

Implicit adaptation's effect on motor awareness and confidence

VSS 2025

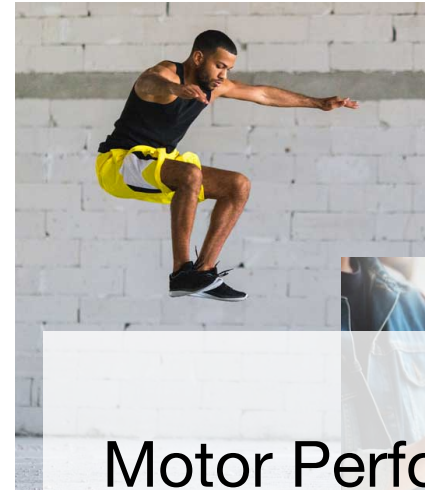
Marissa H. Evans¹, Jordan A. Taylor,² Michael S. Landy¹

1. New York University Psychology

2. Princeton University Psychology

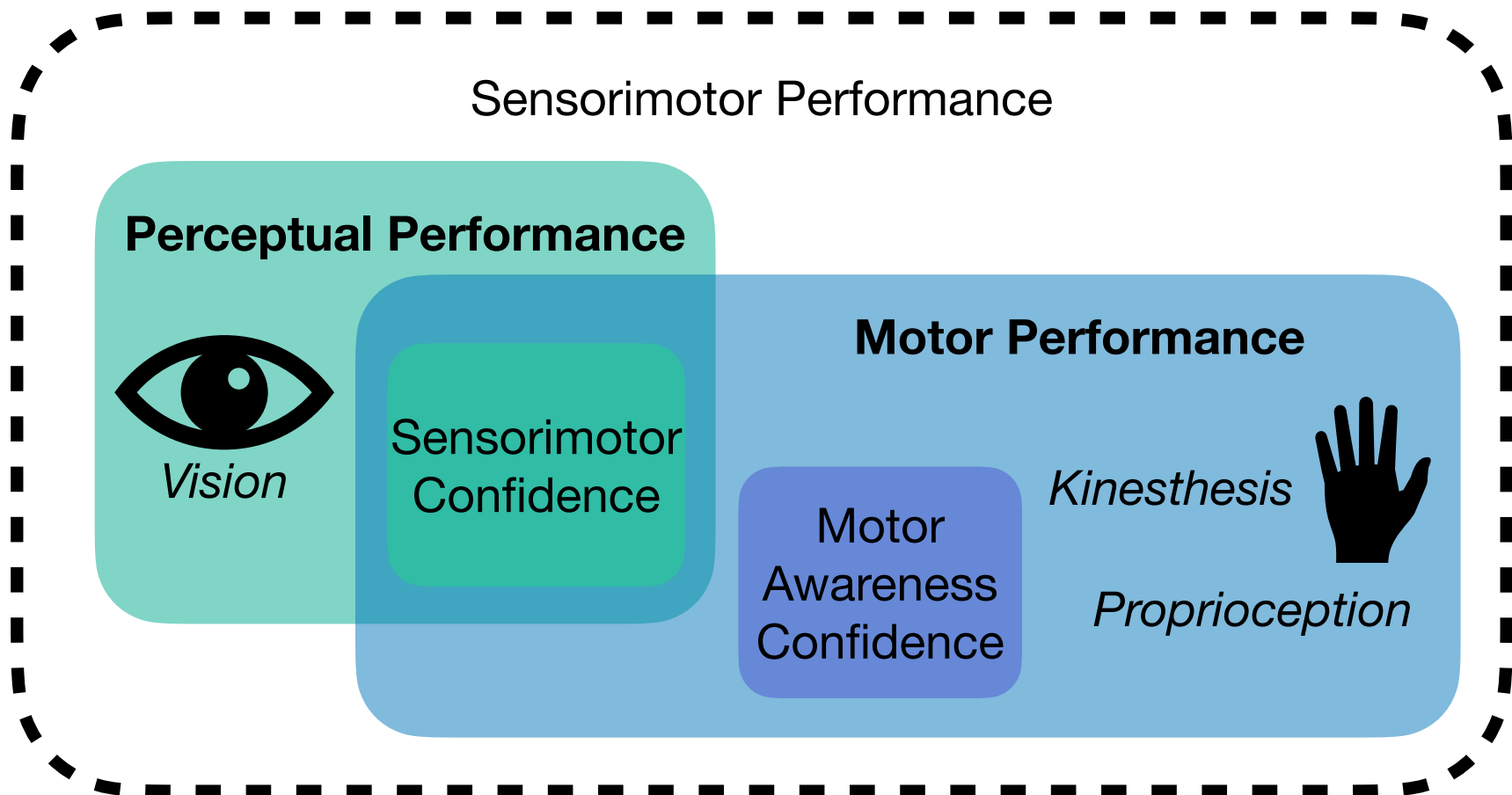


Perceptual & Motor Performance



Motor Performance





*Fassold, Locke & Landy, 2023; PLoS Comp Bio

Sensorimotor Confidence

- Confidence in the success of an action with a perceptually directed goal, given your sensory estimate and inferred action.

“How confident are you that you hit the target?”



Motor Awareness Confidence

- How accurately you can infer your true action, given your inferred and intended actions.

“What is your body’s position? How confident are you that you’re correct?”



Implicit Adaptation

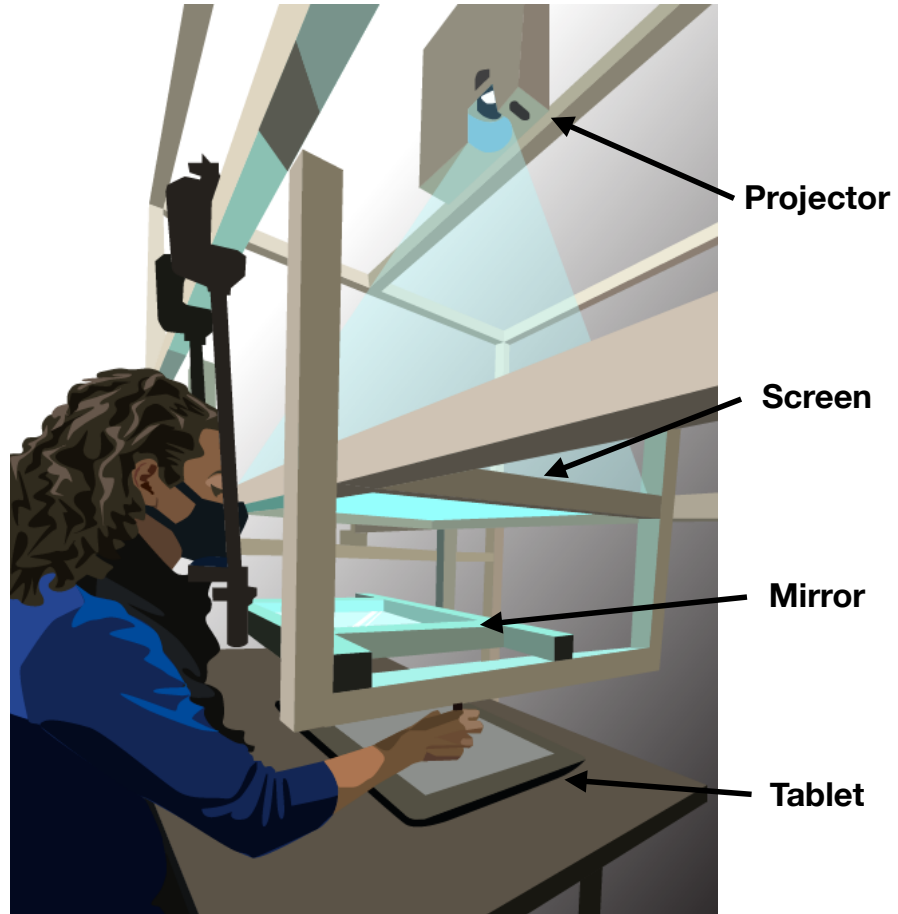
- An automatic and incremental recalibration of sensorimotor mapping while the motor plan remains constant.



Questions

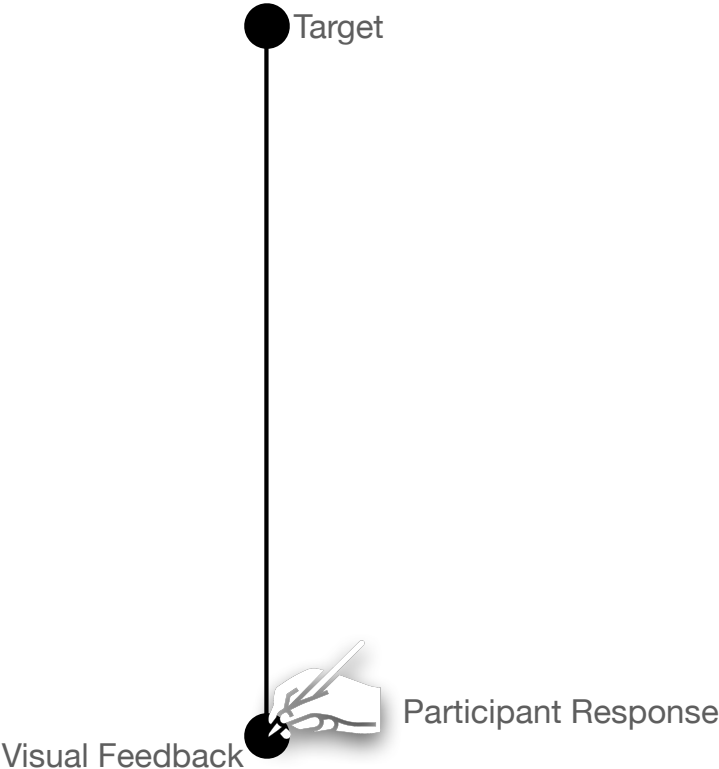
- Is confidence affected by implicit adaptation?
- Are sensorimotor confidence and motor awareness confidence calculated differently?

Task



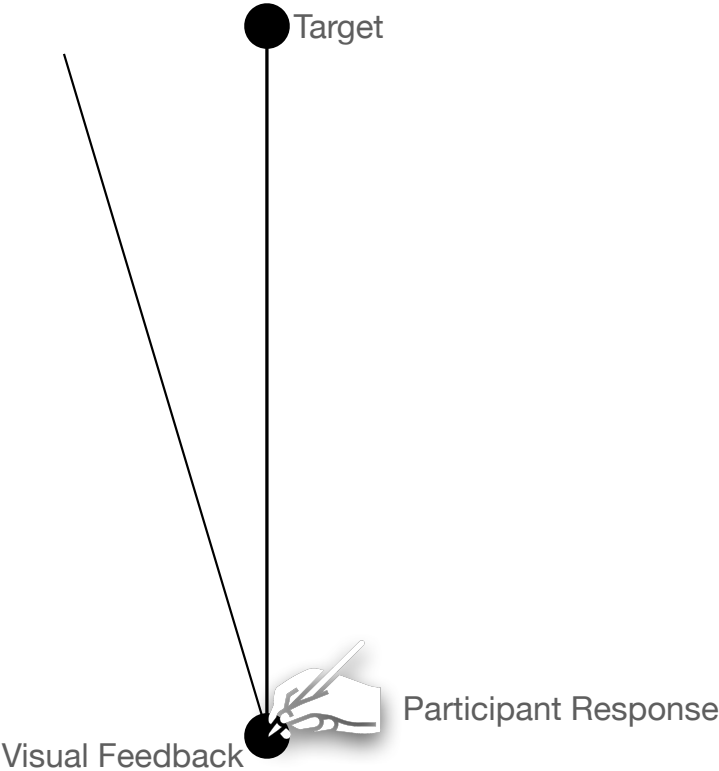
**Motor
Adaptation**

Feedback Congruent



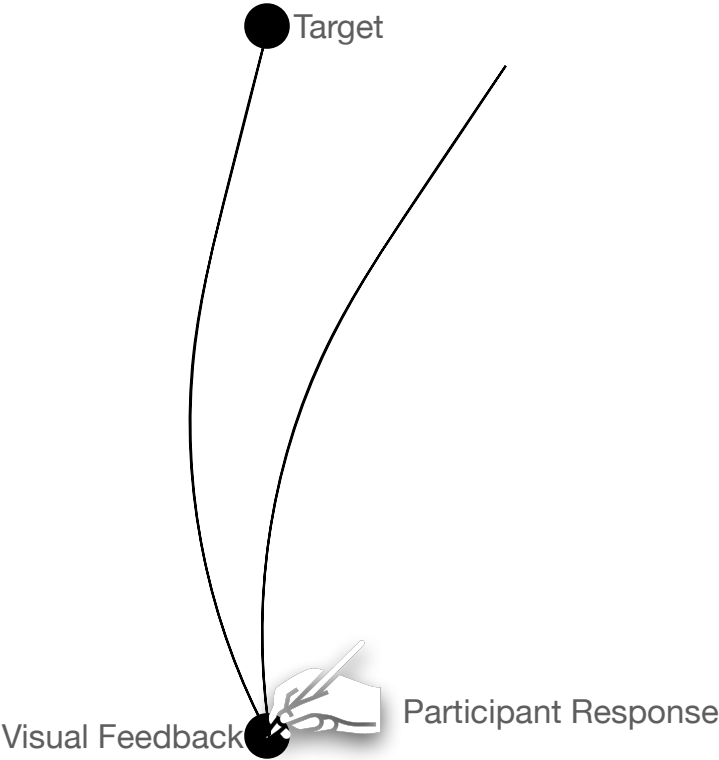
**Motor
Adaptation**

Feedback Perturbed



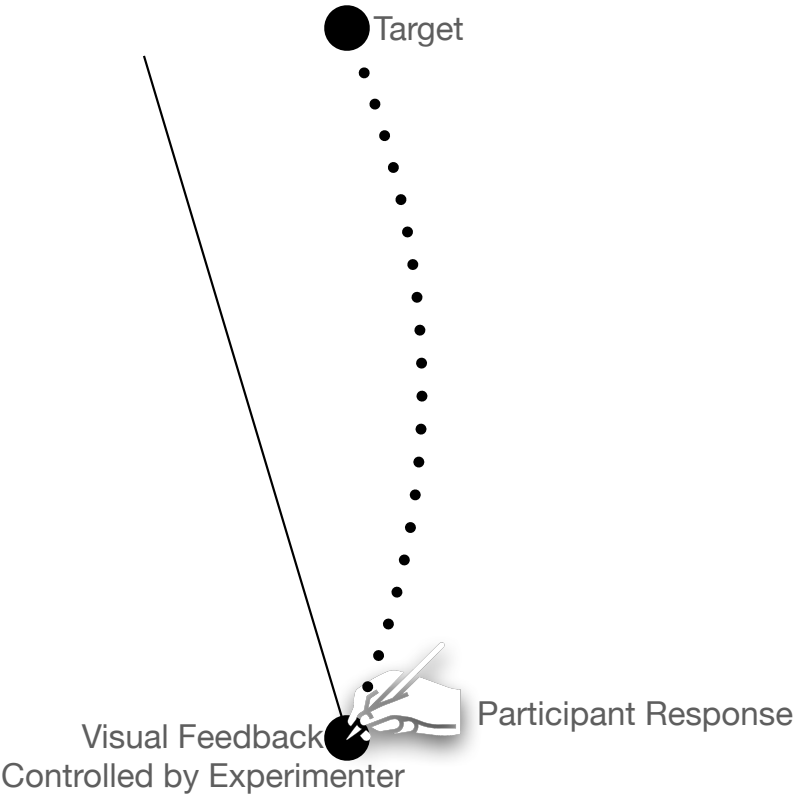
**Motor
Adaptation**

Feedback Perturbed



Error Clamp Paradigm

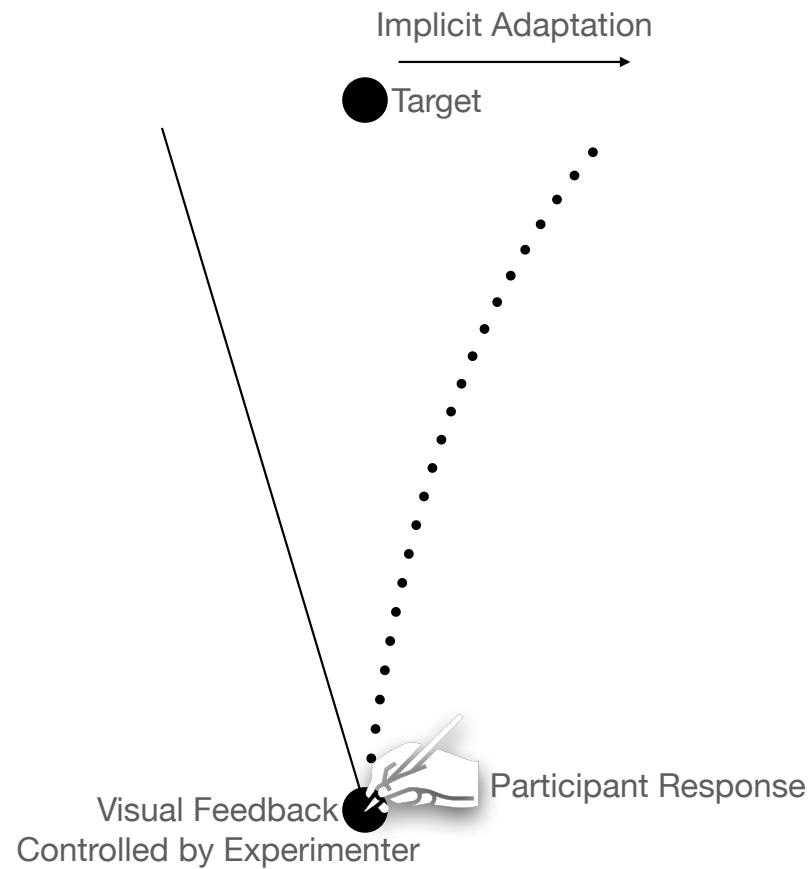
Feedback Decoupled



*Morehead, Taylor, Parvin, & Ivry 2017; J Cog Neuroscience

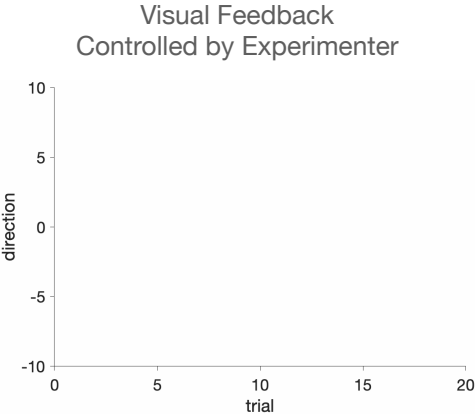
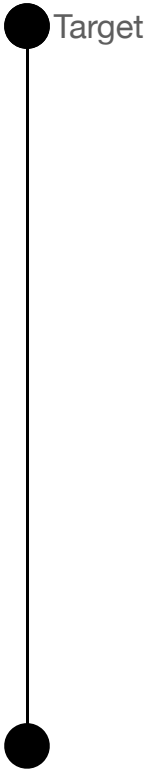
Error Clamp Paradigm

Feedback Decoupled

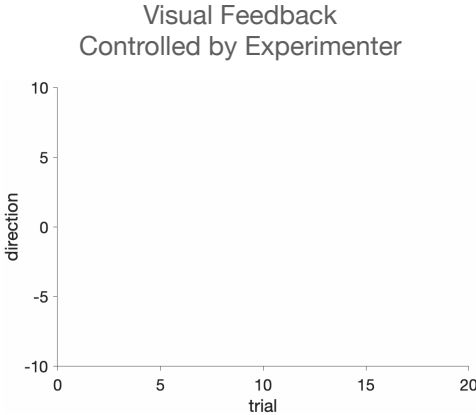
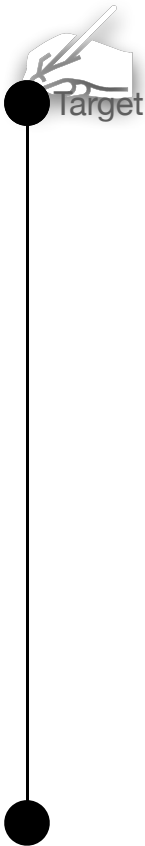


*Morehead, Taylor, Parvin, & Ivry 2017; J Cog Neuroscience

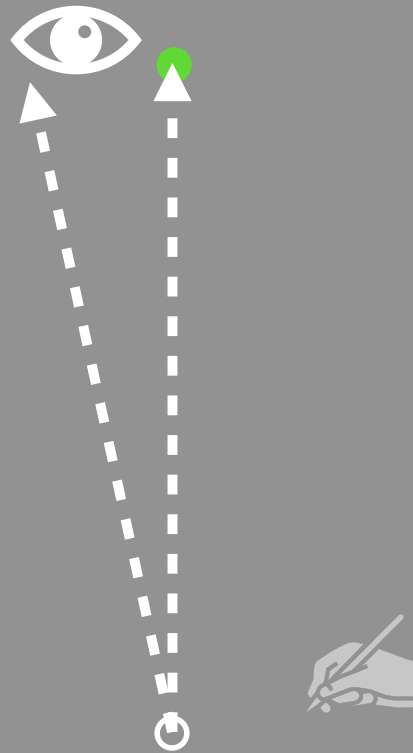
Error Clamp Paradigm



Error Clamp Paradigm

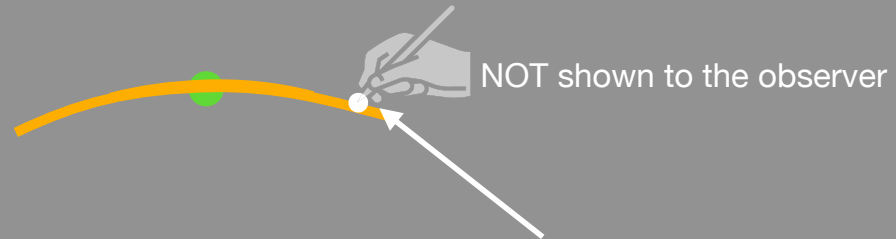


Sensorimotor Trial



Sensorimotor Trial

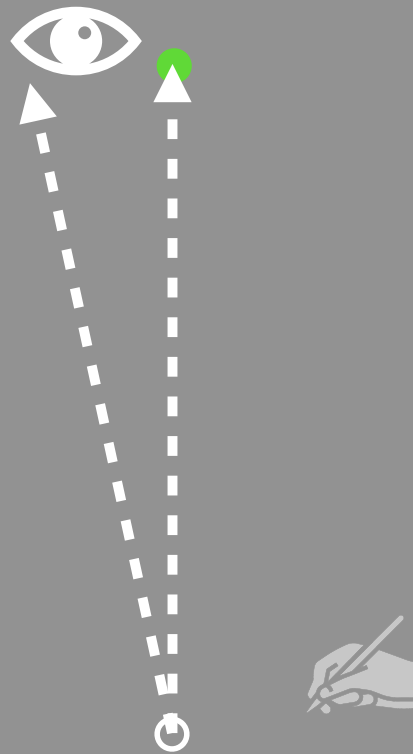
Confidence Judgement
Points Possible: 8.8



Total points possible would have been earned on this trial
because end point was enclosed in the arc



Motor Awareness Trial



Motor Awareness Trial

Confidence Judgement
Points Possible: 8.8



Zero points would have been earned on this trial
because end point was not enclosed

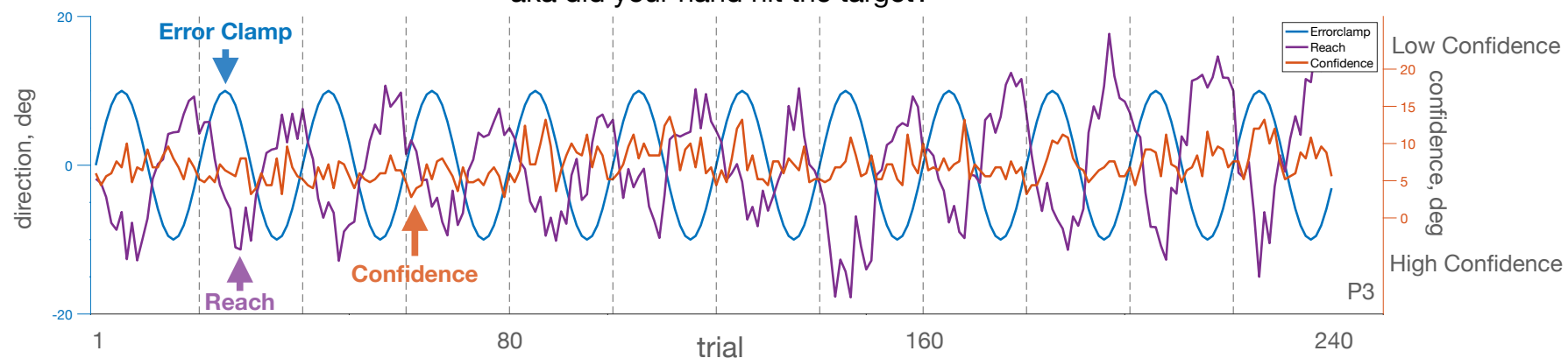


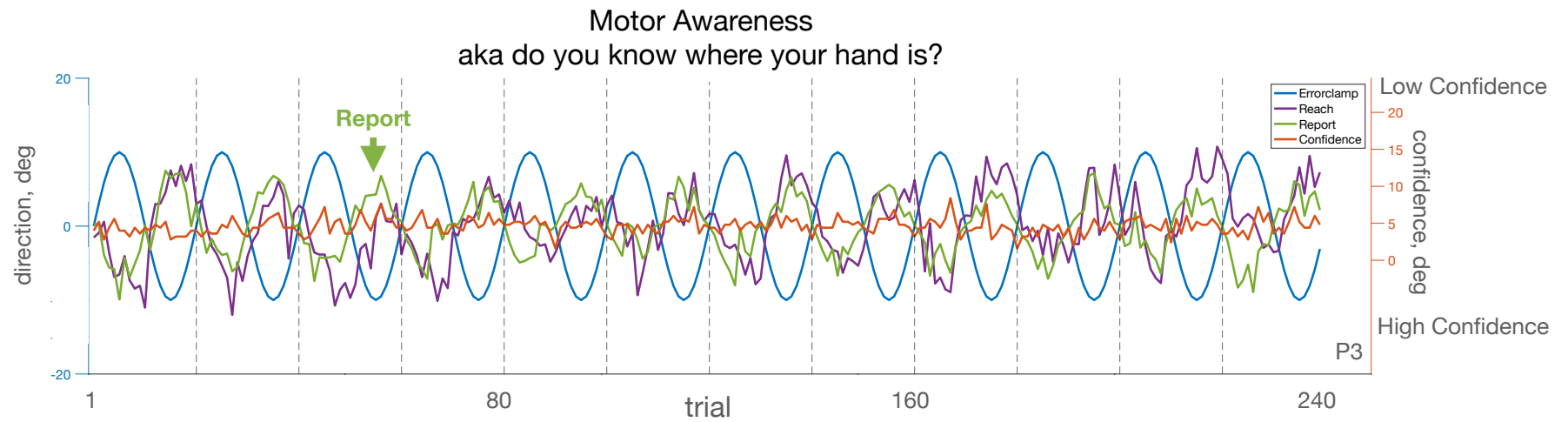
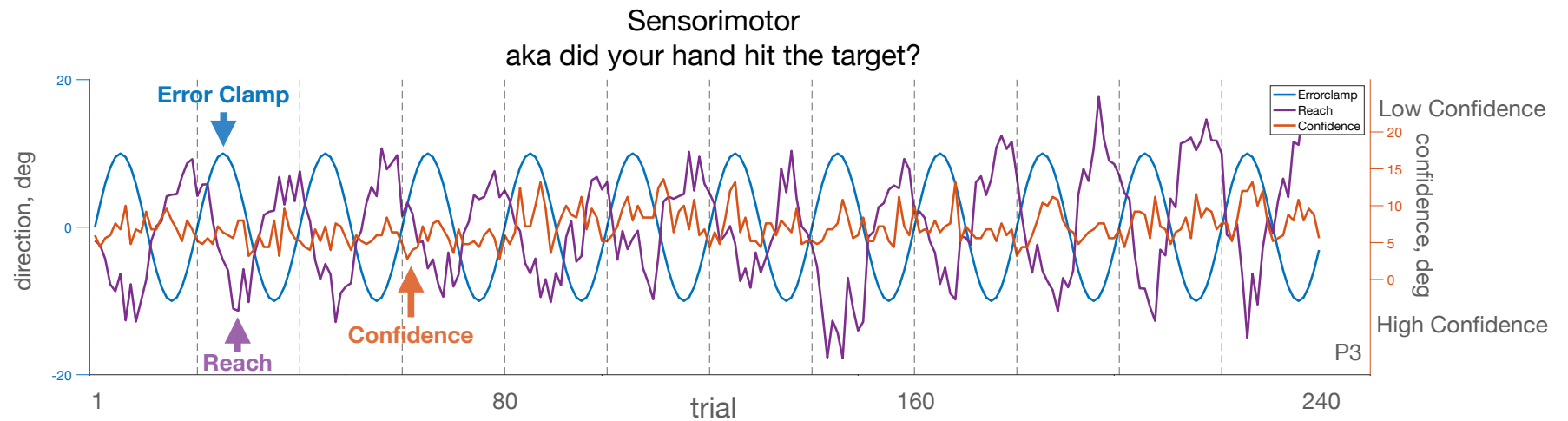
input knob

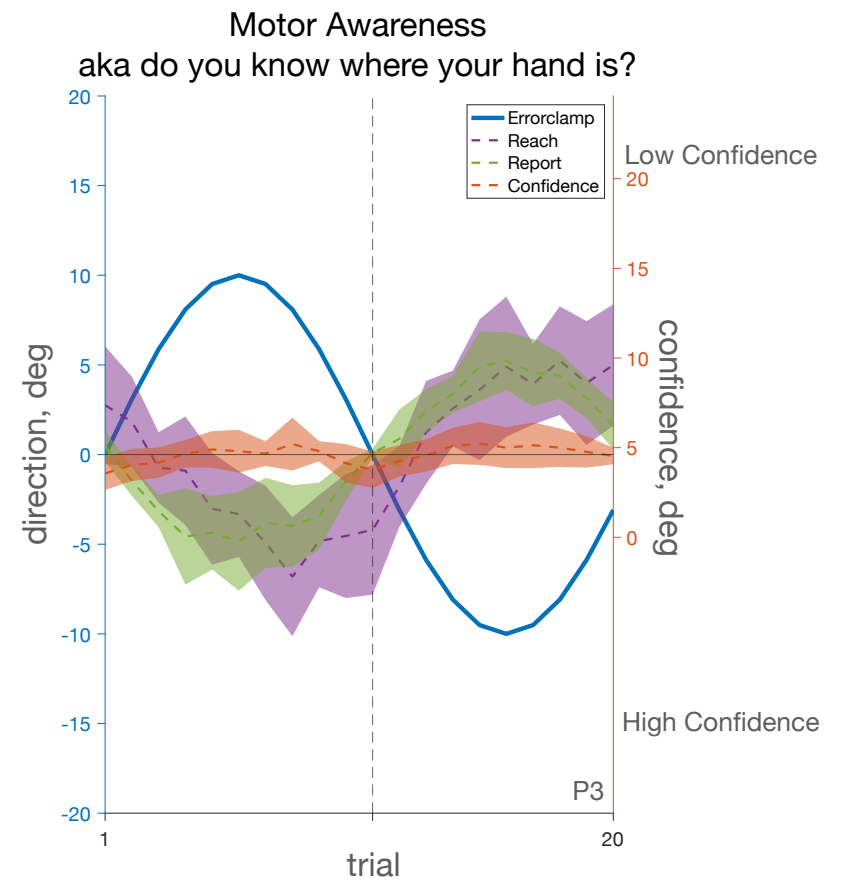
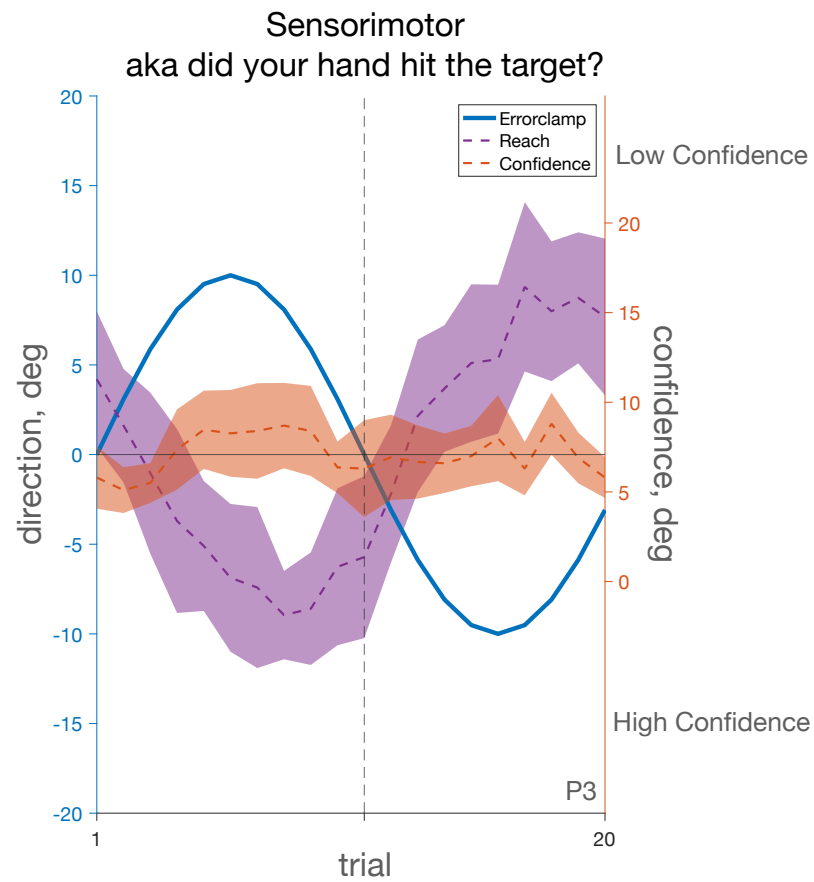


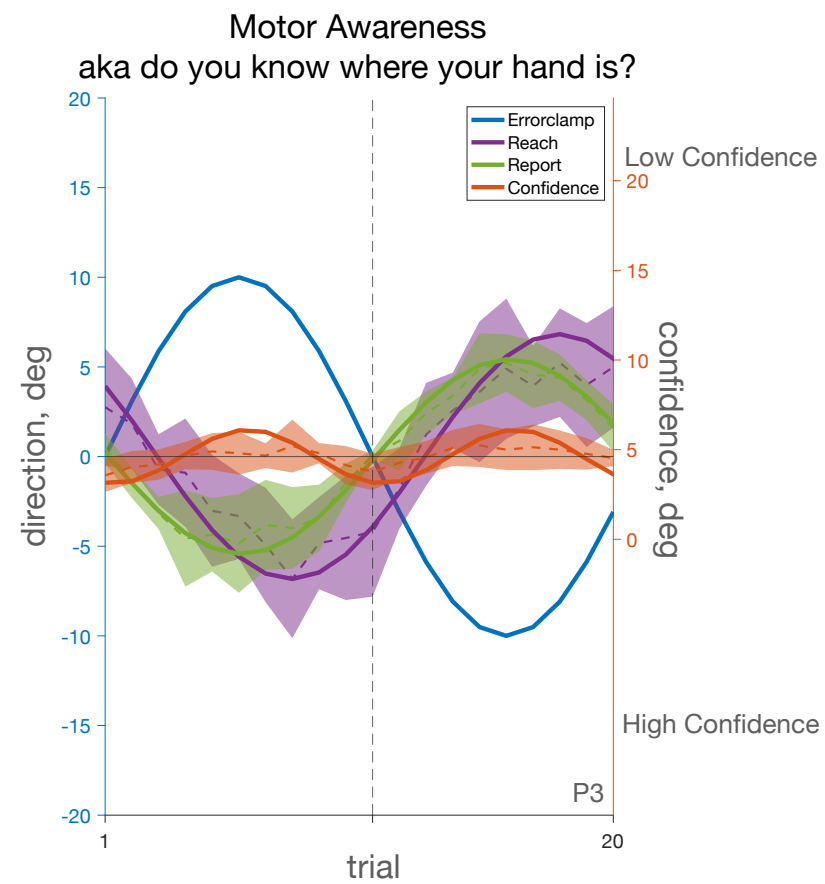
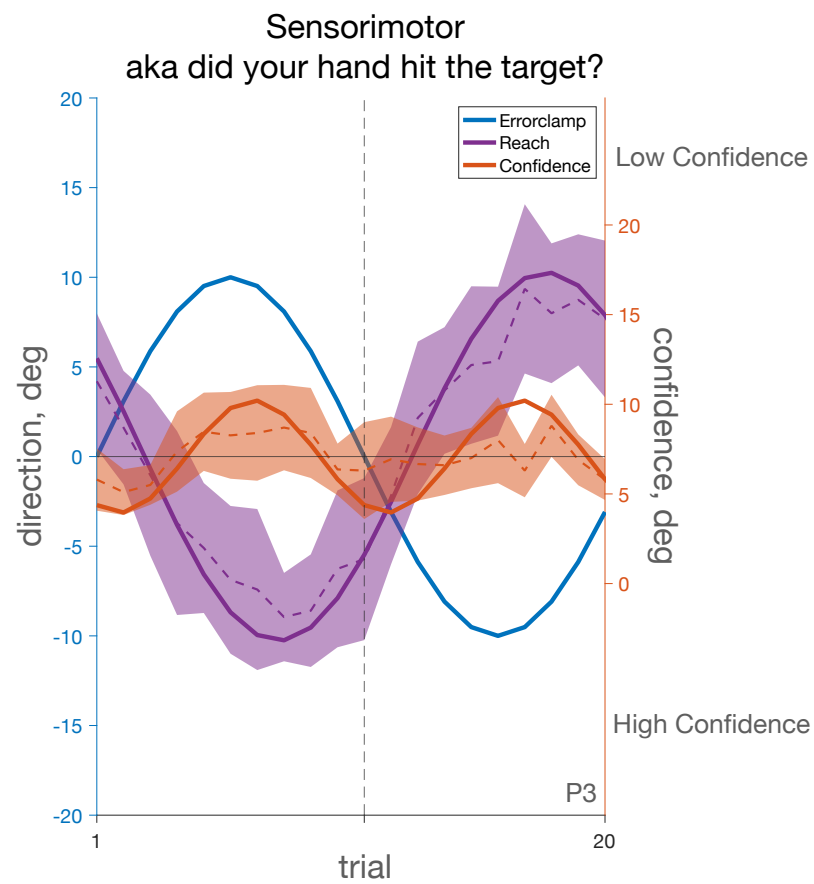
Results

Sensorimotor
aka did your hand hit the target?

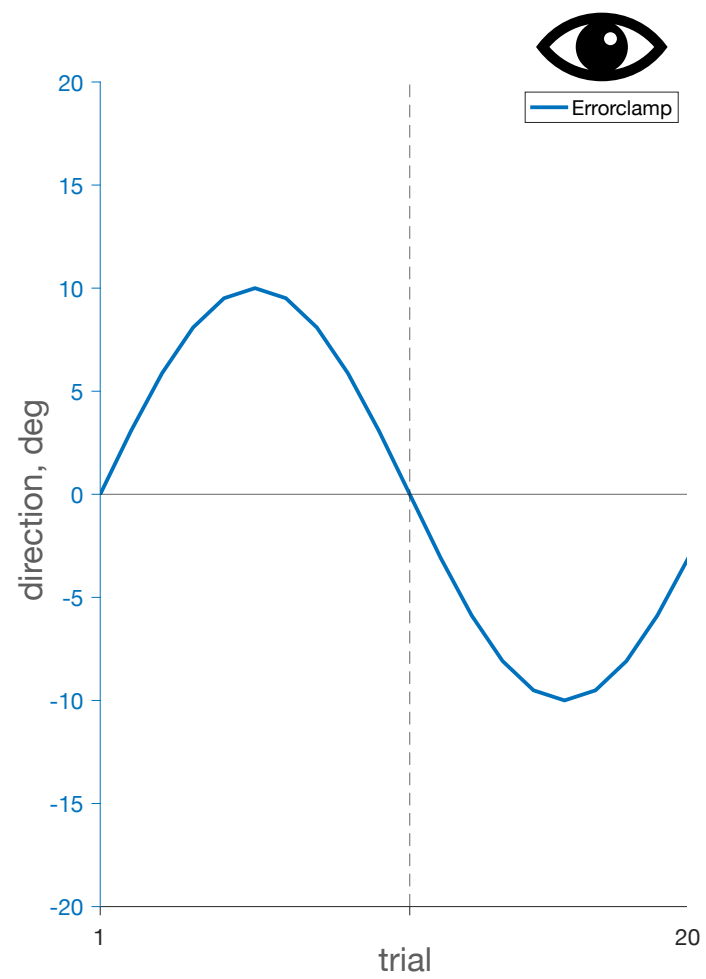


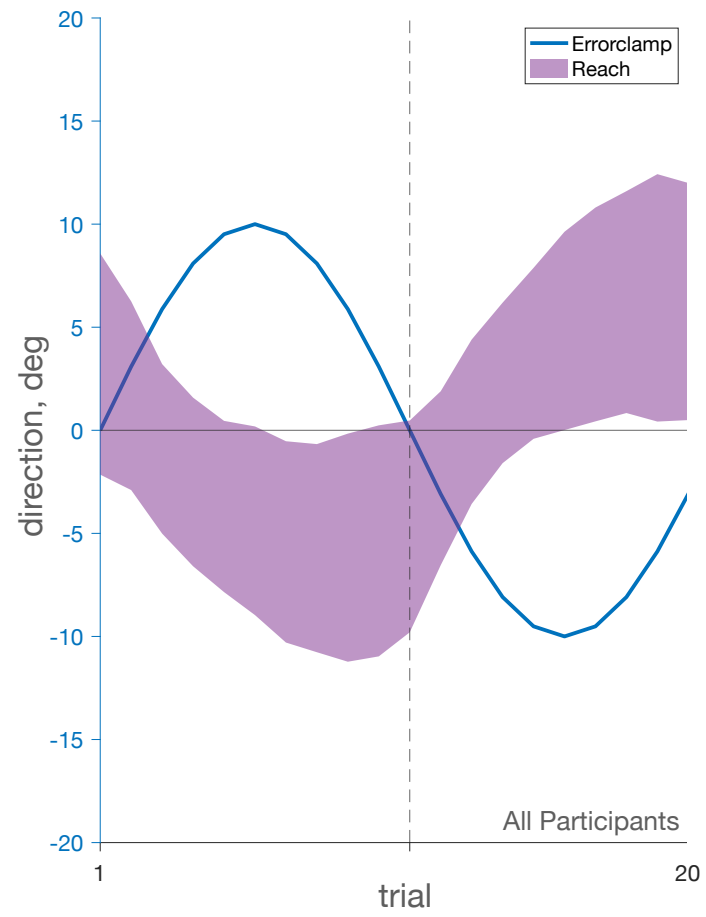


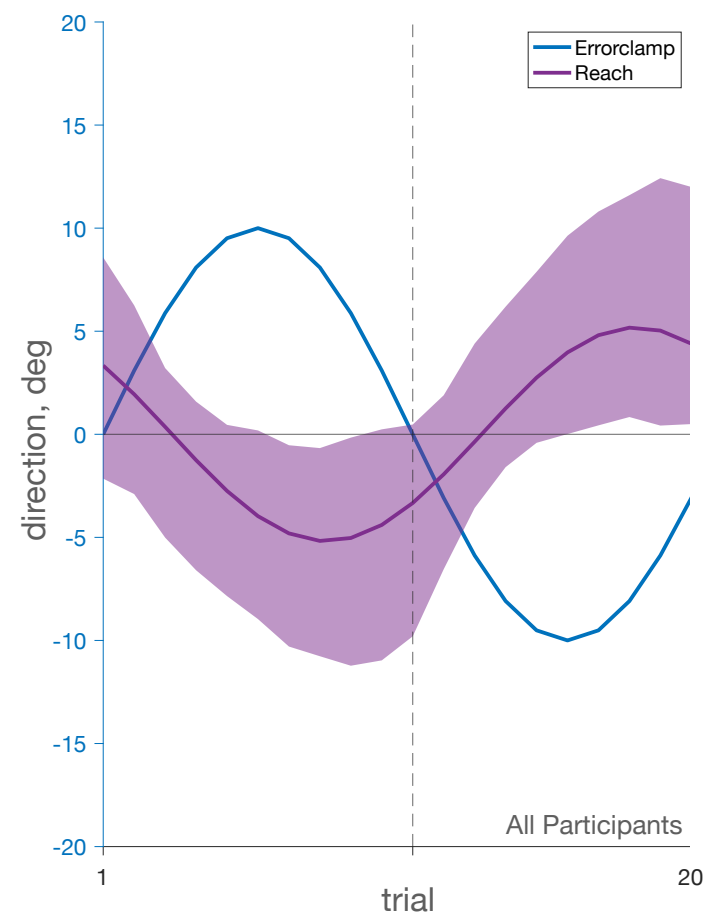


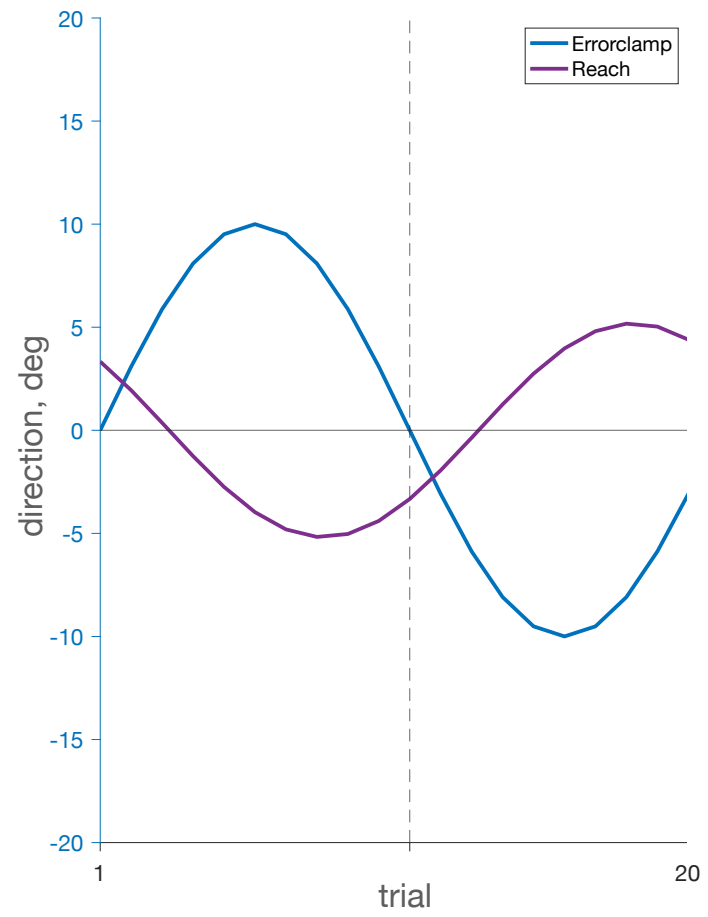


Hypotheses

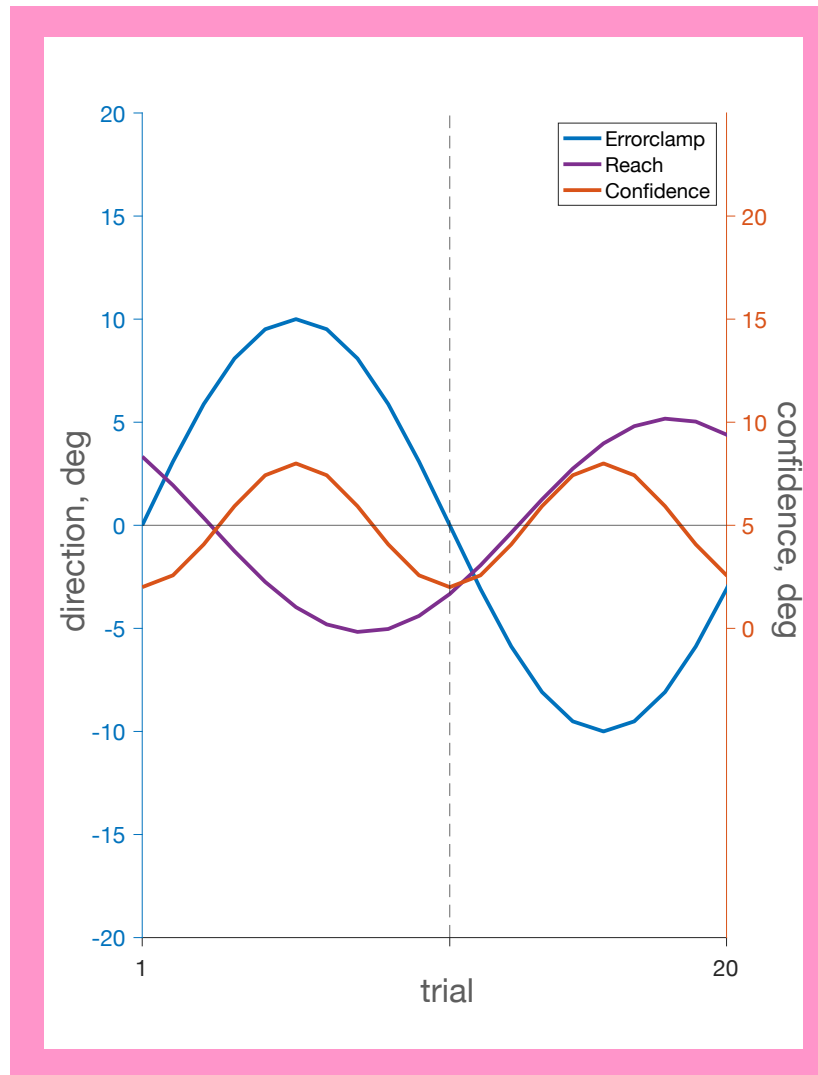








Sensorimotor Confidence

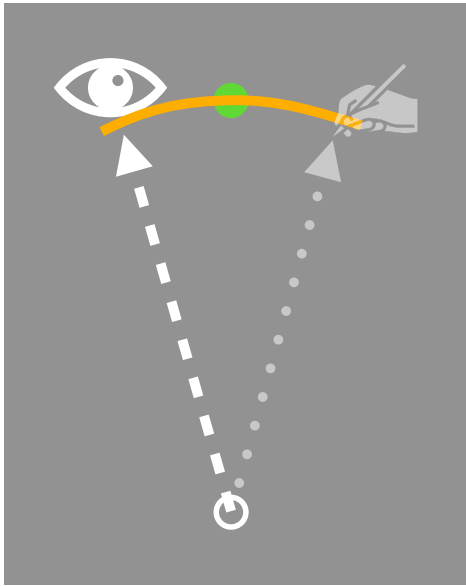


Low Confidence

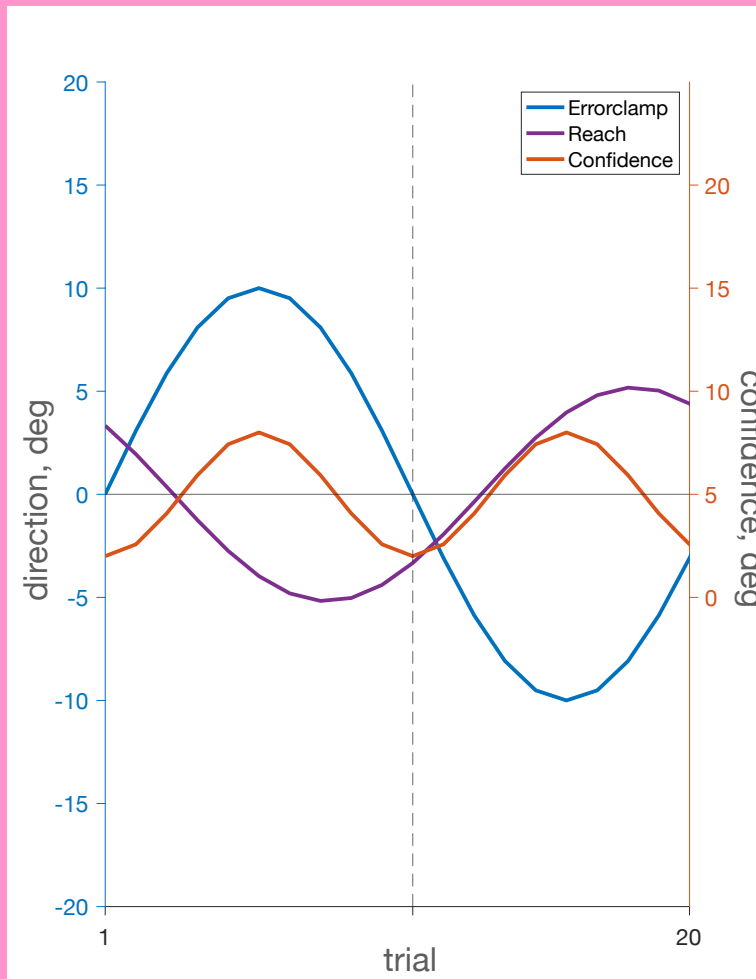
- ✓ Uses proprioception
- ✓ Influenced by visual feedback
- ✓ 24 cycles per session

High Confidence

Sensorimotor Confidence



Smaller arcs = higher confidence

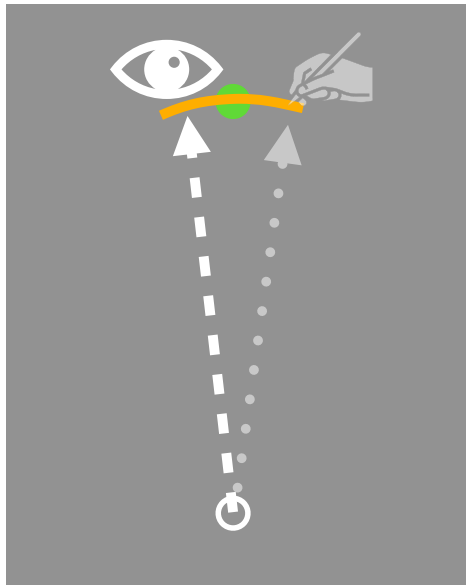


Low Confidence

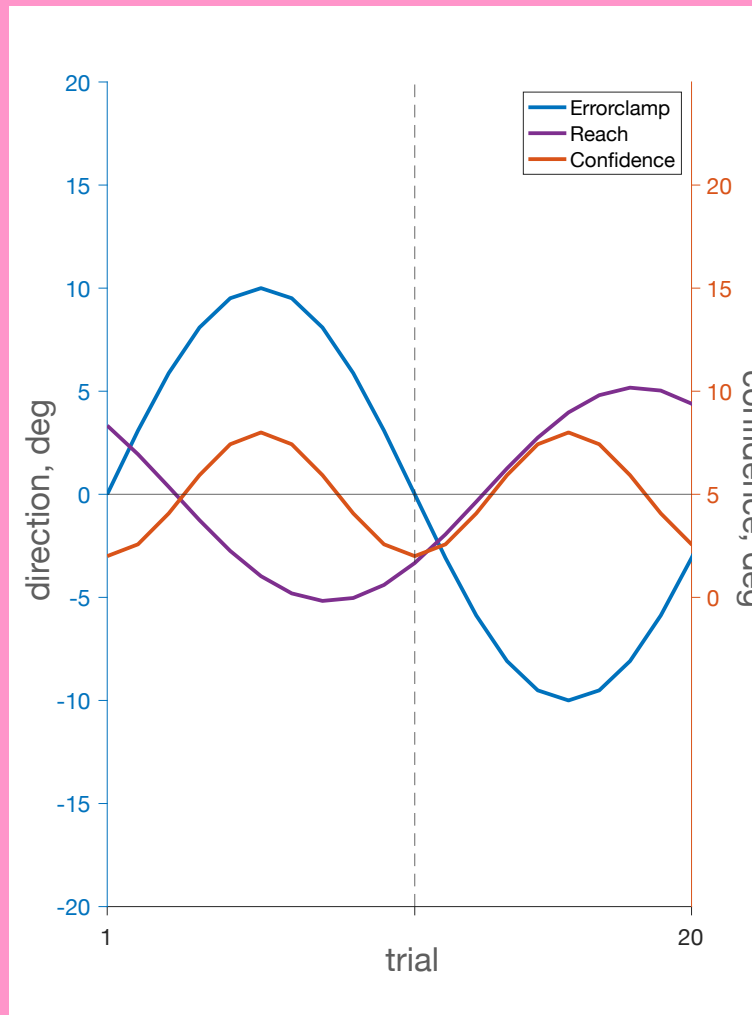
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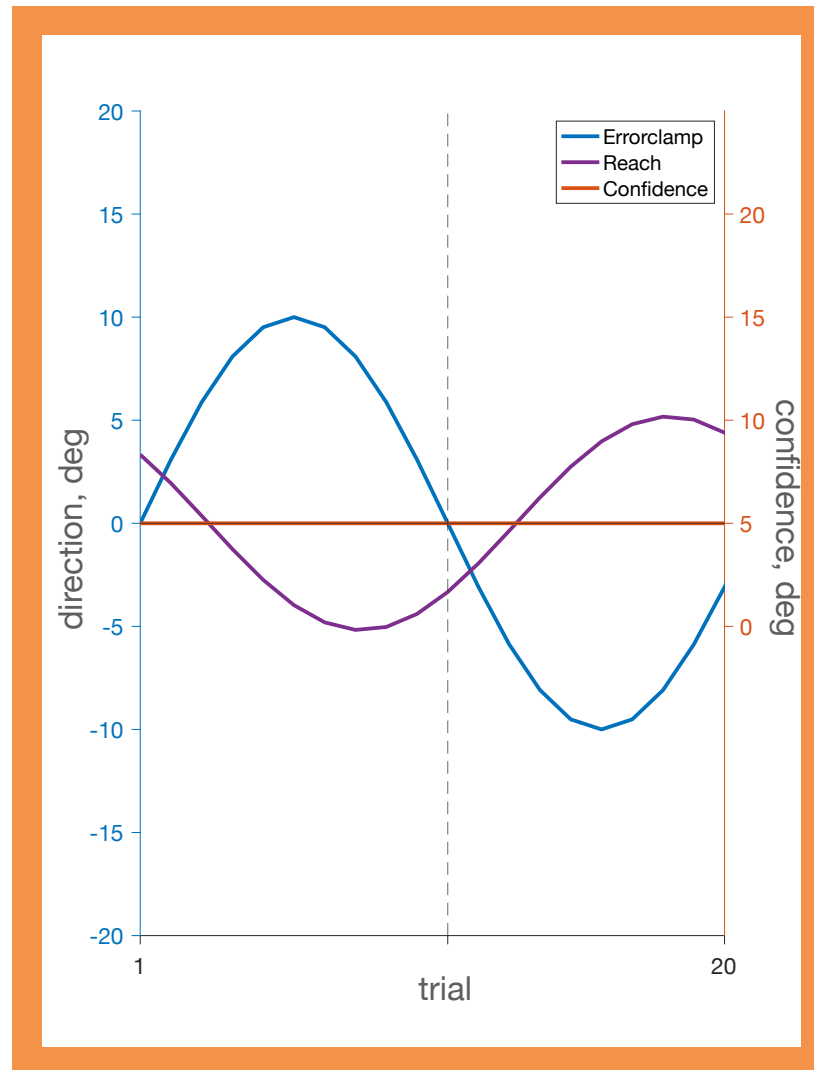


Low Confidence

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High Confidence

Sensorimotor Confidence

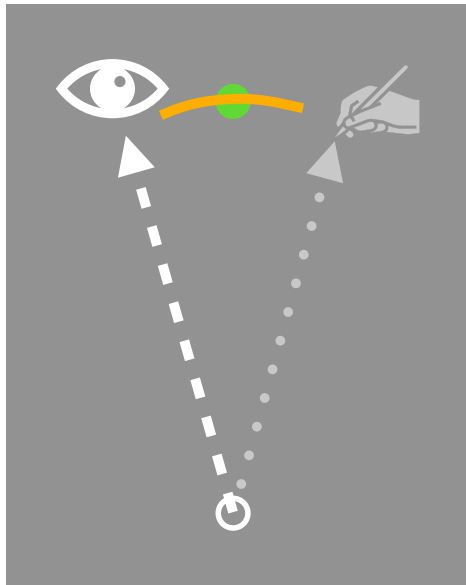


Low Confidence

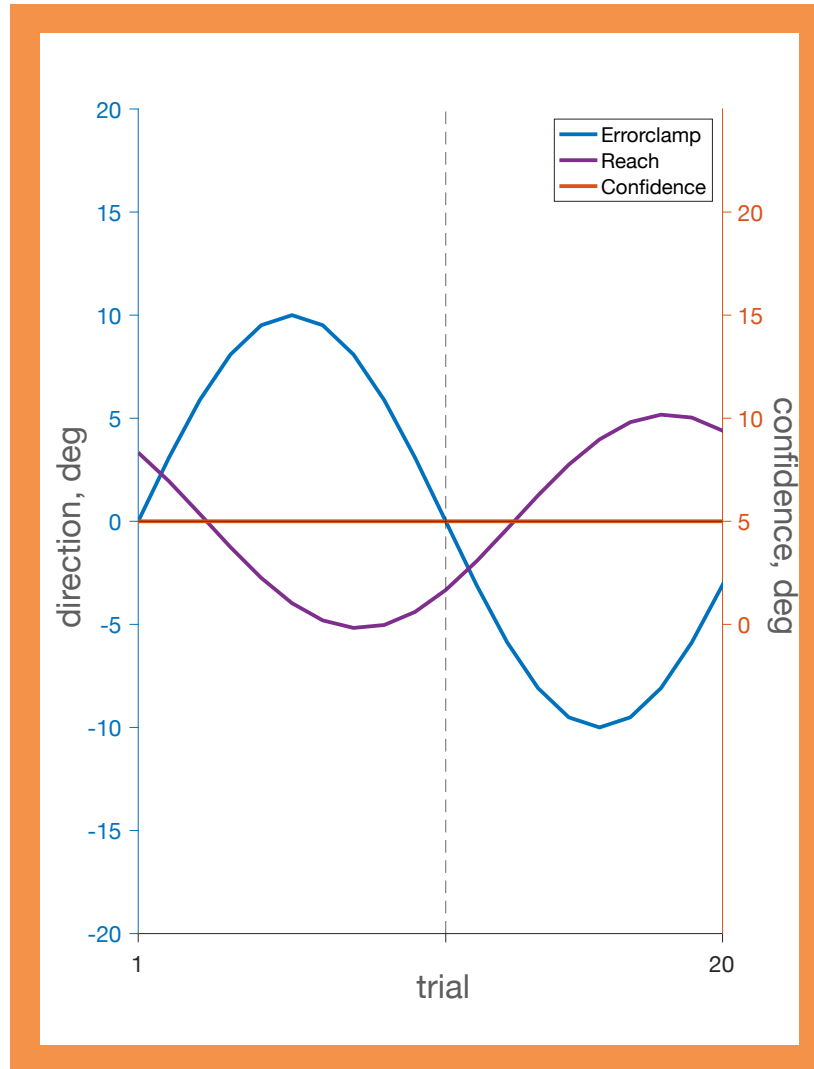
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High Confidence

Sensorimotor Confidence



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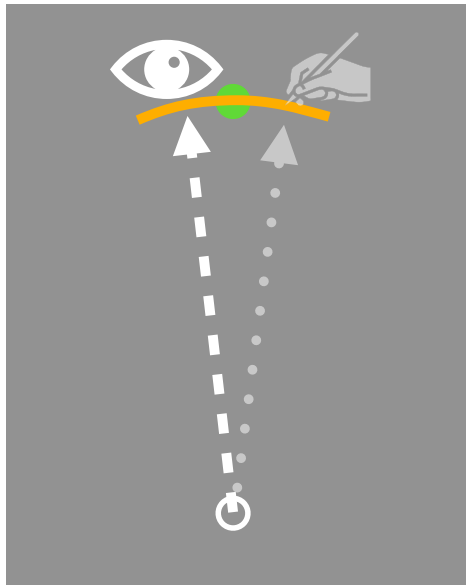


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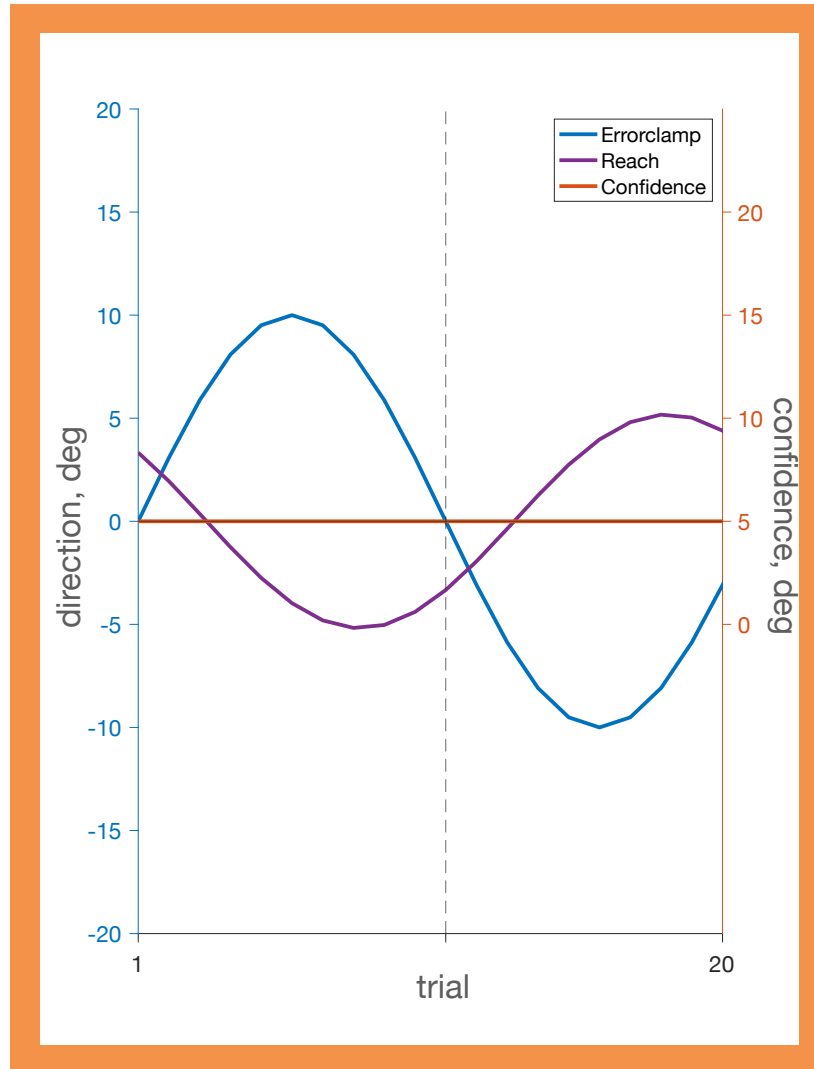
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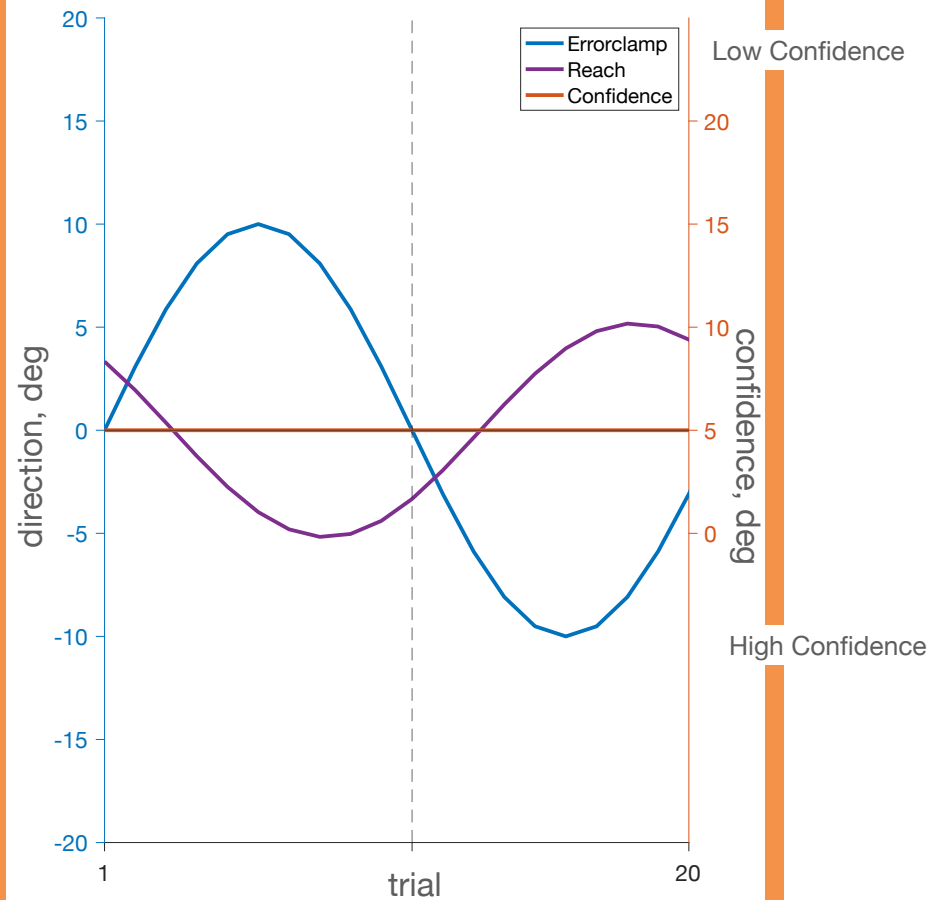
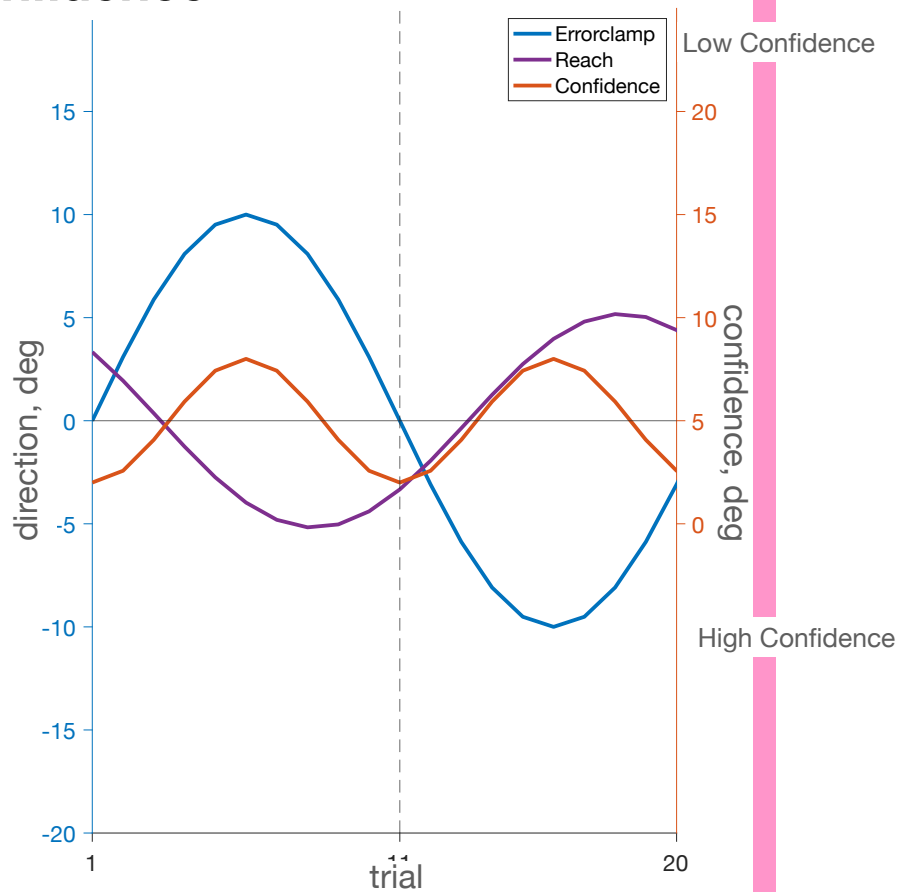


Low Confidence

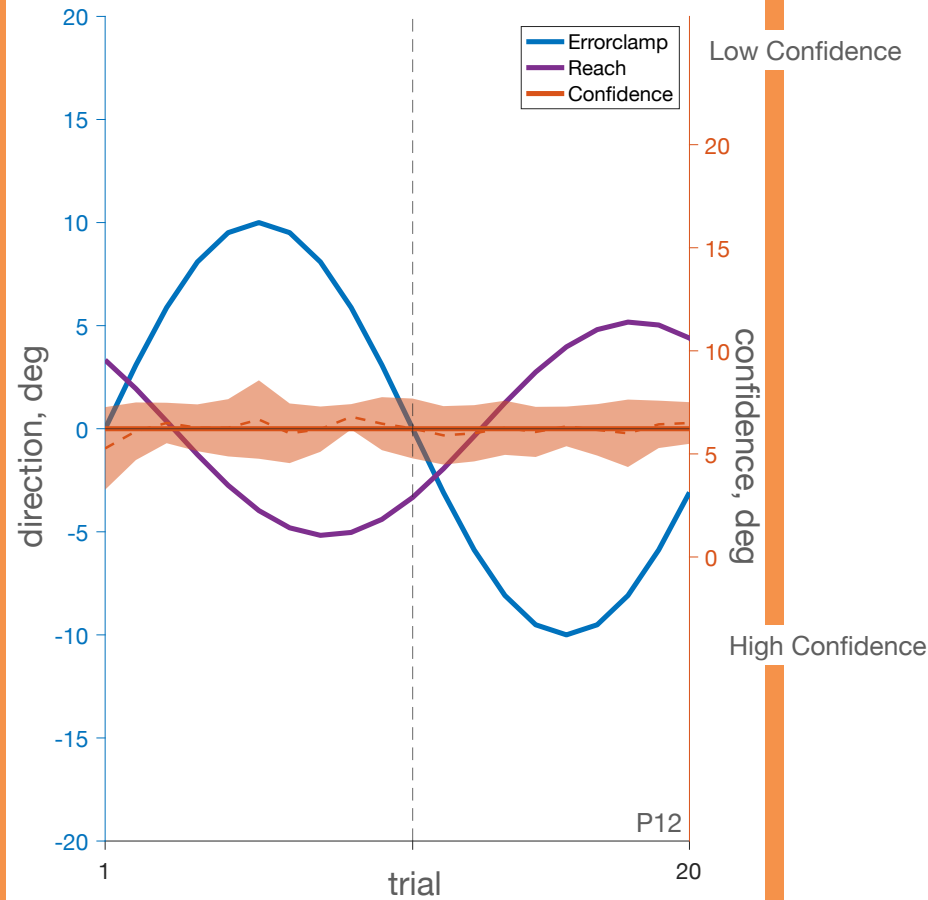
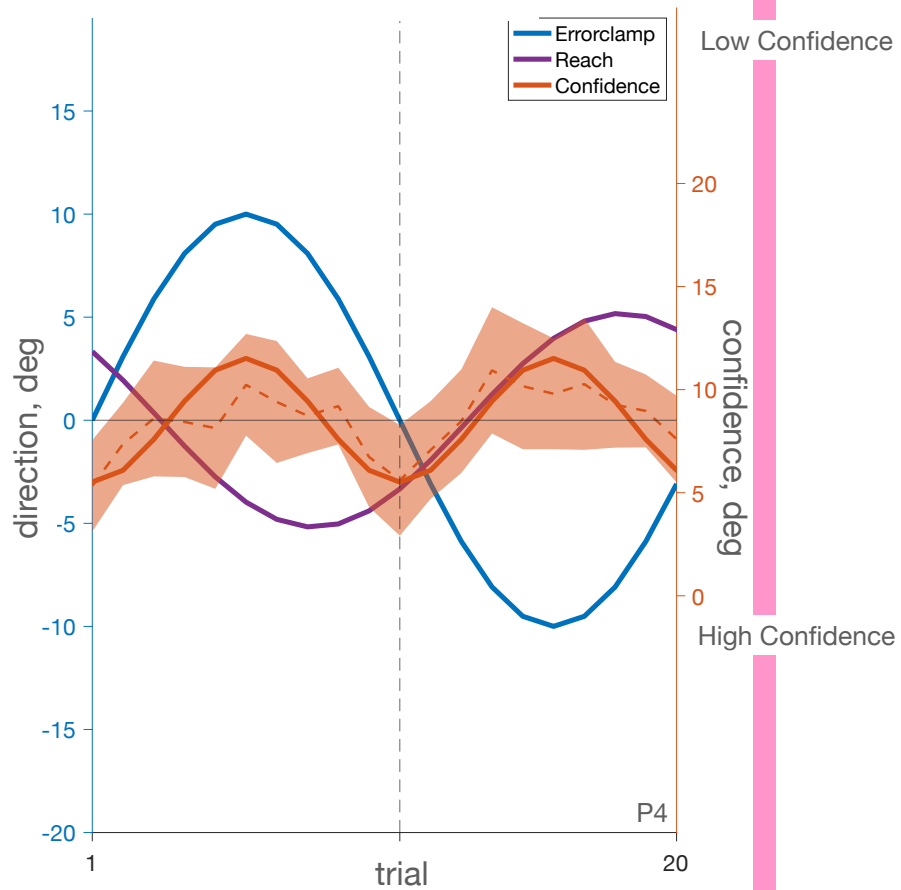
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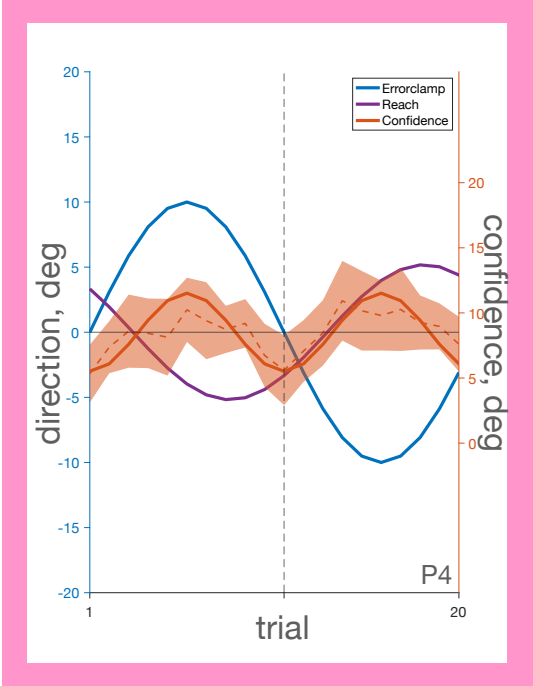
Sensorimotor Confidence



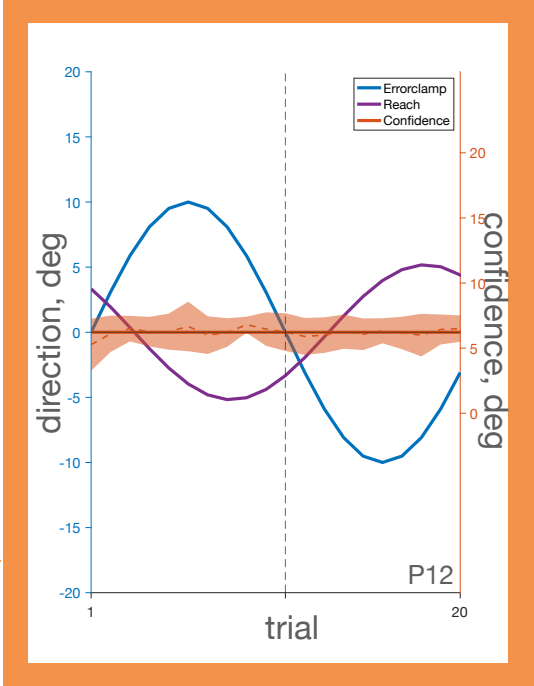
Sensorimotor Confidence



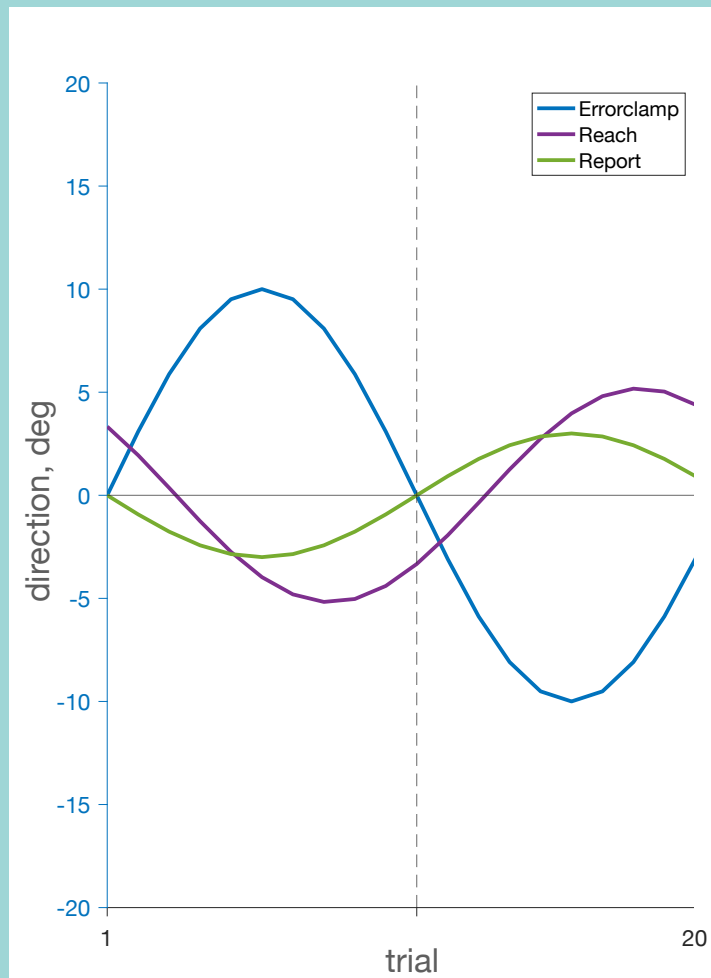
Sensorimotor Confidence



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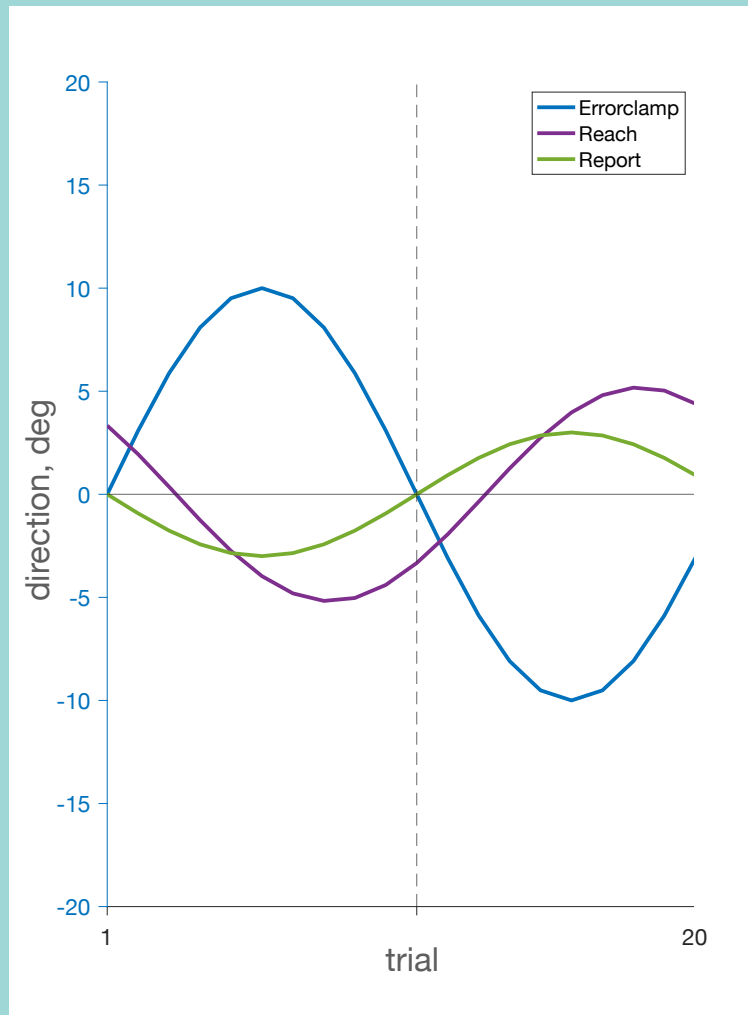
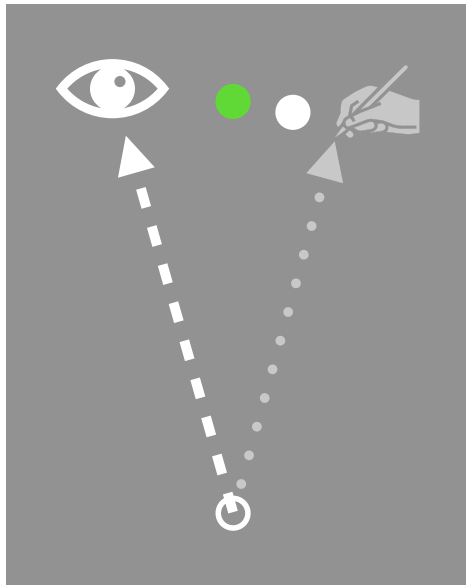


Motor Performance Report



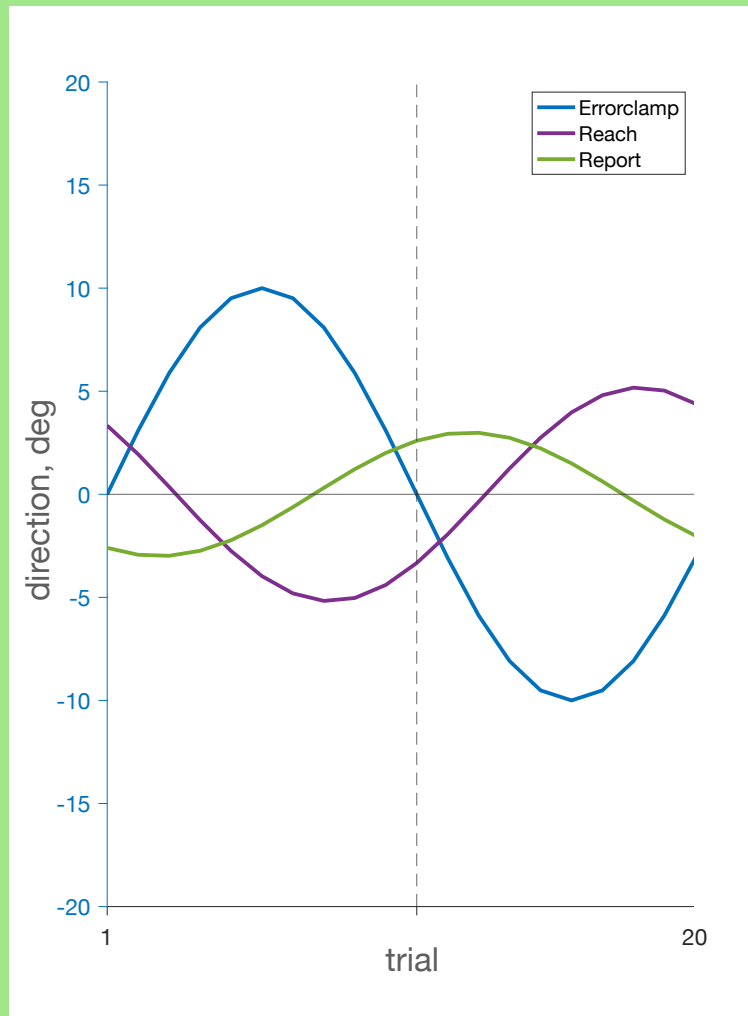
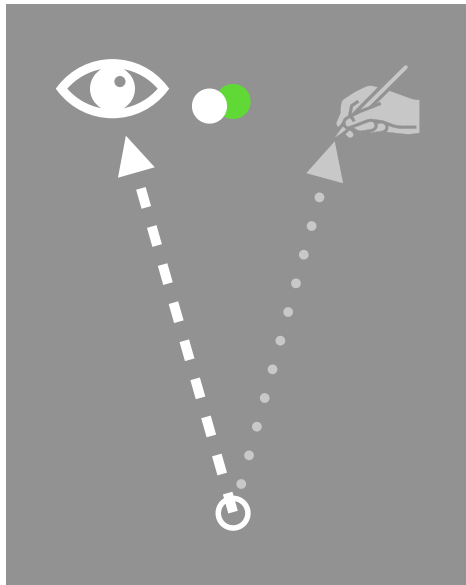
- ✓ Uses proprioception
- ✓ Influenced by visual feedback
- ✓ 12 cycles per session

Motor Performance Report



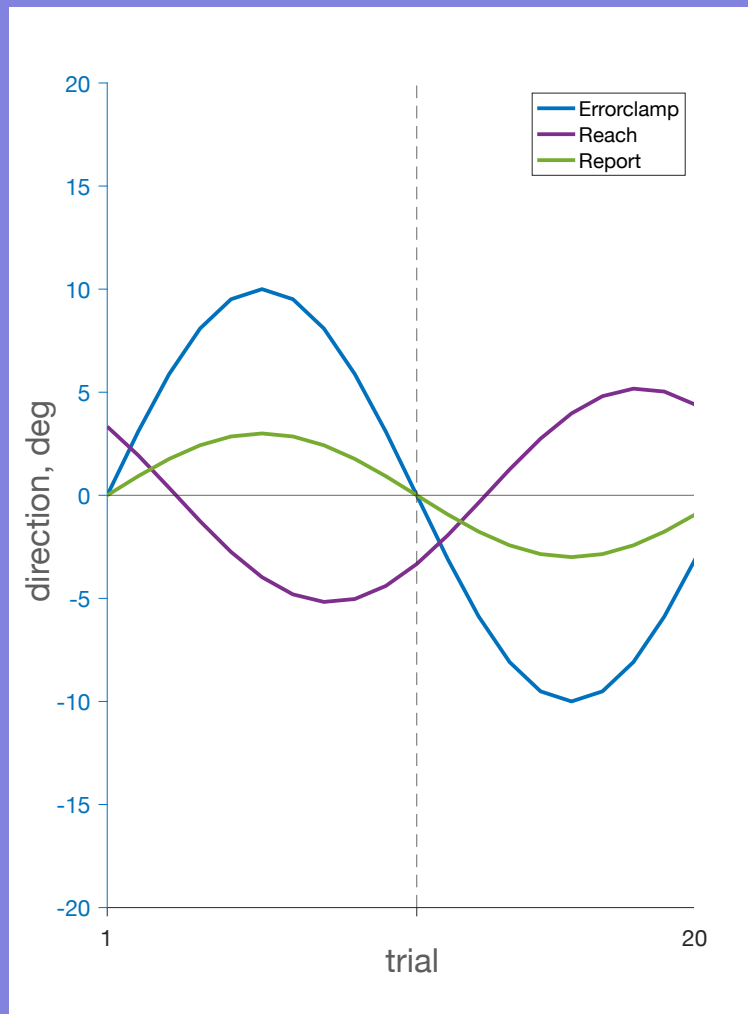
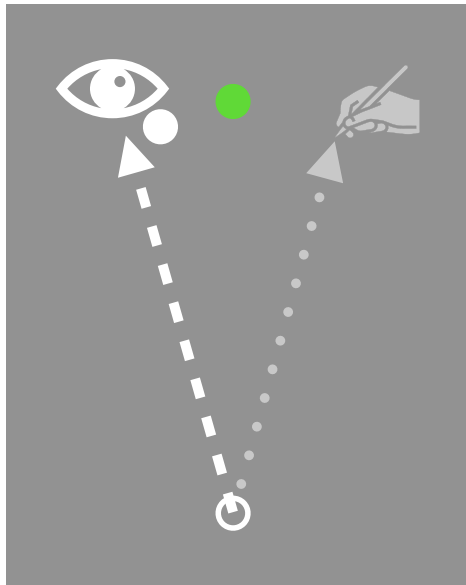
- ✓ Uses proprioception
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Motor Performance Report



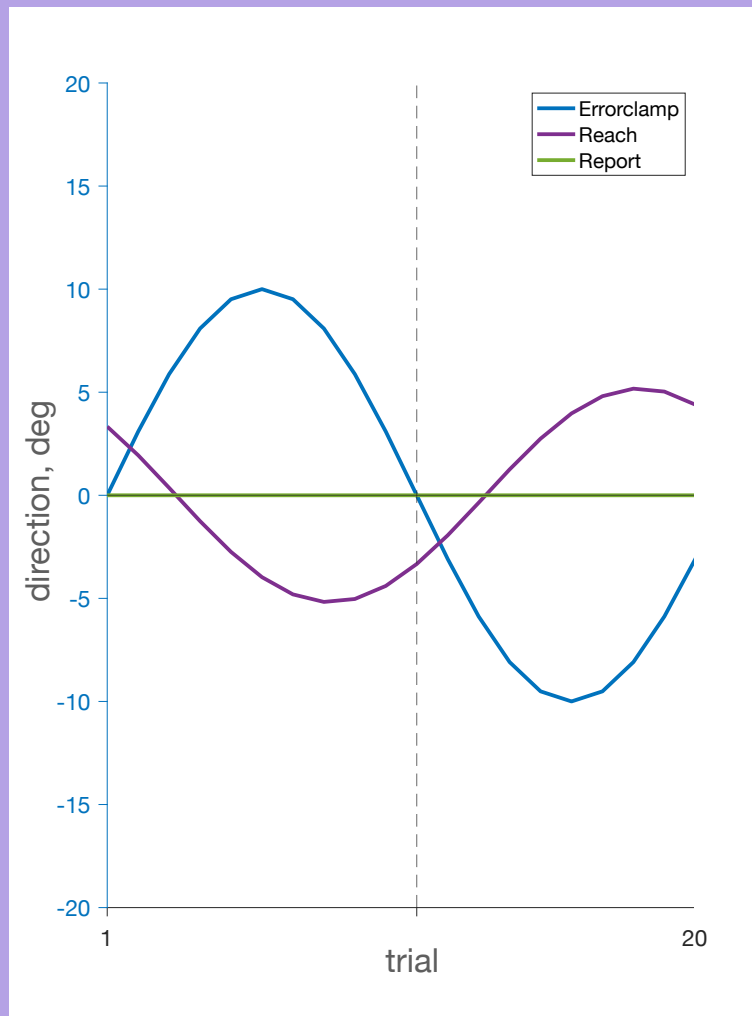
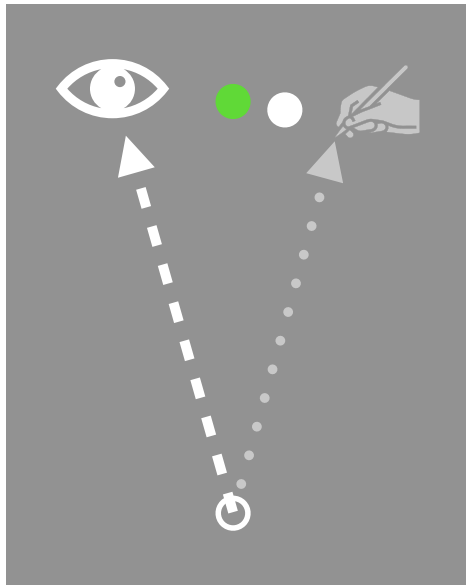
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Motor Performance Report

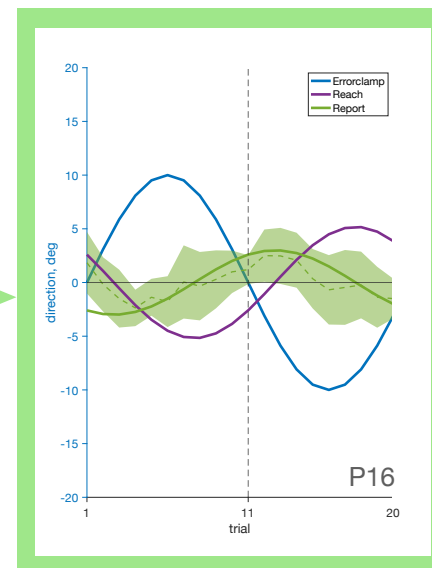
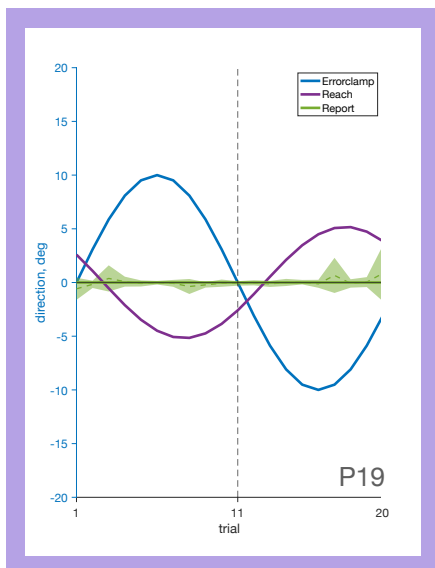
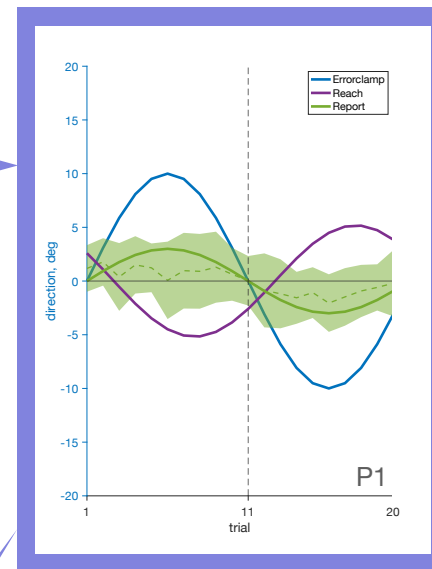
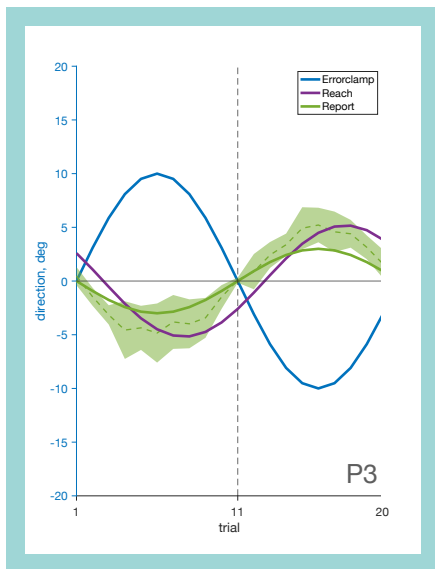


- ✗ Uses proprioception
- ✓ Influenced by visual feedback
- ✓ 12 cycles per session

Motor Performance Report



- ✗ Uses proprioception
- ✗ Influenced by visual feedback
- ✗ 12 cycles per session



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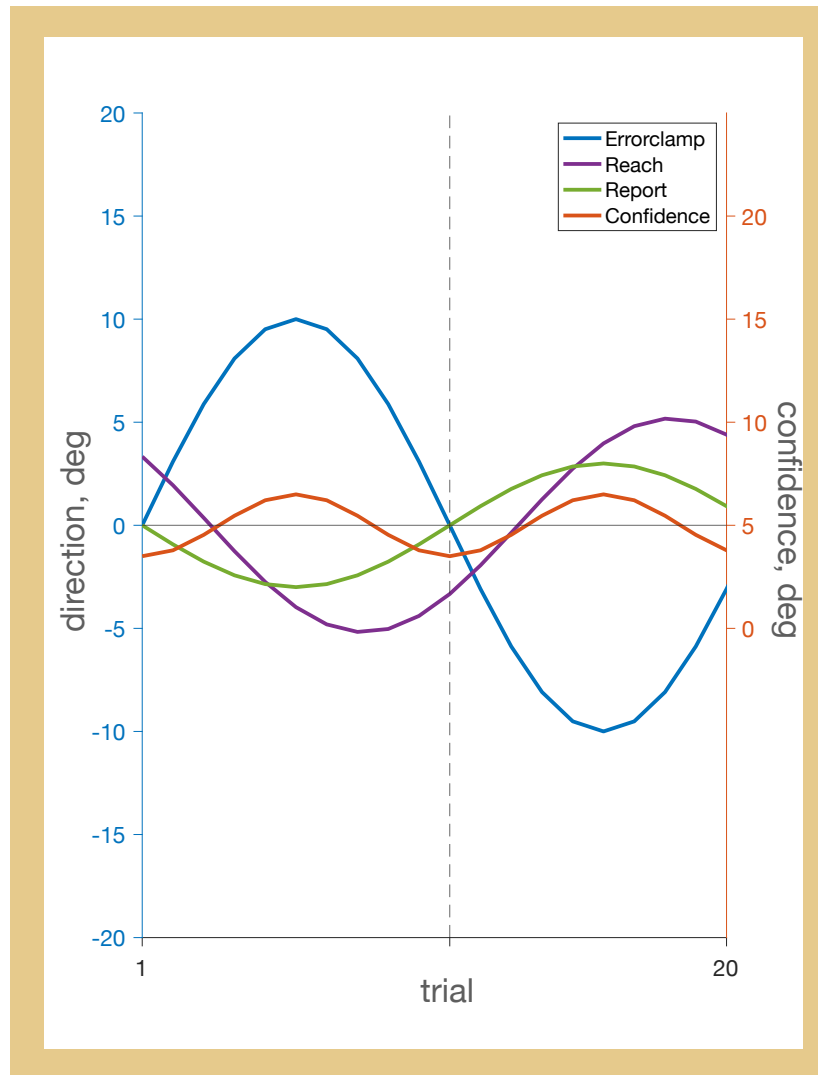
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Motor Awareness Confidence

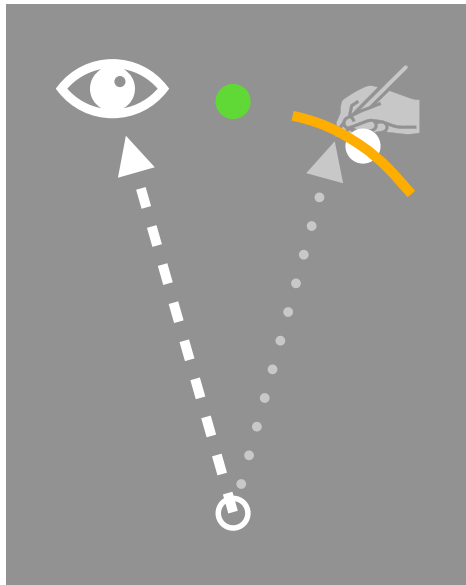


Low Confidence

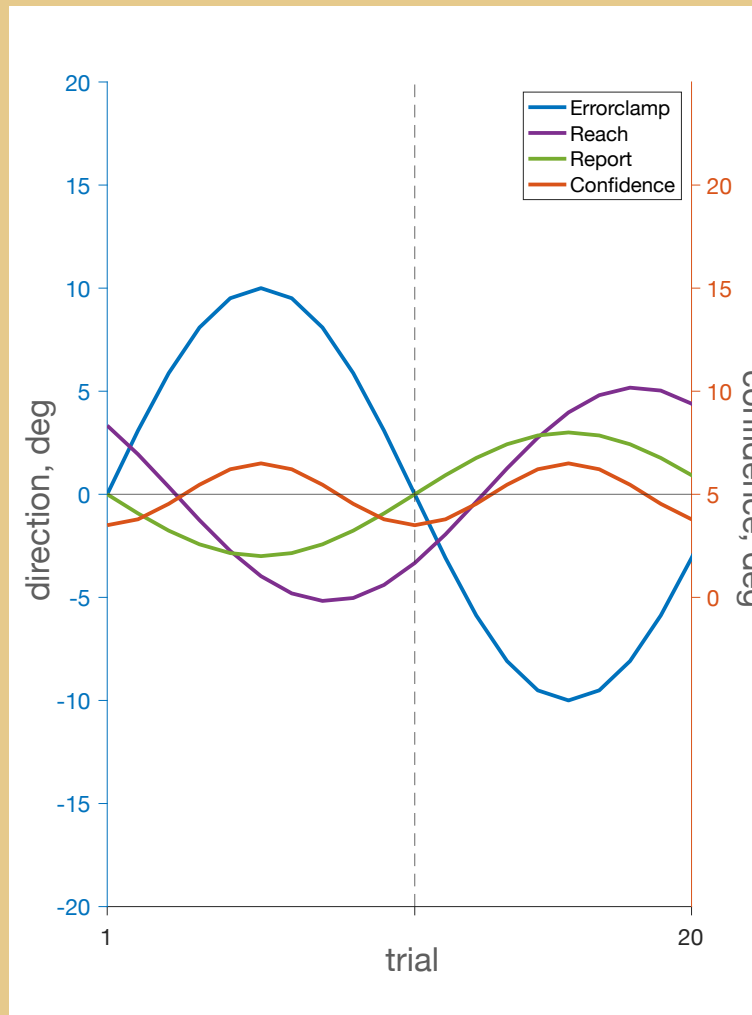
High Confidence

- ✓ Uses proprioception
- ✓ Influenced by visual feedback
- ✓ 24 cycles per session

Motor Awareness Confidence



Smaller arcs = higher confidence

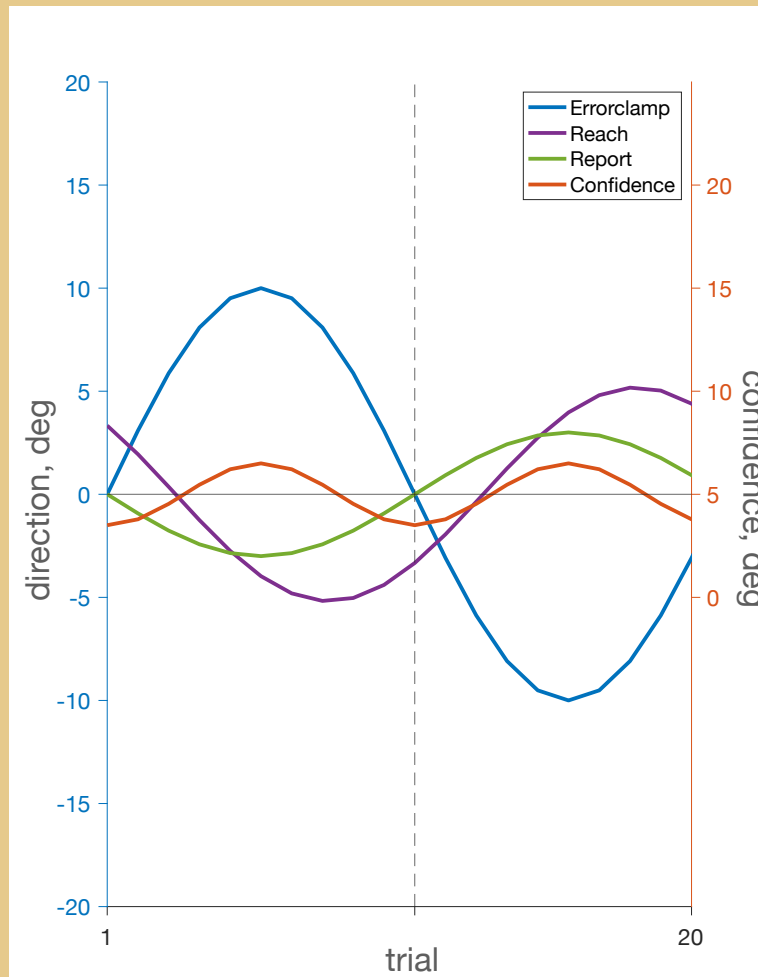
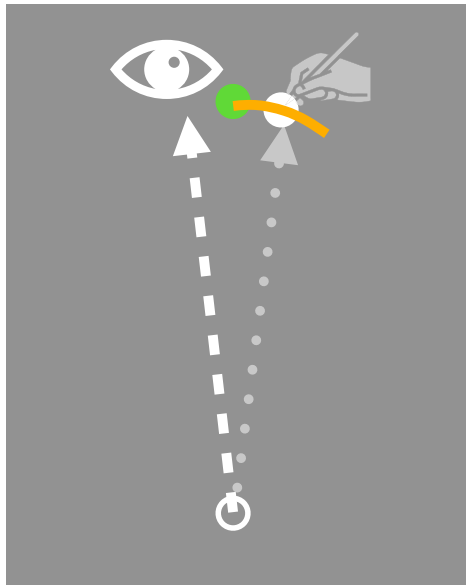


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Motor Awareness Confidence

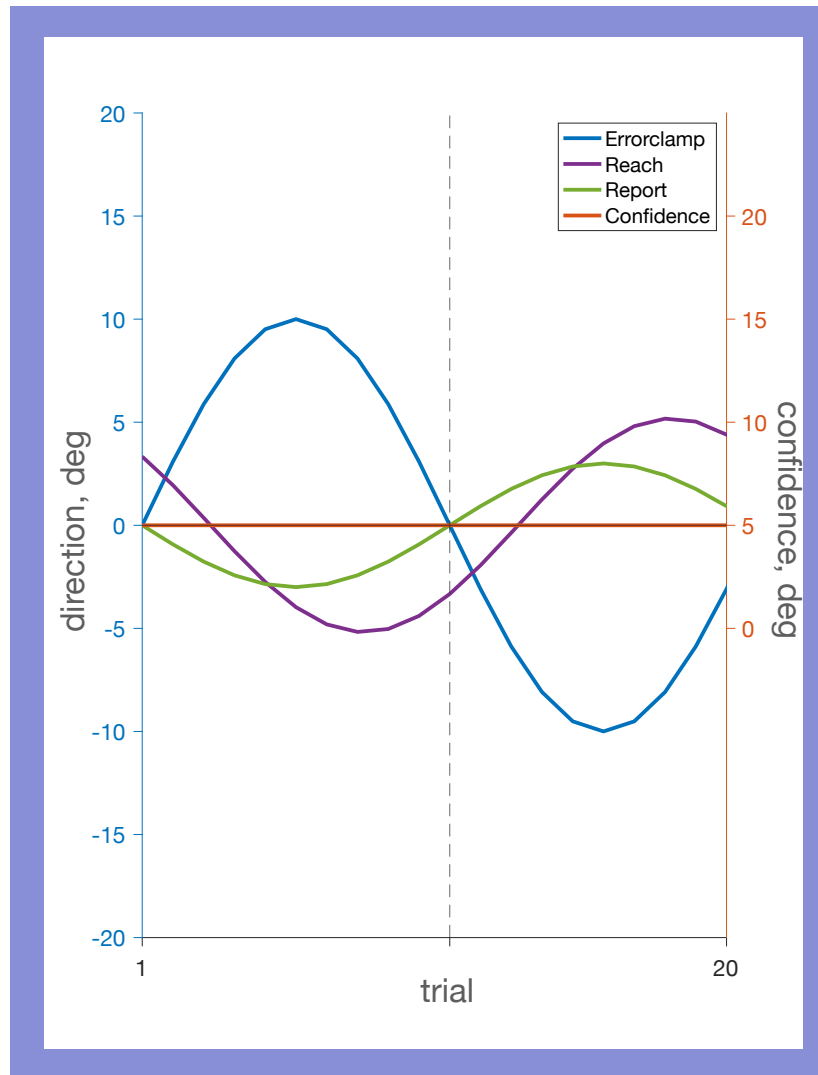


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Motor Awareness Confidence

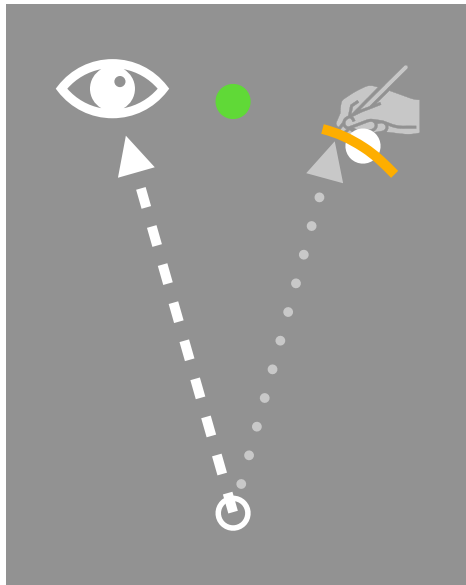


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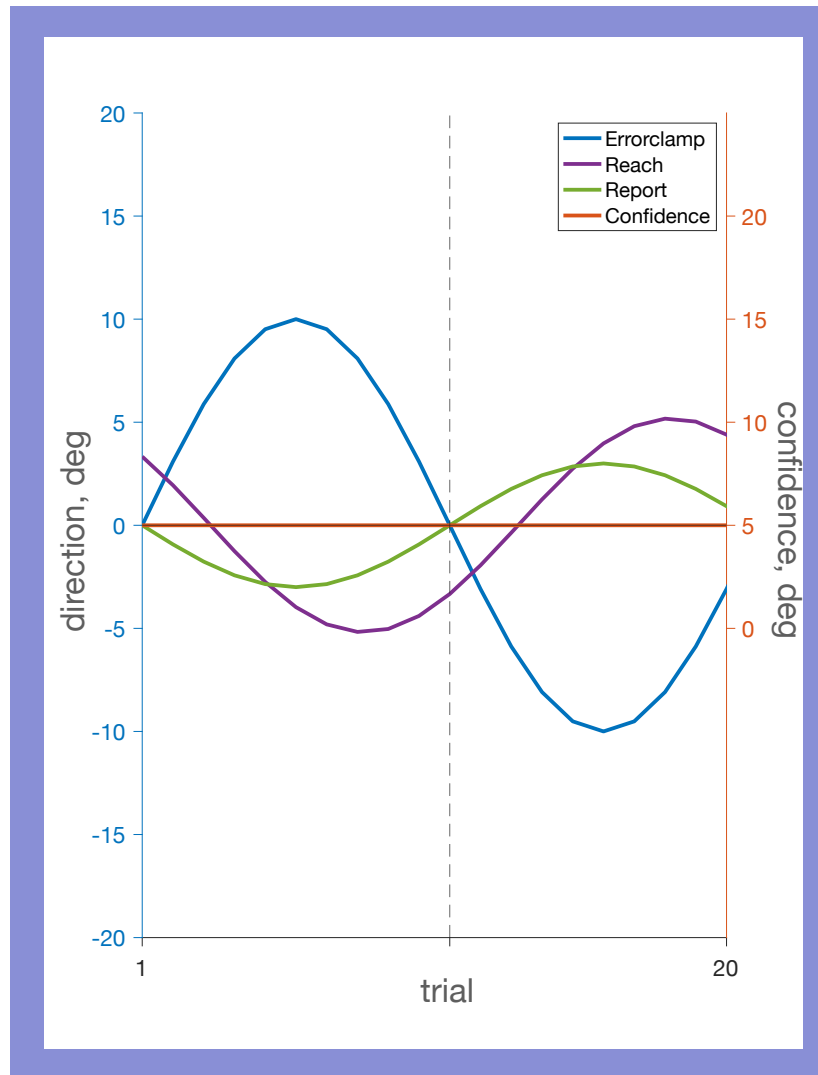
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Motor Awareness Confidence



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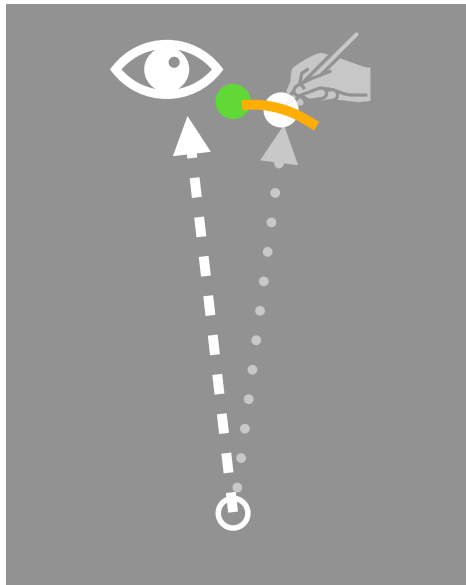


Low Confidence

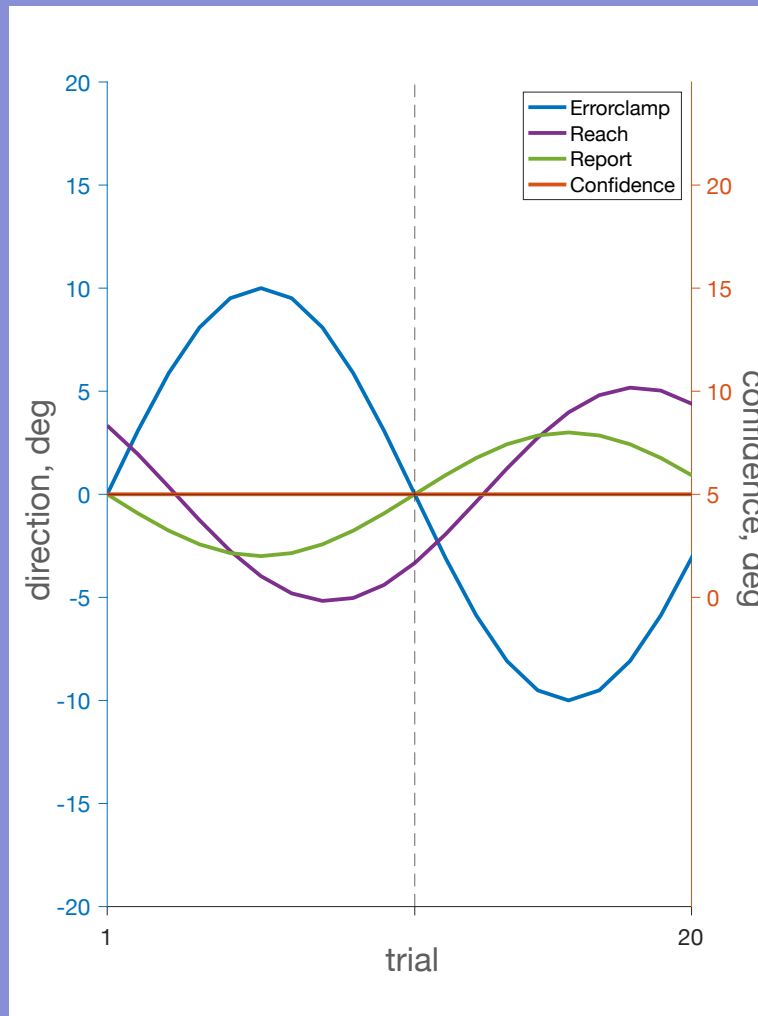
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Motor Awareness Confidence



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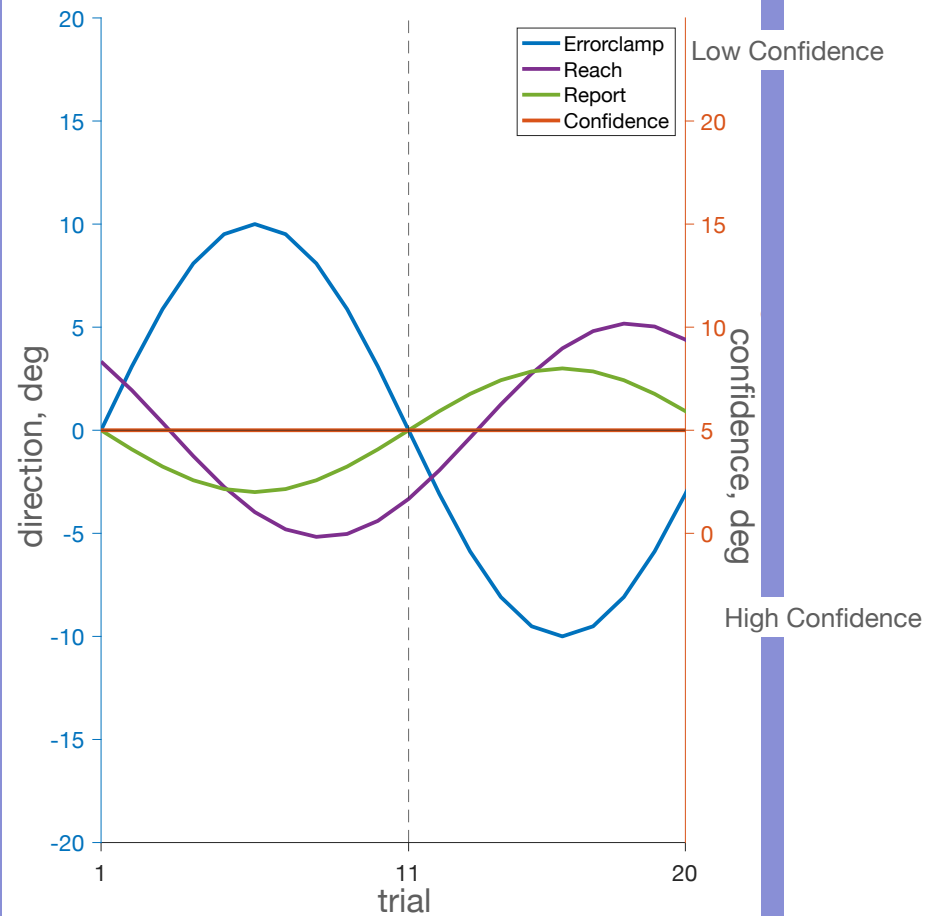
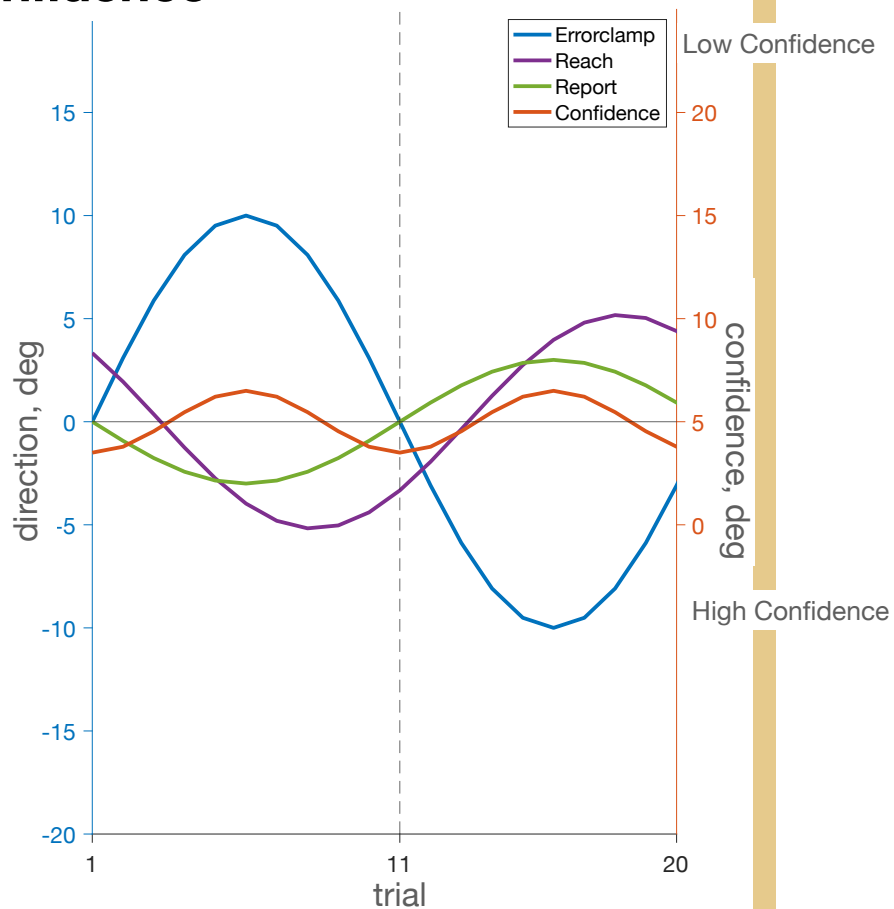


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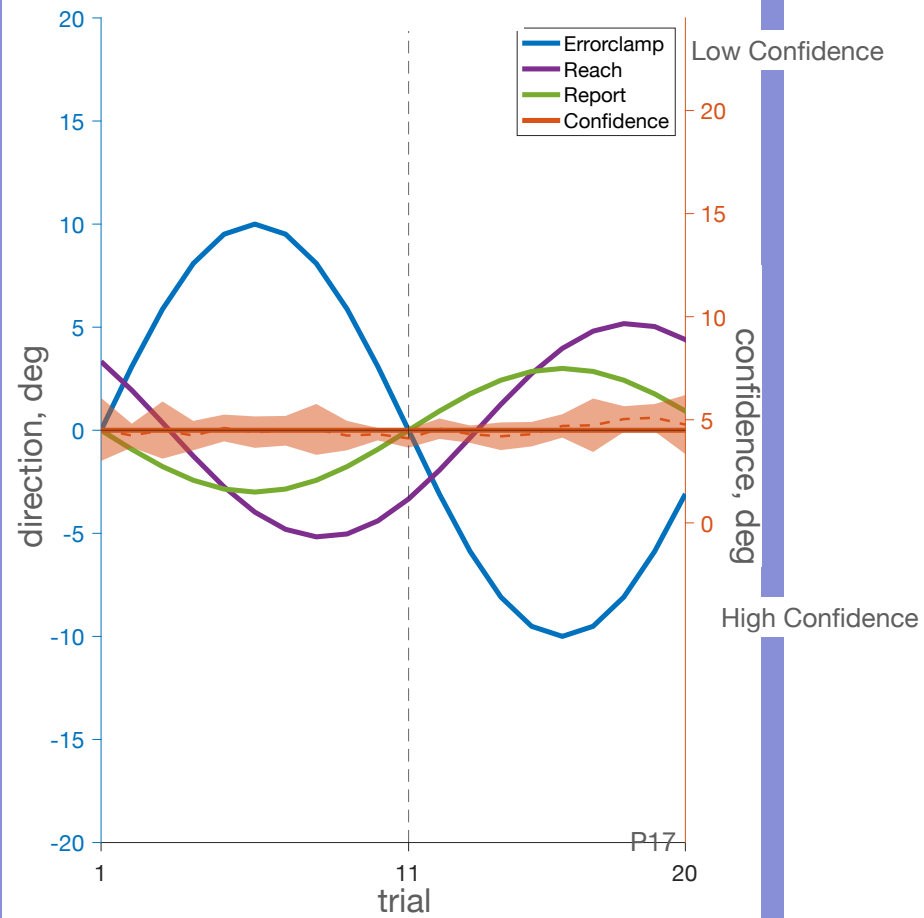
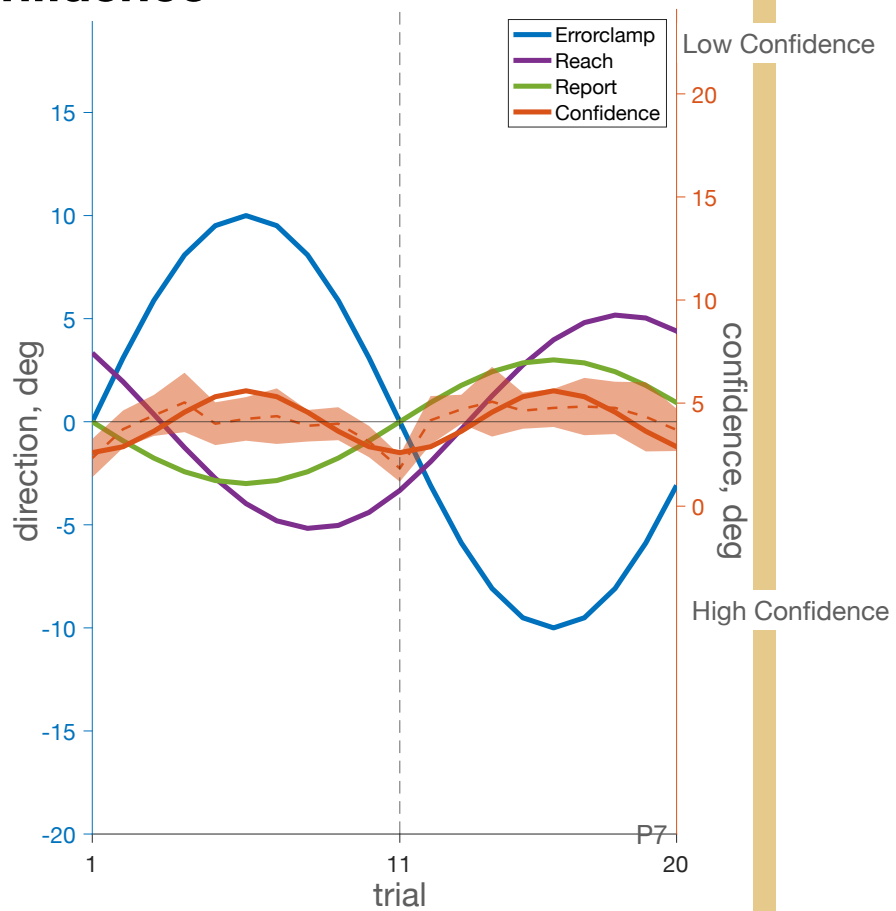
High Confidence

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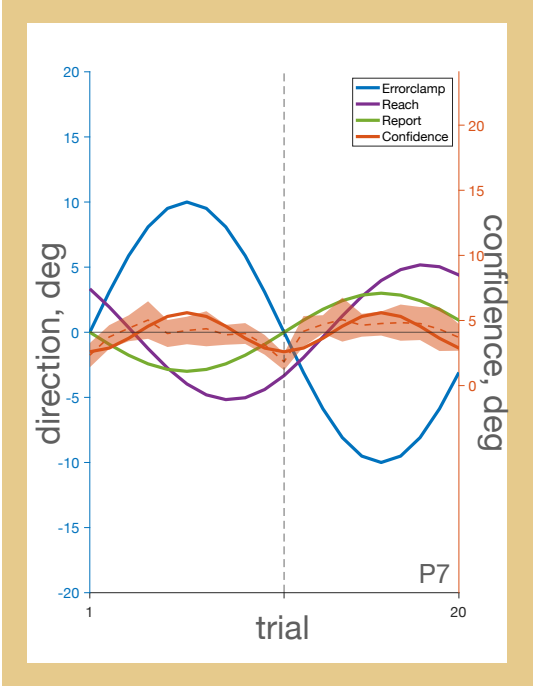
Motor Awareness Confidence



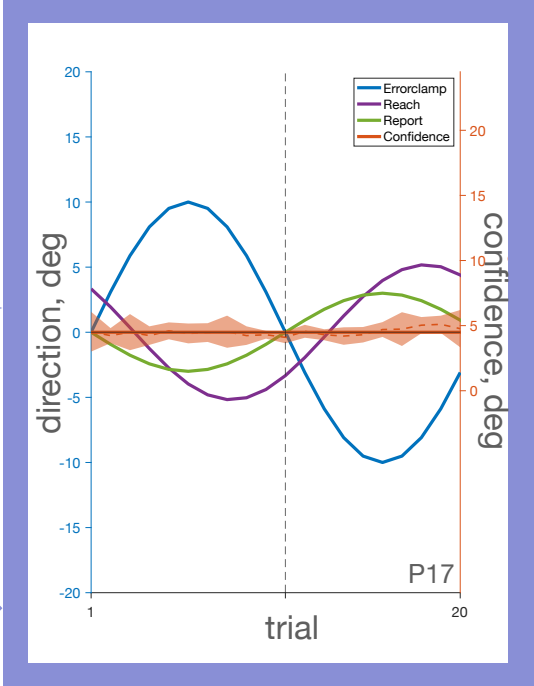
Motor Awareness Confidence



Motor Awareness Confidence



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Correlation

Participant Sensori- Motor
 motor Awareness

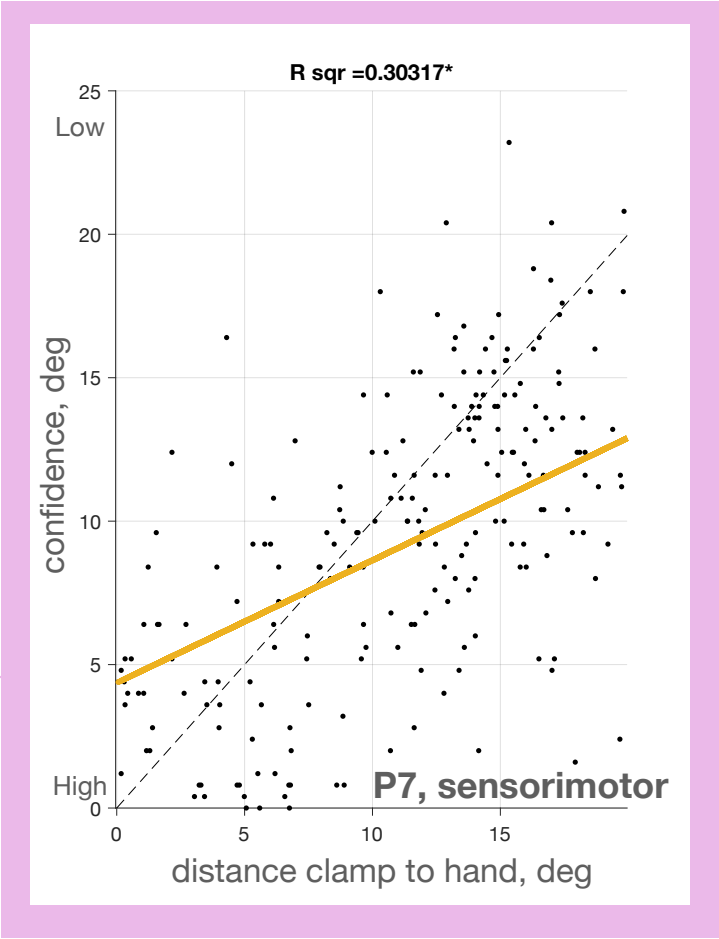
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 Significant 24 cycle frequency in confidence

Correlation

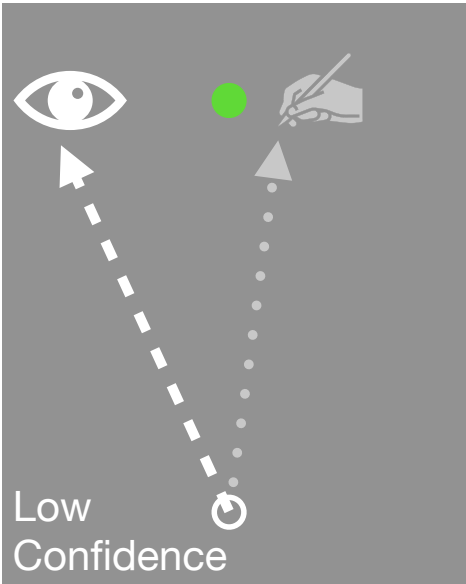
Participant	Sensori- motor	Motor Awareness
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Significant 24 cycle frequency in confidence



Confidence significantly correlated with mismatch of hand positions and visual feedback

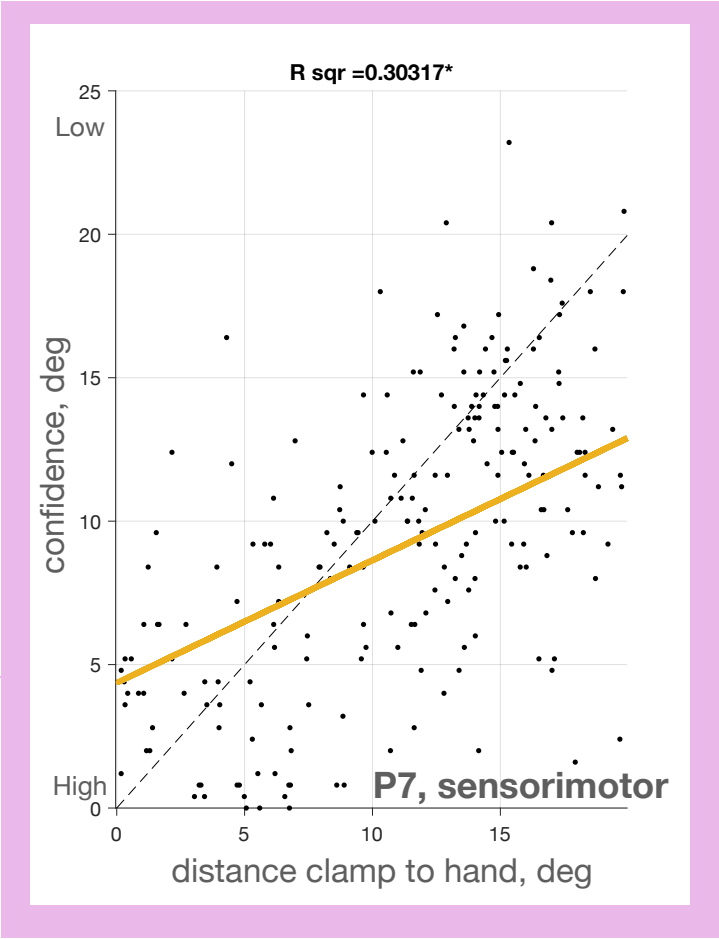
Correlation



Participant Sensori- Motor
motor Awareness

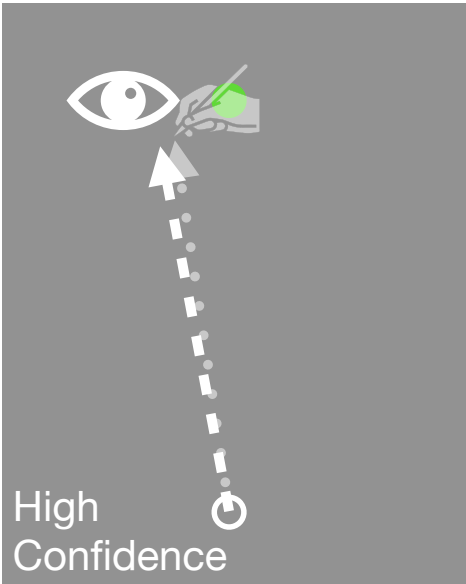
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Significant 24 cycle frequency in confidence



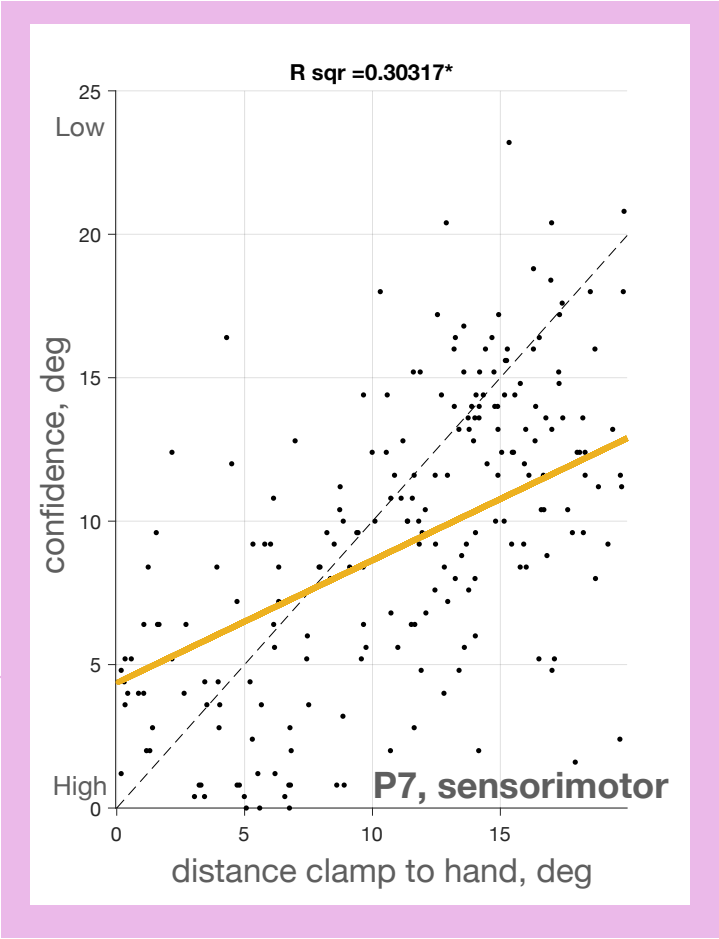
Confidence significantly correlated with mismatch of hand positions and visual feedback

Correlation



Participant	Sensori- motor	Motor Awareness
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Significant 24 cycle frequency in confidence



Confidence significantly correlated with mismatch of hand positions and visual feedback

Conclusions

- Implicit adaptation is reliable across participants with similar behavioral effects.

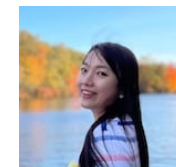
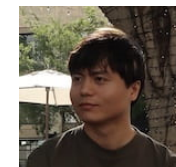
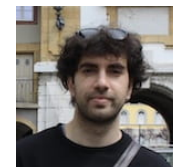
Thank you!



Jordan Taylor
Princeton University



Michael Landy
New York University



NEW YORK UNIVERSITY



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Conclusions

- Implicit adaptation is reliable across participants with similar behavioral effects.
- How inputs are weighed during meta-cognitive judgments differs across participants
- Participants that use proprioception are likely to have their confidence reduced when there is a mismatch between visual feedback and sensed hand position.