The role of proprioceptive sensory consequences in movement replication

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When a movement is successful, one typically exploits the success by replicating the movement. What does one replicate: the successful motor command (H1), or the proprioceptive sensory consequences of the successful movement (H2)?

Methods

32 Participants (20 F, 22 ± 2 years) performed elbow flexion tasks without visual feedback of the arm with no, agonist or antagonist muscle vibration (123 Hz). We use antagonist muscle vibration to induce a difference between the motor command ("Plan") and the proprioceptive sensory consequences at the end of the succesful movement ("Endpoint feedback").

feedback

Plan

Tasks

1. Moving to visual targets





X No target movement found 名 Target movement found: replicate

Hypotheses & predictions

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Q2. What is replicated after a target movement with vibration?





Elbow flexion to visual targets:

- No performance feedback.
- Muscle vibration during flexion:
 - no (control)
 - agonist (biceps) (sham)
 - antagonist (triceps) (illusion)



Searching for target movements and replicating them twice:

- Random hit(<a>/>)-miss() feedback for defining target movements (hits)

- No feedback on 2 replication trials following target movements

- Muscle vibration during flexion:
 - no (control)
 - antagonist (triceps) (illusion)

Based on the results of question Q1, we assume target movements with vibration undershoot the planned movement. *Prediction: target error < 0*

Hypothesis 1: Motor command

Endpoint

feedback

Plan

Antagonist muscle vibration causes undershooting of visual targets. Q1. Does it cause undershooting of target movements?

Hypothesis 2: Sensory consequences





Antagonist muscle vibration induces an illusory percept of muscle lengthening. When an antagonist muscle is vibrated during a movement, vibration causes an undershoot when moving to visual targets.

When participants hit a **target** movement without vibration, we test whether they undershoot the target movement on a replication trial with vibration.



A replication trial without vibration should end at the same angle as the target movement.

Prediction: trial-to-trial change = 0

Results

Q1. Vibration induces undershooting of visual targets and target movements





Q2. Participants do not replicate motor commands (H1) and instead show behaviour in between hypotheses H1 and H2

SEM



Within participants, trial-to-trial changes are normally distributed, indicating that they show consistent behaviour in between H1 and H2.

A replication trial without vibration should **overshoot** the target movement with the size of the vibration undershoot. *Prediction: trial-to-trial change > 0*



Target movement undershoot (°)



Conclusion

When reproducing a movement, participants do not replicate their successful motor command but seem to take both sensory and motor signals into account.

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This project was funded by the Nederlandse Organisatie voor Wetenschappelijk Onderzoek: Rubicon Grant 2024.