101 – Perception & Imagery (5)

The influence of passive self-motion on spatial perspective taking, and the role of attention

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Introduction

- There is increasing evidence that the vestibular system is not only involved in vestibulo-ocular reflexes and postural control, but also in higher cognitive processes (Mast et al., 2014).
- A case in point is the ability to adopt a different spatial perspective (spatial perspective taking, SPT). SPT requires egocentric mental rotations and can be influenced by postural or vestibular information (Kessler & Thomson, 2010; Grabherr et al., 2011).
- Indeed, a vestibular self-motion stimulus that is directionally congruent to the required egocentric transformation increases the mental rotation speed when compared to incongruent stimuli (van Elk et al., 2014).
- To gain further insight into the processes underlying this interaction, the present study investigated the role of attention on the influence of passive self-motion on egocentric mental rotation performance.
- Three experiments were conducted where subjects had to perform egocentric mental rotations while being passively rotated. The experiments differed in the amount of attention that subjects were required to place on the physical rotation stimulus.

Methods

Egocentric Mental Rotation Stimuli

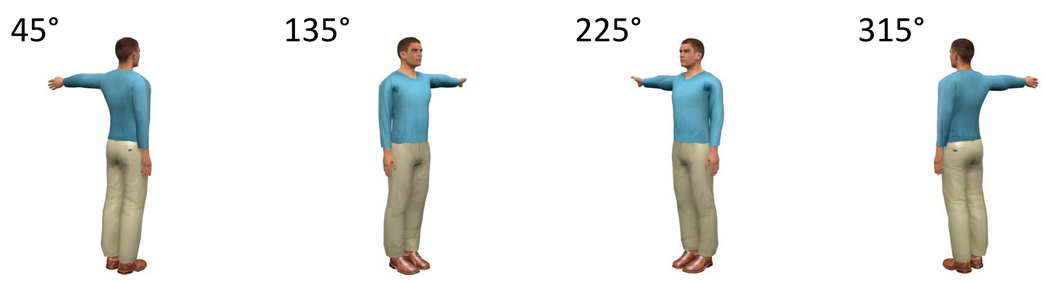


Fig. 1: Example Stimuli for the mental rotation task. Participants had to indicate which hand was outstretched. For the first and second stimulus, the correct answer was left, for the third and fourth stimulus, the correct answer was right. Stimuli were presented for 1 s.

Physical Rotation Stimuli

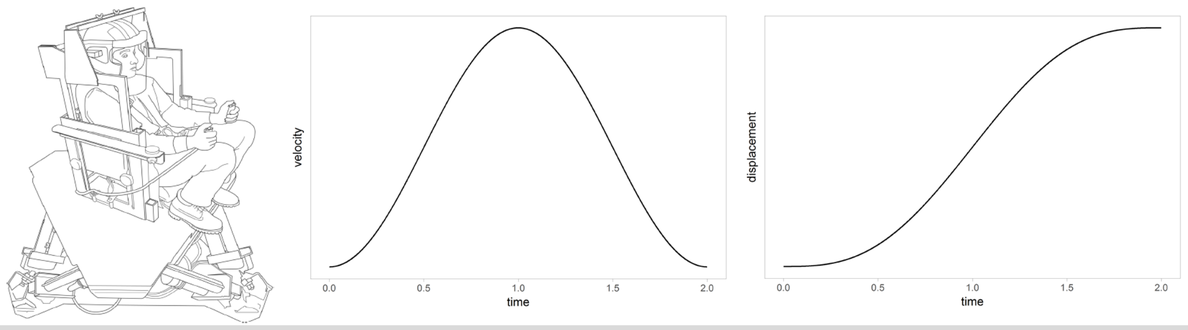
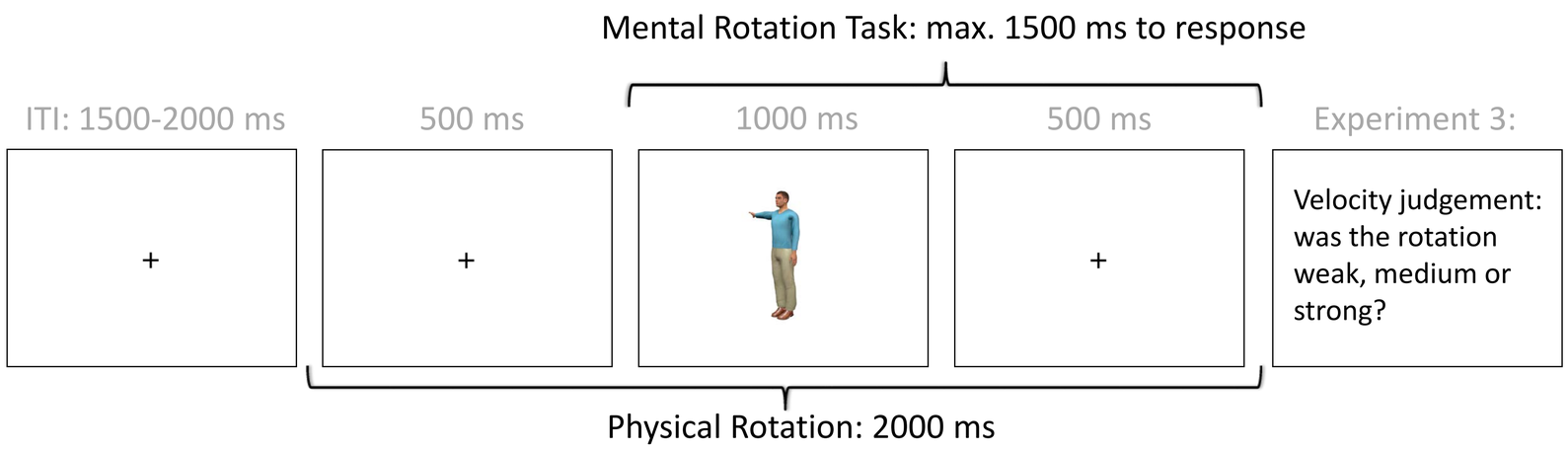


Fig. 2: Single cycle acceleration yaw rotations with a frequency of 2 Hz were presented on a Moog motion platform with a peak velocity of 15°/s (Exp 1 & 2) or with peak velocities of 11, 13 or 15°/s (Exp 3) either to the left or to the right. The total displacement was equal to the peak velocity (i.e. 15° for 15°/s).

Experimental Procedure



Exp 1: Leftward and Rightward rotations were presented in seperate blocks in order to be predictable for subjects.

Exp 2: Leftward and Rightward rotations were presented interleaved so they were not predictable for subjects.

Exp 3: Leftward and Rightward rotations were presented interleaved at three different velocities. Subjects had to judge the velocity (weak, medium or strong) after having performed the Mental Rotation Task.

Fig. 3: Illustration of the Experimental Design. Subjects were seated on a Moog Motion Platform wearing a Head Mounted Display. Mental rotation stimuli were displayed 500 ms after onset of the physical rotation stimulus and shown for 1000 ms. Subjects had 1500 ms to respond. The response was followed by an inter trial interval of 1500-2000 ms in Experiments 1 and 2. In Experiment 3, subjects had to judge the velocity of the rotation first. Subjects were only required to attend to the physical rotation in Experiment 3.

Results

- There was no difference in reaction times for congruency in Experiment 1 (b = 2.1 ms, 95% Credible Interval (95%CrI) = [-7.74; 12.13]).
- There was also no difference in reaction times for congruency in Experiment 2 (b = 4.23 ms, 95%CrI = [-6.36; 19.79]).
- However, in Experiment 3 reaction times were increased for the incongruent condition compared to the congruent condition (b = 24.96 ms, 95%CrI = [0.03; 50.09]).
- Overall, reaction times were the longer in Experiment 3 (M = 978.07 ms, 95%CrI = [965.06; 990.85]), than in Experiment 2 (M = 806.31 ms, 95%CrI = [798.49; 814.08]) and Experiment 1 (M = 761.69, 95%CrI = [752.69; 770.58]).

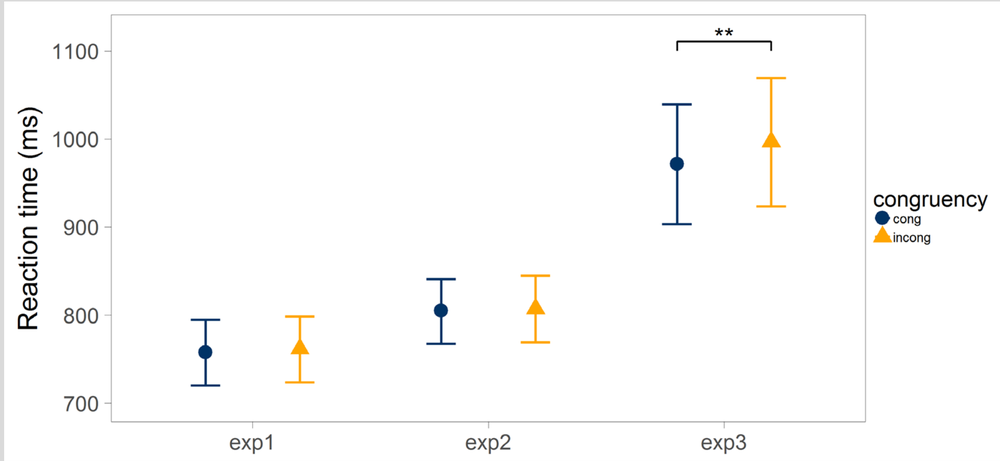


Fig. 4: Posterior estimates and 95%CrI for the Generalized Linear Mixed Model predicting the mean reaction time as a function of congruency for all three experiments. Reaction times differed between congruent and incongruent only in Experiment 3.

Discussion

- Reaction times in an egocentric mental rotation task were increased when simultaneous physical rotation stimuli were incongruent to the direction of imagined self-motion, but only when subjects were required to attend to the physical rotation stimulus (Experiment 3).
- The increased reaction times in Experiment 3 indicate an overall decreased mental rotation speed when subjects additionally attended to the physical rotation stimulus.
- When subjects were not required to attend to the physical rotation stimulus (Experiments 1 & 2), there was no difference between the congruent and incongruent condition.
- Vestibular information influenced spatial perspective taking, but only when the passive self-motion stimulus had to be processed consciously.

References:
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