

THE ROLE OF VISUAL FEEDBACK IN A RHYTHMIC TASK

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INTRODUCTION

Are rhythmic tasks controlled as a succession of discrete events, or as a single movement? We propose a simplified juggling task that is controlled by one of these behaviors, depending on the task tempo. A model of the task predicts the stability of periodic patterns with a passive (feedforward) control of the arms. We evaluate human tendency to balance this stable feedforward path with an active feedback loop. Once again, this trade-off depends on the task tempo, but is also influenced by the availability of the visual feedback. When subjects are asked to close their eyes during the task, they adapt their behavior towards more sustained and sync movements, where the feedforward path takes the advantage over the feedback loop.

CONCLUSIONS

- The same rhythmic task can either be intermittent or sustained, depending on its tempo.
- Fast tempi correspond to movements that are sustained and sync while slow tempi correspond to movements that are intermittent and decoupled.
- Visual feedback suppression shifts the transition towards sustained and sync movements.
- Accordingly, visual tracking is lazy at fast tempo.
- A classical signature of passive strategies (acceleration < 0) is observed, in particular without visual feedback.
- A feedback loop of energy control is validated, particularly when visual feedback is available.

METHODS



WIPER robot

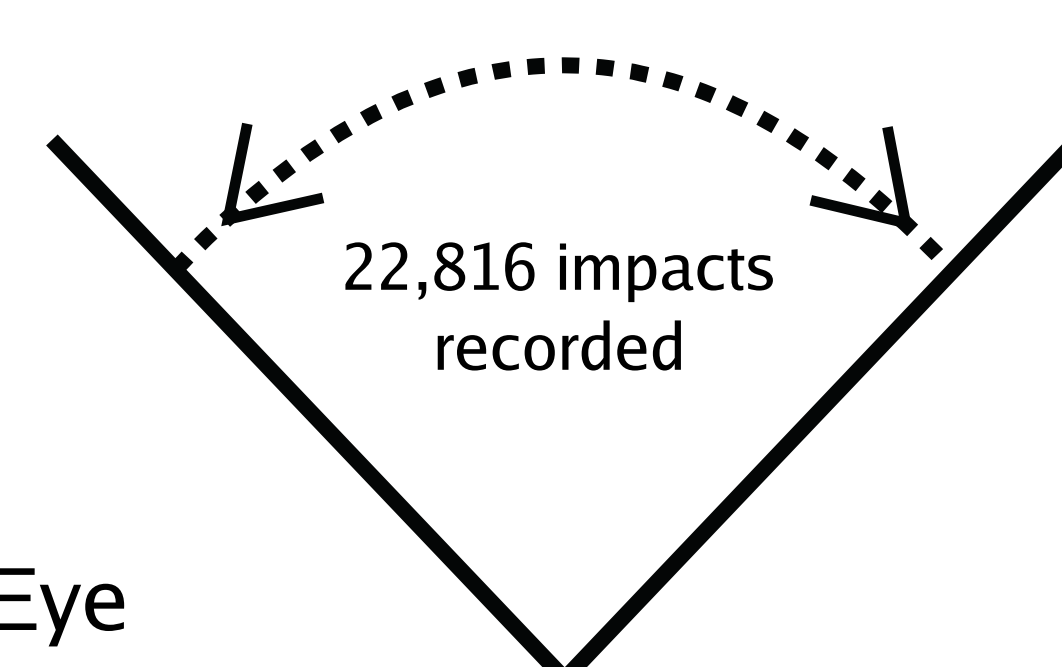
Four human subjects had to juggle a puck between two edges on a tilted air-hockey table. They stabilized a round-trip of the puck (period-one) by controlling the edges rotation. Puck, edges and head position were measured with an Optotrak. Eye position was measured with a Chronos Eye Tracker. During half of the blocks, subjects were asked to close their eyes.

Measured position:

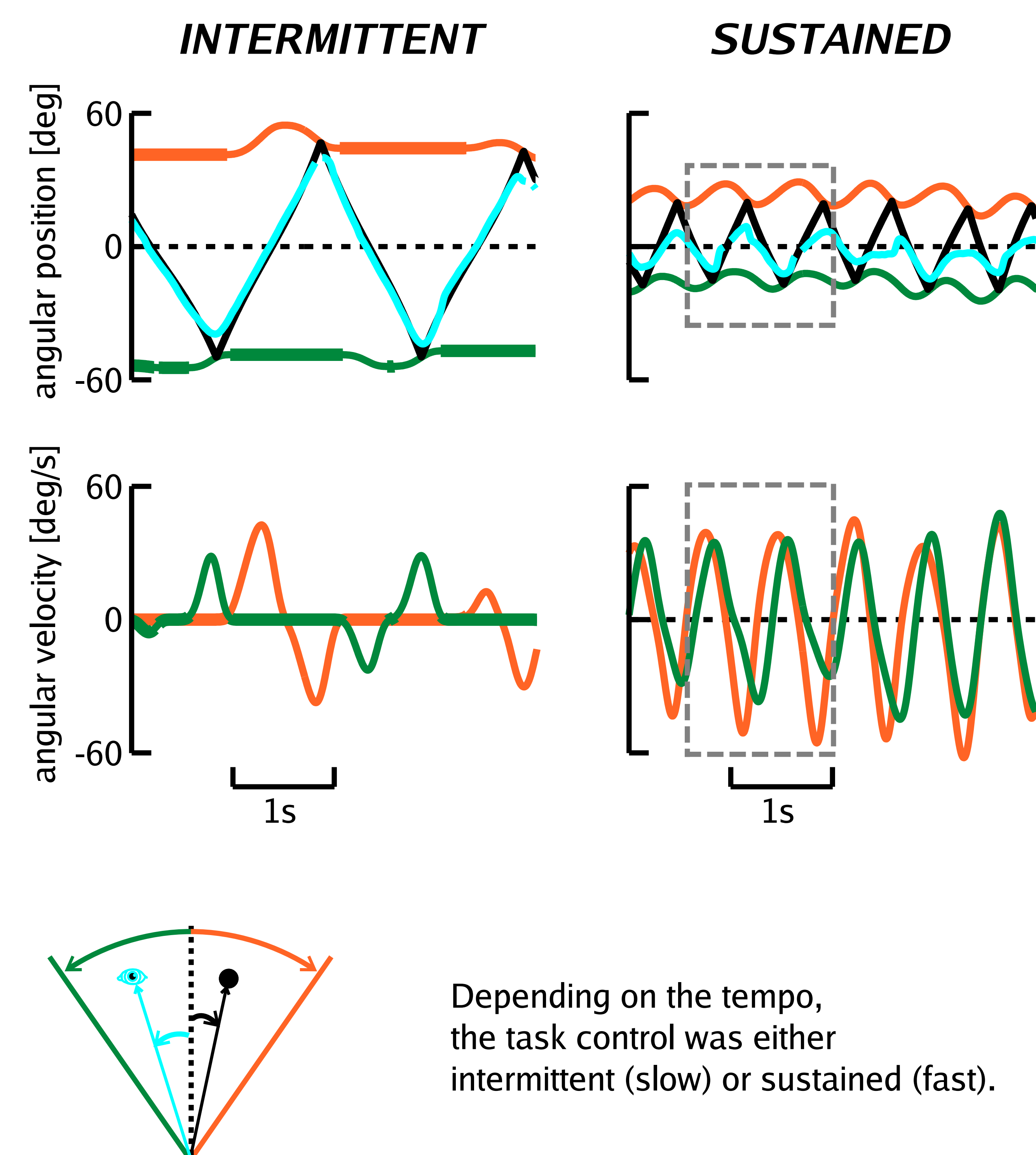
- head
- eye
- edges
- puck

Conditions:

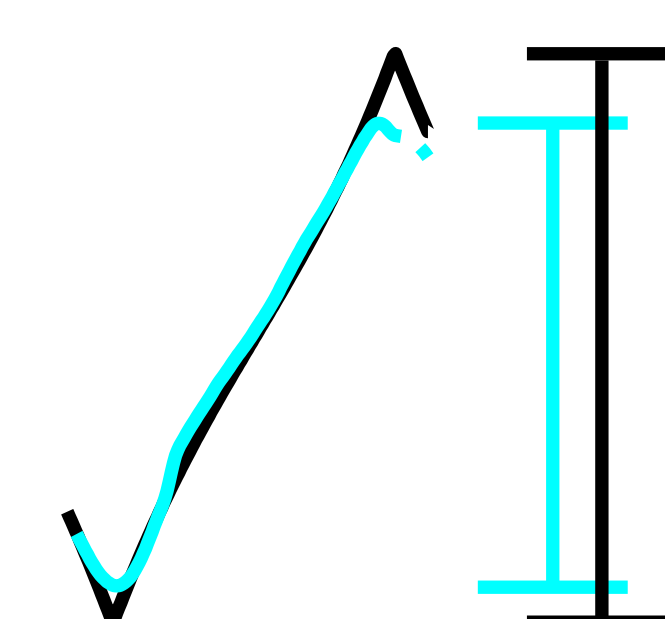
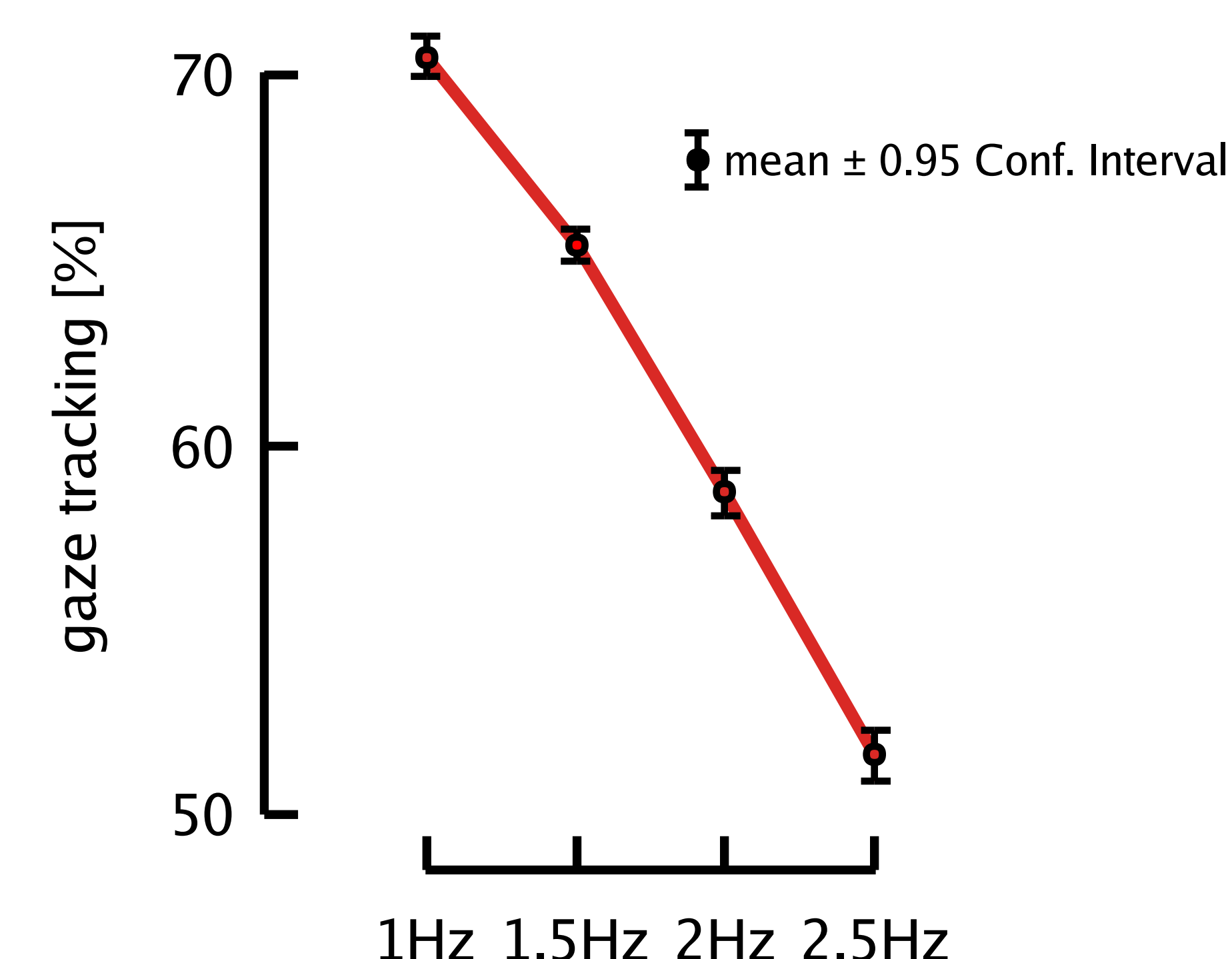
- metronom at 1Hz
- metronom at 1.5Hz
- metronom at 2Hz
- metronom at 2.5Hz



TYPICAL STRATEGIES

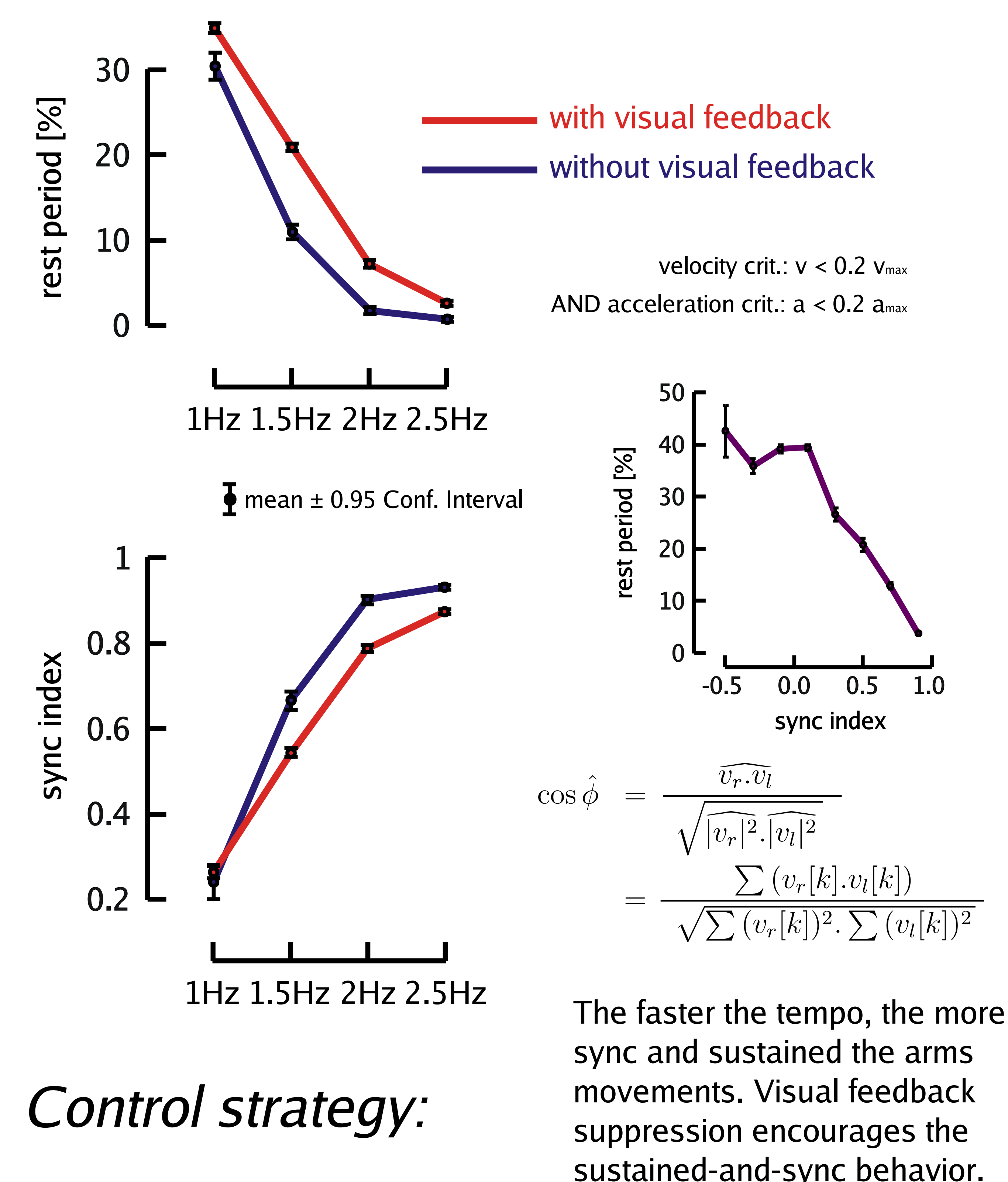


VISUAL TRACKING

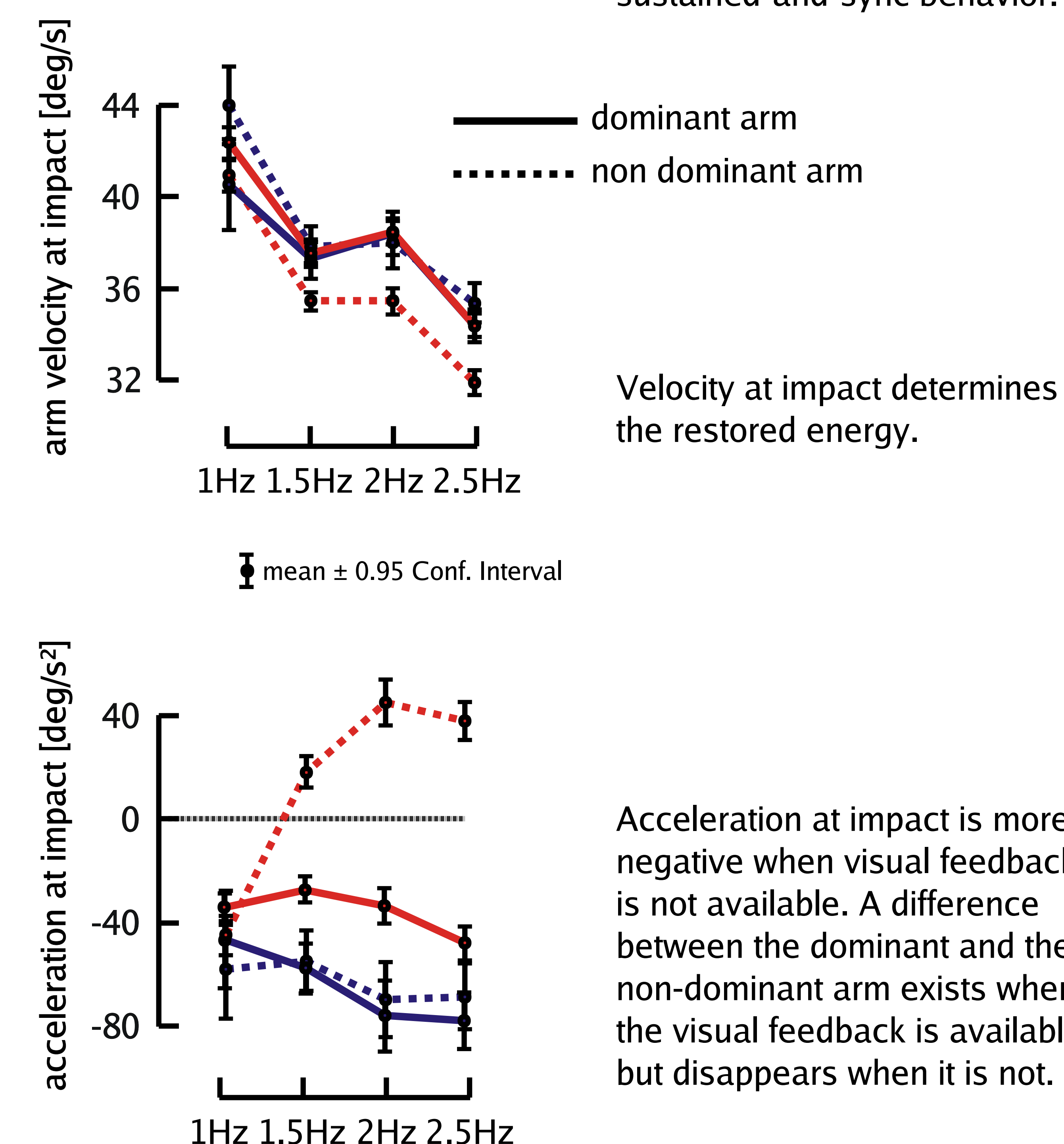


Slow tempi are associated with accurate tracking, while fast tempi are associated with lazy tracking.

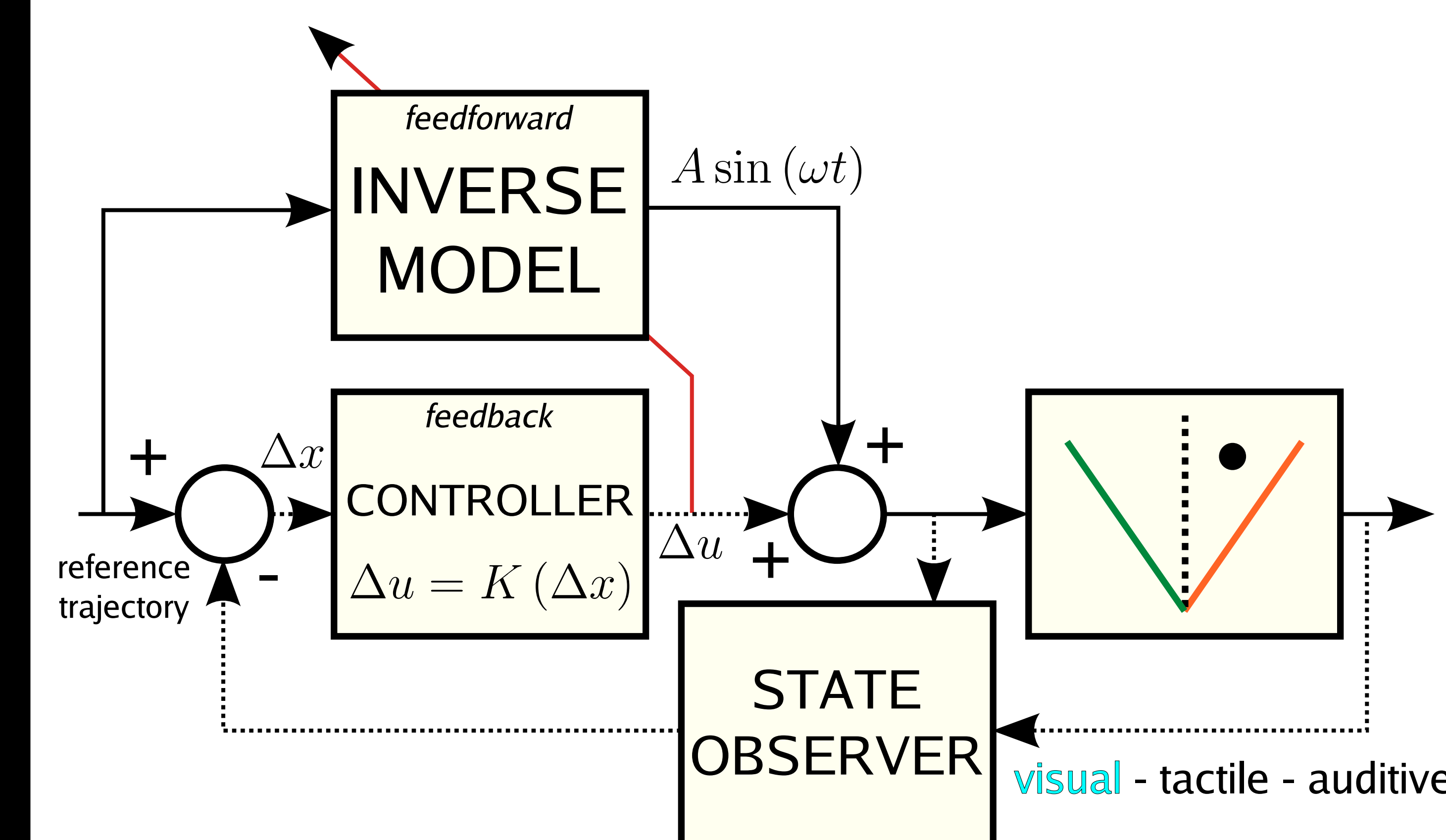
Bimanual coordination:



Control strategy:



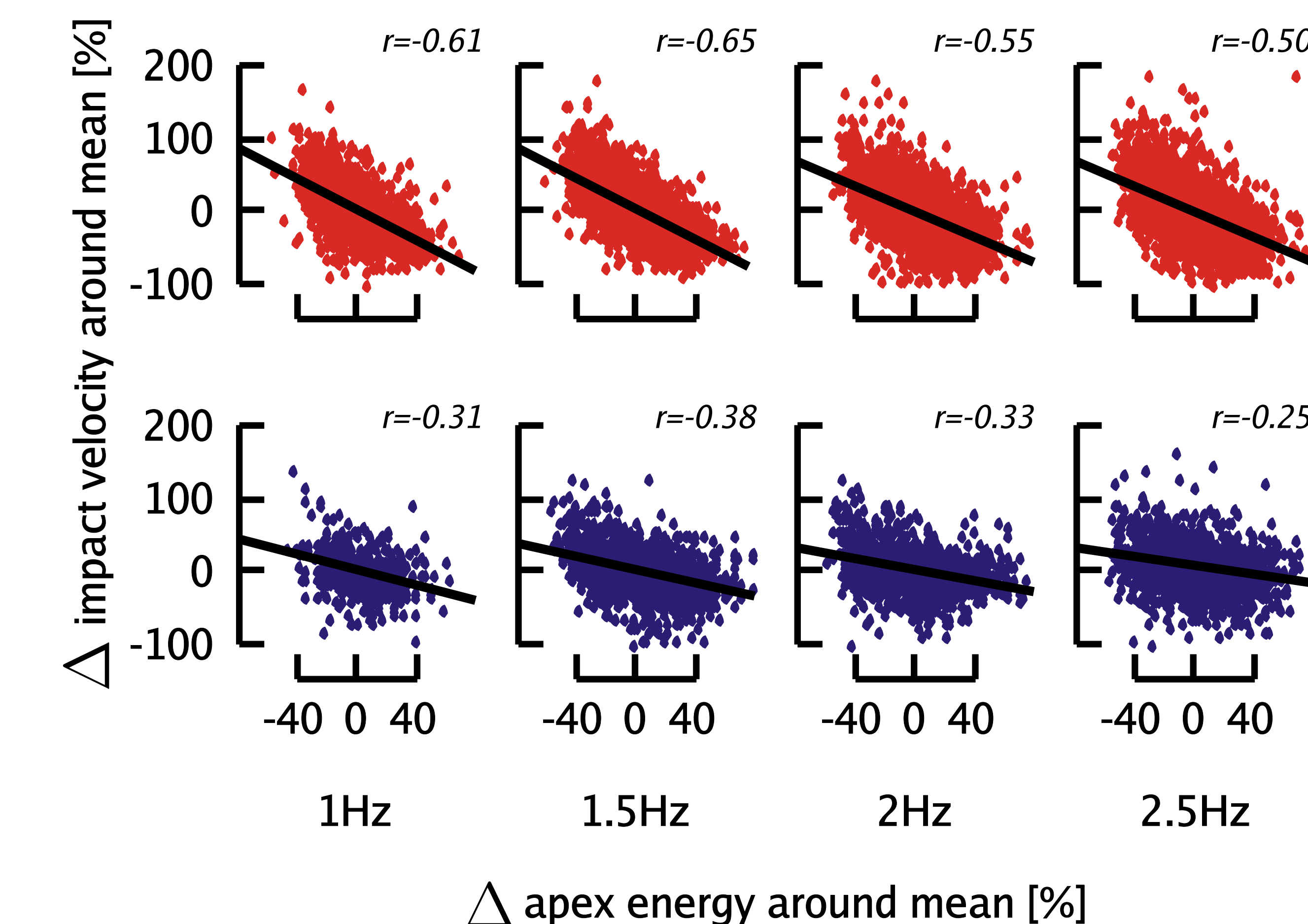
CONTROL LOOP



With a simple open-loop sinusoidal input, period-one of Wiper is stable, depending on the impact position, the amplitude (A) and the coefficient of restitution.

Without feedback, this feedforward path forces negative acceleration at impacts.

ENERGY CONTROL



Puck energy = potential en. (position) and kinetic en. (velocity).

A simple proportional gain ARM VELOCITY (output) / ENERGY (input) fits the data. When visual feedback is not available, both the gain and the correlation decrease.

Correlation decreases also for fast tempi, therefore supporting the idea that the feedforward path plays a more important role in these cases.