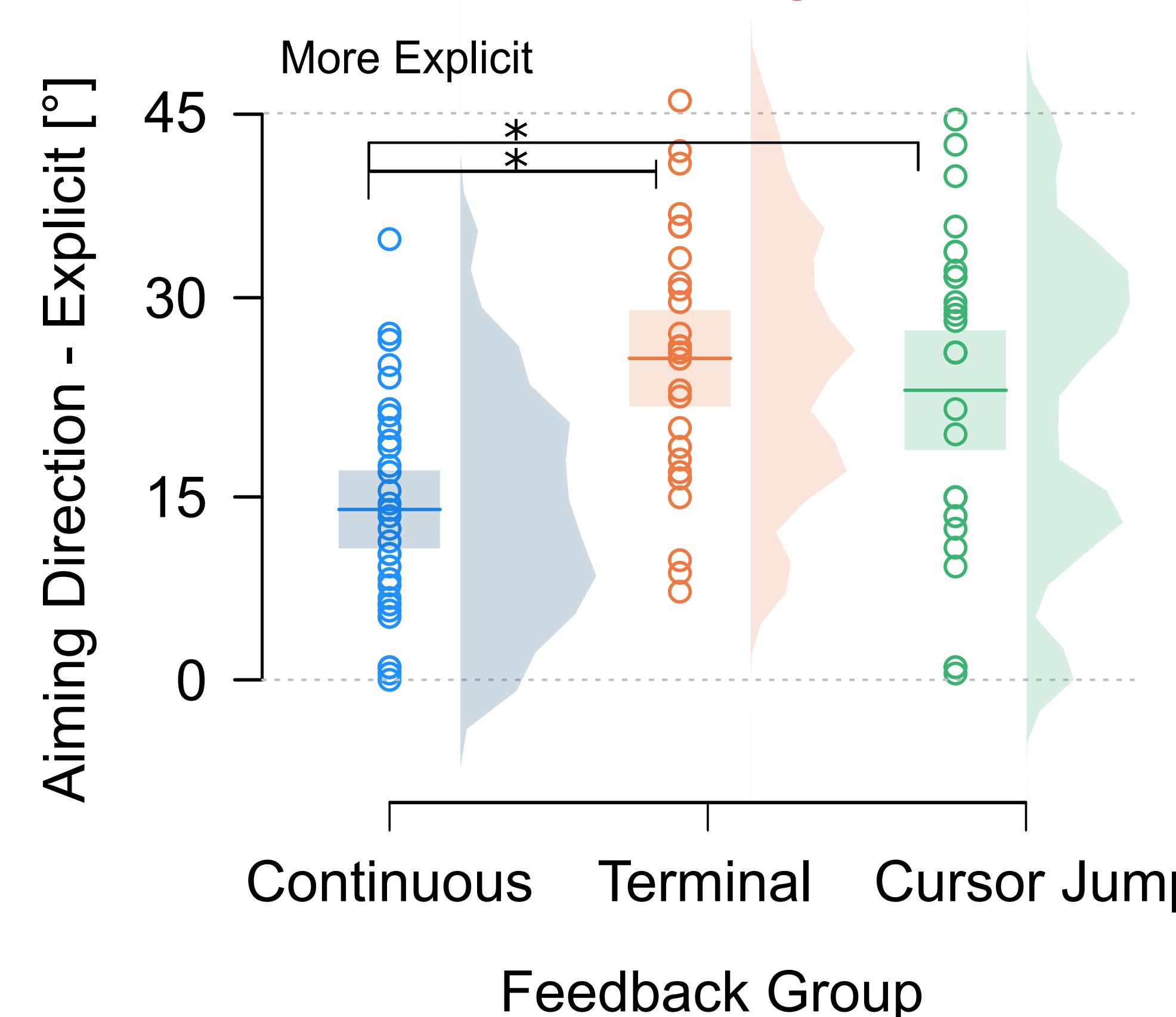
## No Effect of Condition on Adaptation to Training



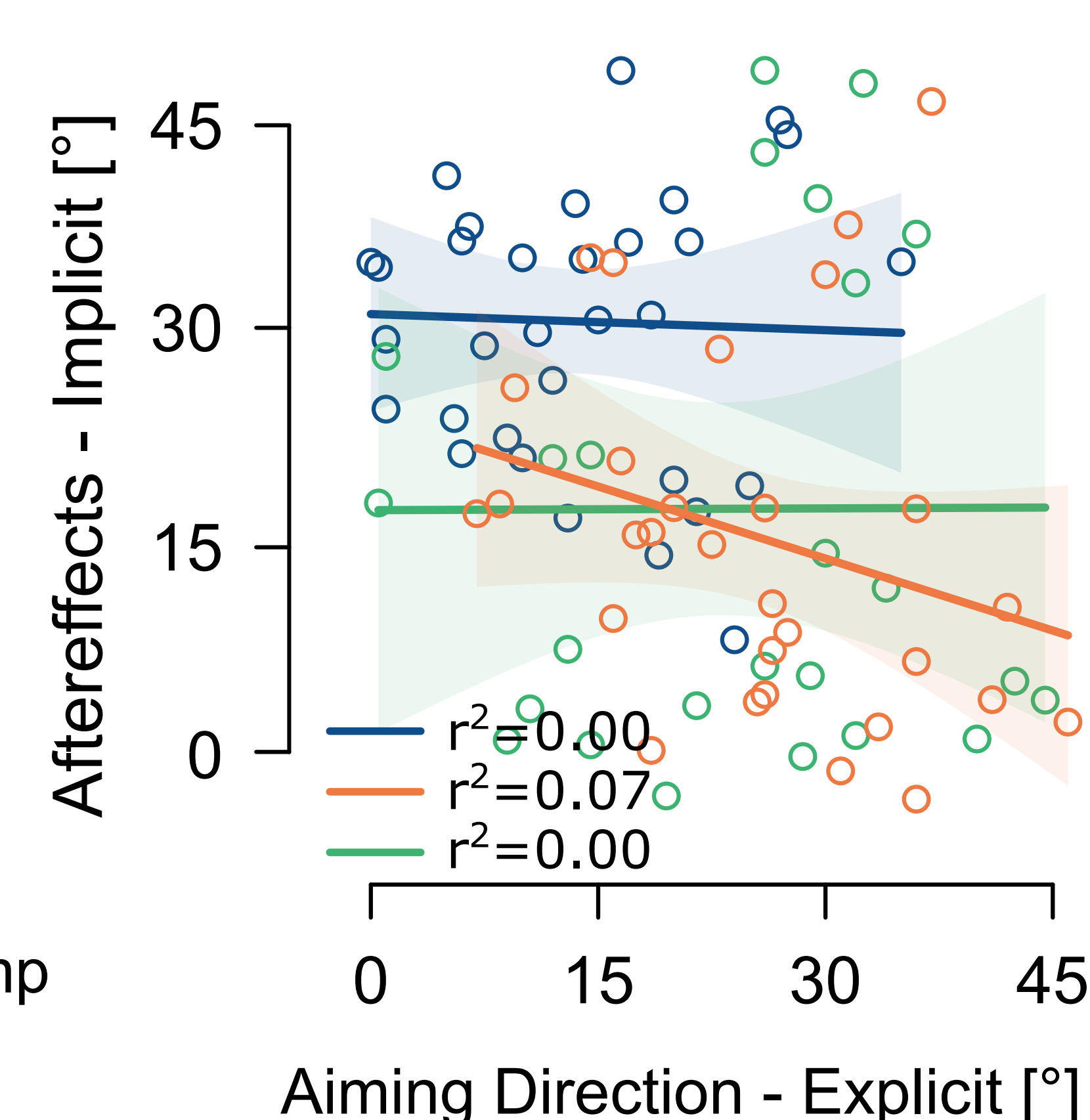
## Higher Implicit Adaptation with Continuous Feedback



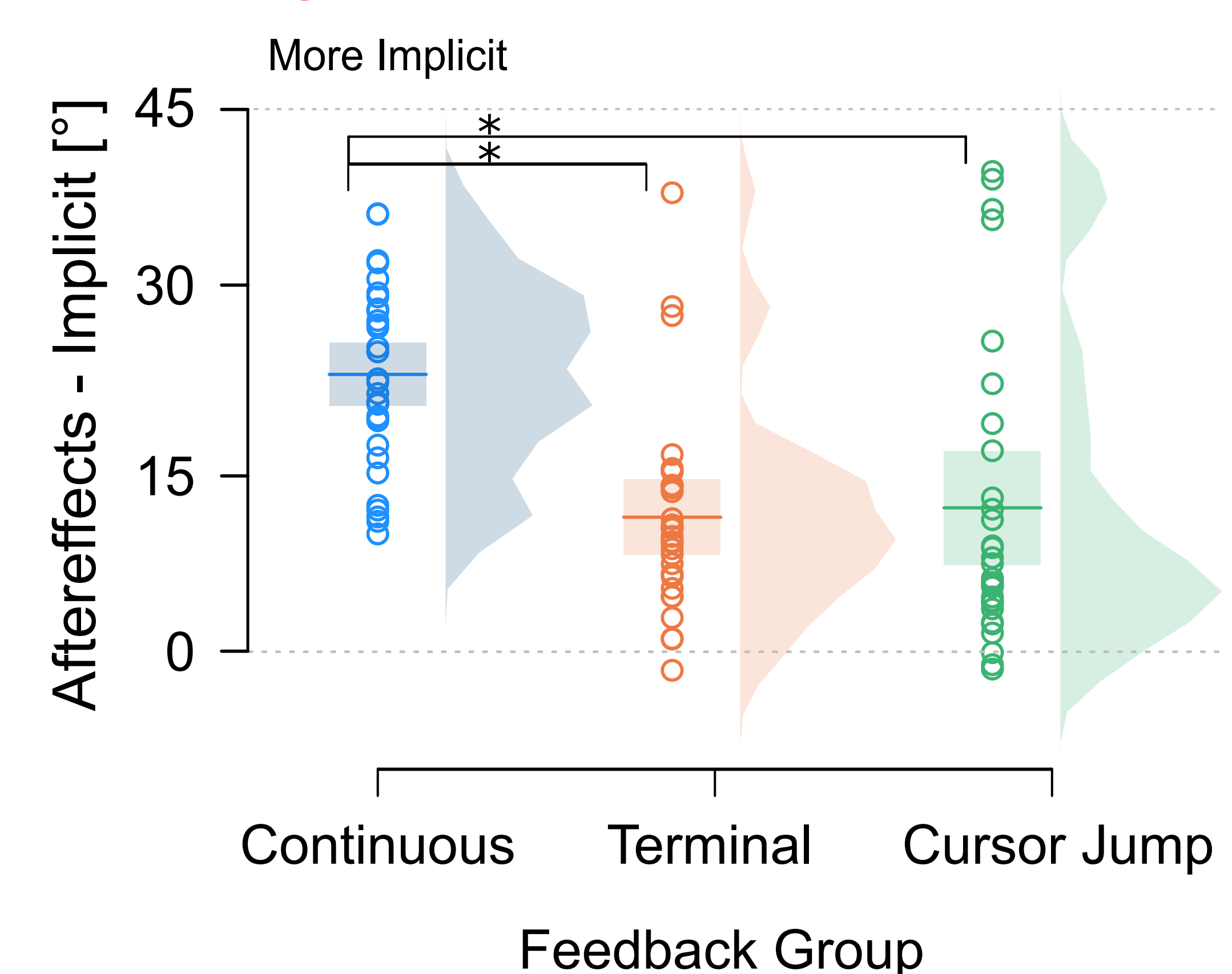
## Less Implicit use with Changed Feedback



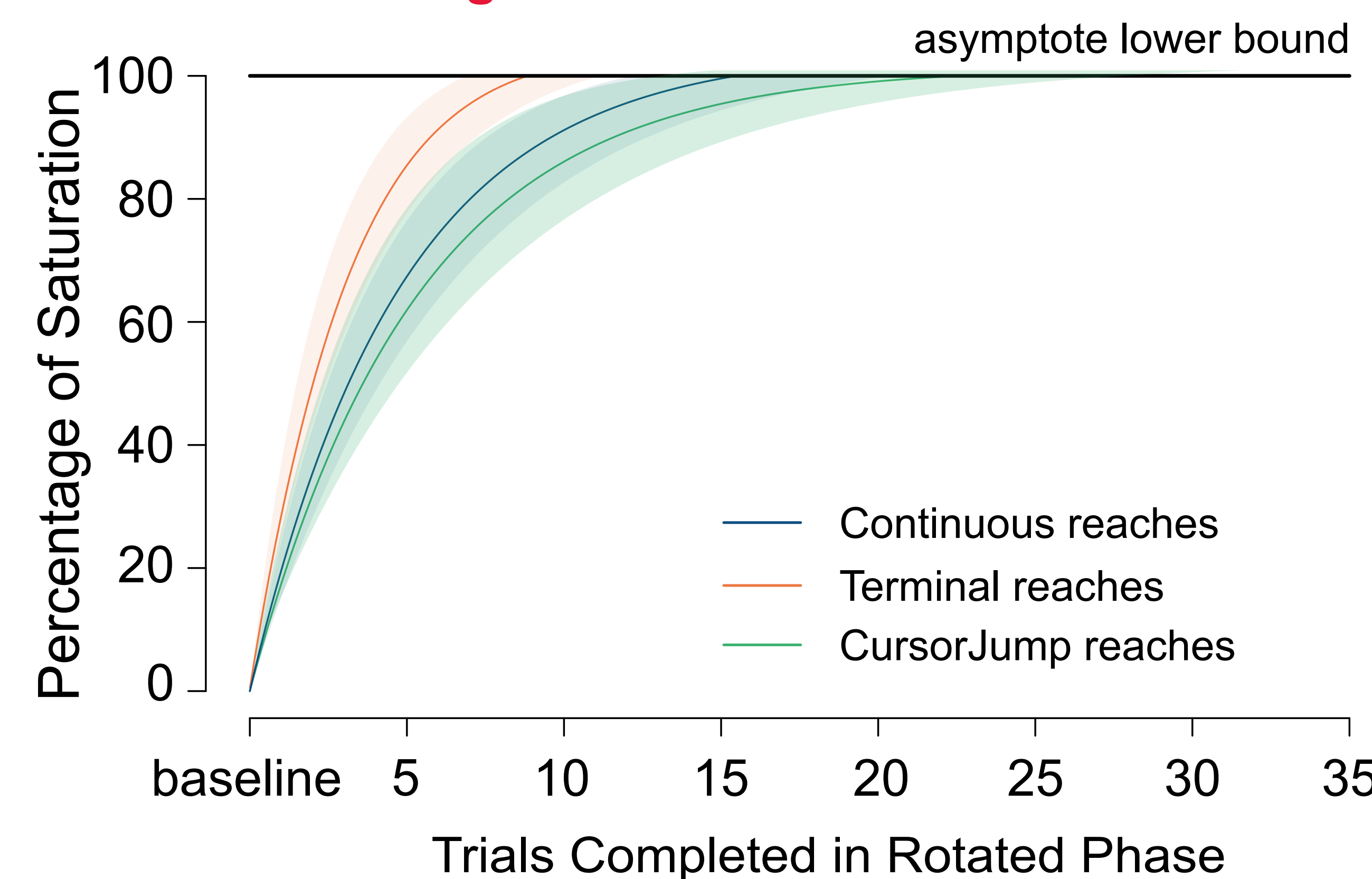
## Implicit and Explicit are not Related



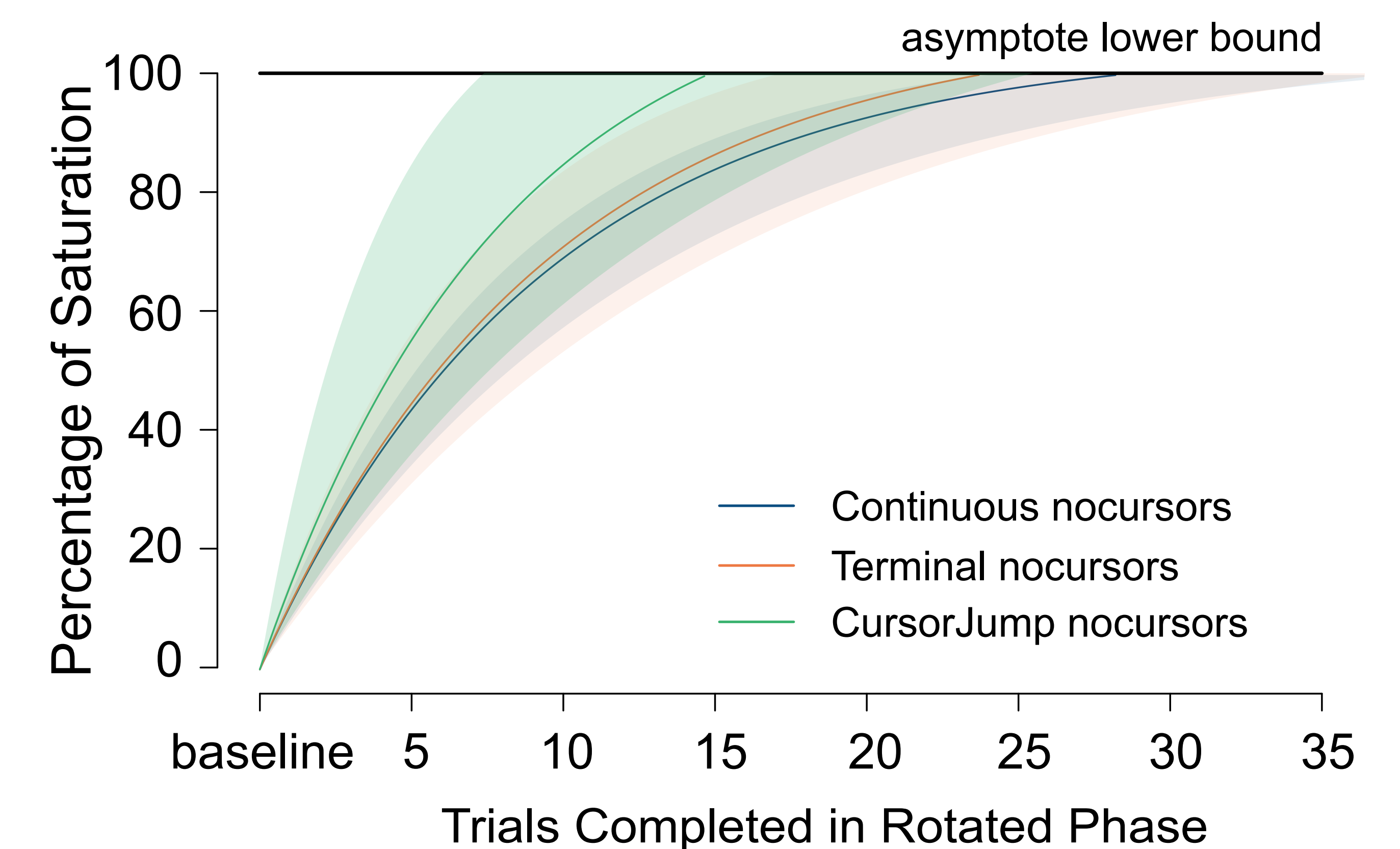
## Changed Feedback Lowers Aftereffects



## Terminal Training Saturates Fastest



## Aftereffect Saturation Rate



**Error feedback affects the level but not the rate of implicit adaptation**