MEASURING METACOGNITION OF DIRECT AND INDIRECT PARAMETERS OF MOVEMENT

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INTRODUCTION

Human movement can be very precisely described in terms of kinematics by an external observer. But how well can we describe our actions ourselves? How much do we know about the way we move? Do we judge our movements based on their effect or on the movement parameters of the body itself? When judging our own movements, do we use the same mechanisms for metacognition as we use for the other cognitive domains, or are these mechanisms different?

AIMS

— to develop a paradigm for measuring metacognition of voluntary movement;
— to compare metacognitive ability in visual and motor domains, and how they are combined;
— to compare the metacognitive access to proximal (direct) and distal (indirect) parameters of movement.

METHODS

How do we measure metacognition of action?

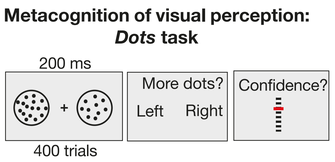
We used a virtual version of the *Skittles* task: a ball-throwing task, where the trajectory of the ball is fully determined by 2 parameters: the speed and the angle at the point of ball release.

We quantified metacognitive efficiency as the ratio between *meta-d'* and *d'* to account for Type I performance level fluctuations (Maniscalco & Lau, 2012). To avoid large fluctuations in *d'*, we controlled Type I performance level with a staircasing procedure at ~71%.

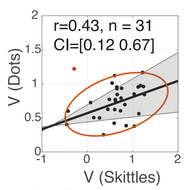
Experiment 1:

Skittles task with Type I task about trajectories + visual metacognition task (*Dots* task). Type II task responses on a continuous scale.

Metacognition of visual perception: *Dots* task



Visual (*Skittles*) vs visual (*Dots*)



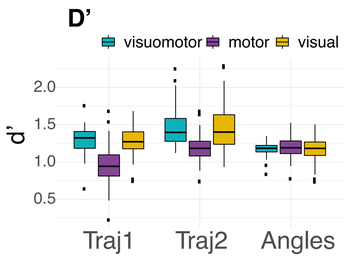
Validation of the visual 'Skittles-Trajectories' task using visual 'Dots' task

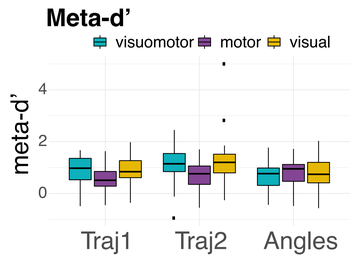
Experiment 2:

Skittles task with two Type I tasks:
1) about a distal parameter (trajectories)
2) about a proximal parameter (angle at the point of the ball release).
Type II responses on a discrete 6-point scale.

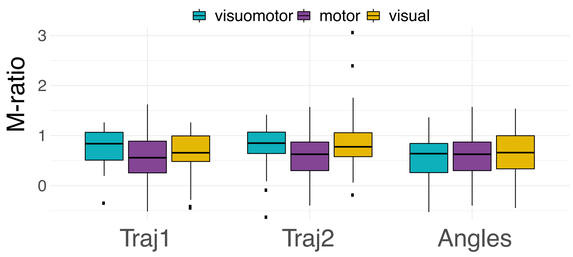
RESULTS

D' and meta-d' were stable in *Angles* task across conditions, but were lower in motor than in other conditions in *Trajectories* tasks.



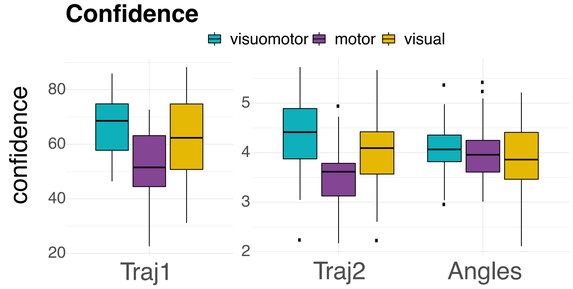


M-ratios



M-ratios had a similar pattern, however, the difference was not significant.

Confidence



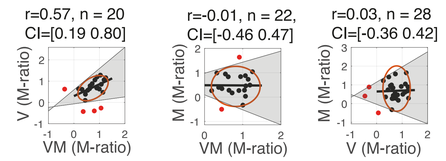
Confidence ratings showed the same pattern across tasks and within conditions.

Correlations:

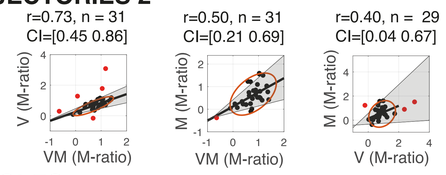
For correlations analysis, we used a robust procedure: skipped correlations. They take into account the data structure and protect against bivariate outliers (Pernet et al 2013).

In *Trajectories-1*, there was correlation only between visuomotor and visual conditions. Correlations were found in *Trajectories-2* and *Angles* tasks across all conditions. No correlations were found for the same conditions across two tasks. Different correlation patterns in *Trajectories-1* and *Trajectories-2* could be explained by noisier *M-ratios* estimates in the Exp. 1, due to poorer staircasing and lower number of trials in Exp. 2.

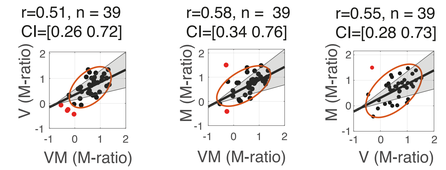
TRAJECTORIES 1



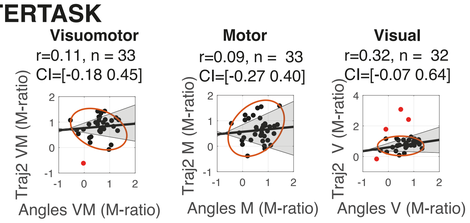
TRAJECTORIES 2

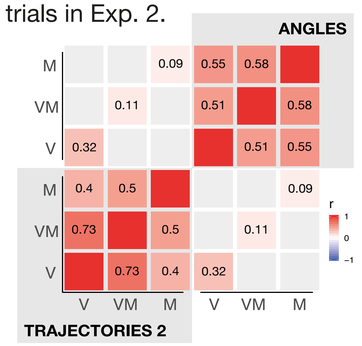


ANGLES



INTERTASK





DISCUSSION

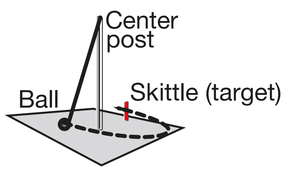
— No significant difference was found between metacognitive efficiency when measured with proximal and distal parameters of movement. Both are available for metacognitive access.

— Correlations between metacognitive efficiency in motor and visual conditions (in *Angles* and *Trajectories-2* tasks) indicate a domain-general mechanism of metacognition.

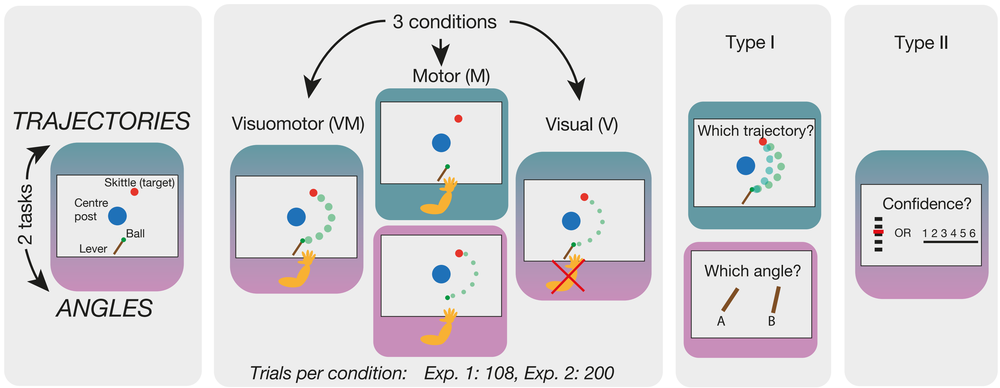
— However, the absence of intertask correlations for the same domains shows that metacognition was affected by differences between the tasks, such as different temporal properties, attentional demands and different information integration over the course of trials or testing sessions.

— Correlation between visual *Dots* task and visual *Trajectories* task in Experiment 1 shows that similar metacognitive mechanisms were used in two very different tasks.

***Skittles* game**



Metacognition of arm movements: *Skittles* task



References:

Maniscalco, B., & Lau, H. (2012). A signal detection theoretic approach for estimating metacognitive sensitivity from confidence ratings. *Consciousness and cognition, 21*(1), 422-430.

Pernet, C. R., Wilcox, R. R., & Rousselet, G. A. (2013). Robust correlation analyses: false positive and power validation using a new open source Matlab toolbox. *Frontiers in psychology, 3*, 606.