Obstacles to mental imagery: How bodily constraints affect apparent motion perception of human body parts. A proposed experiment.

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1. Background and Aim of the Study

- The implicit knowledge of bodily biomechanical constraints (BC) and the physical notion of impenetrability of two solid objects (OI) are important not only for movement planning, monitoring and execution but also for the perception of others' movements. For instance, this happens during the perceptual completion of an actor's movements starting from two static photographs flashed in temporally defined successions and varying only in the position of one of the actor's body parts [1].

- However, a number of behavioral [1][2] and neuroimaging studies [3] showed that this is only the case when the central nervous system is given enough time to allow top-down influences (TDs) to occur, i.e. at a *slow flash-rate* between the two depicted limb postures. When the same photographs are flashed with a relatively *fast flash-rate*, perceived apparent motion paths are not modulated by either BC or OI.

Fig 1. A sample stimulus pair that normally produces an apparent motion perception of the hand rotating around the wrist. The arrow **"L"** indicates a plausible movement trajectory while the arrow **"K"** indicates a non-plausible movement trajectory.

- The **aim of the present study** is twofold. First, to characterize the nature of these TDs, i.e. whether they rely on visual or somatosensory representations of plausible movement trajectories. Furthermore, the proposed experiment introduces an innovative method to investigate, on an implicit level, the integrity of an observer's body representation in clinical samples. Indeed, given the results discussed below obtained recruiting 20 healthy subjects, in the next months the experiment will be tested on ***20 transradial-hand amputees*** and 40 able-bodied subjects.

2. Materials and Methods

❑ 20 Healthy subjects

- Male: 9; Female: 11;
- Mean age: 25.5 ±7 years;
- Right-handed

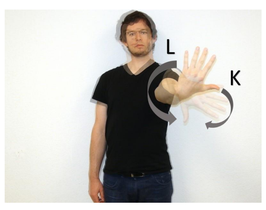
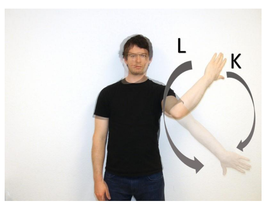
were asked whether they perceived short direct paths (K) or long, biologically feasible (L) paths.

❑ 2 separate experimental sessions (1st and 3rd perspective) x 3 different constraint conditions in a pseudorandomized order.

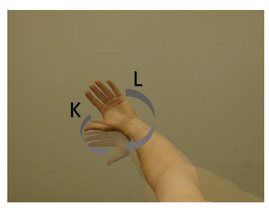
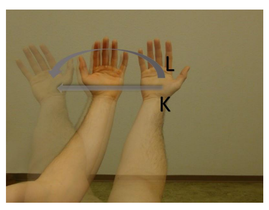
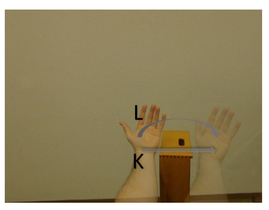
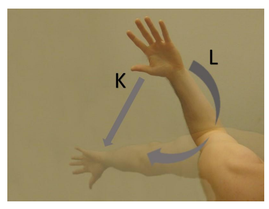
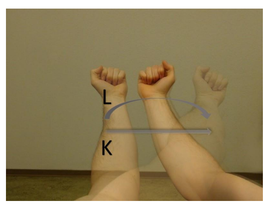
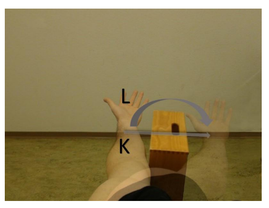
❑ Randomized presentation of stimulus pairs at differing flash-rates, ranged from 50ms to 1350ms in increments of 100ms.

→ 14 flash-rates x 2 moving body parts (below the wrist/below the elbow) x 2 sides (left/right).

3rd PERSPECTIVE

Joint Constraint	*Bodily Constraint*	*Object Constraint*
		
		

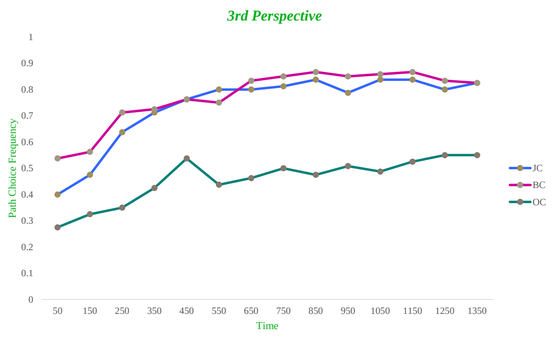
1st PERSPECTIVE

Joint Constraint	*Bodily Constraint*	*Object Constraint*
		
		

3. Statistical Analyses and Results

Non parametric regression

✓ Predictor: 14 Flash-rates
✓ Criteria: Path choice (0 = K; 1 = L)



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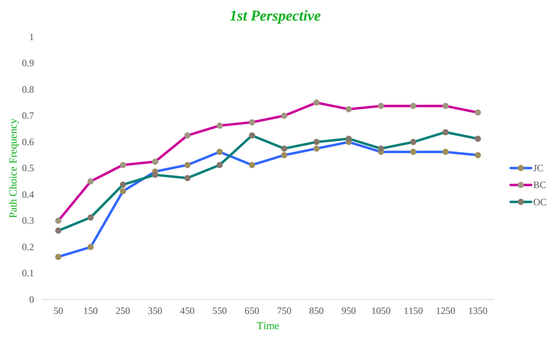
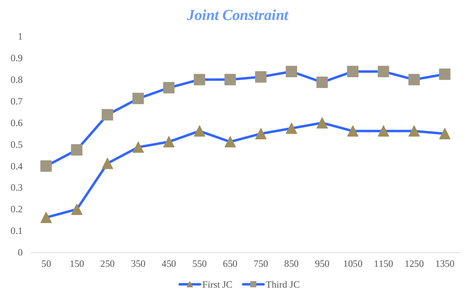


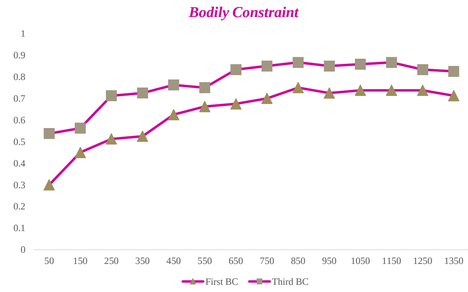
p < 0.001

Wilcoxon Test

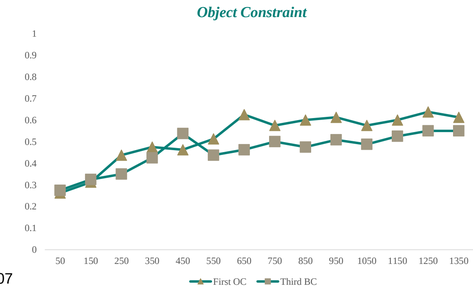
✓ Comparison of the 3 conditions (1st Vs 3rd perspective)



p < 0.001



p < 0.001



p < 0.007

5. Discussion and future directions

❖ Actor's movements were observed from a 1st person (egocentric) perspective which is thought to trigger motoric simulation of the actor's movements and from a 3rd person (allocentric) point of view associated with encoding processes in the observer's visual system. We found the timing at which TDs occur to significantly differ between 1st and 3rd perspective. These view-dependent effects speak against the notion that TDs would rely on visual motion information. Apparently, a crossmodal activation of limb sensorimotor and visual representations is exclusively triggered by a 1st person perspective, which speaks for a crucial role of sensorimotor representations in the visual perception of body-related apparent motion.

❖ We predict that amputees show more variable apparent motion perception patterns, and that this is specific to whether the stimulus is consistent with the side of amputation and with a 1st person perspective. Importantly, performances will be analysed as a function of the observer's phantom limb sensations (painful VS not painful), of the eventual presence of the ***"obstacle shunning"*** (the tendency of a phantom limb to disappear once its phenomenal space is invaded by a solid physical object), and of the use of prosthesis.

❖ We will adopt an interdisciplinary approach combining behavioural, gaze, and superficial electromyography measures in order to better characterize the neurocognitive effects of amputation.

6. References

[1] Shiffrar, M., & Freyd, J. J. (1990). Apparent motion of the human body. *Psychological Science, 1*(4), 257-264. [2] Vannuscorps, G., & Caramazza, A. (2016). The origin of the biomechanical bias in apparent body movement perception. *Neuropsychologia*, In Press. [3| Stevens, J. A., Fonlupt, P., Shiffrar, M., & Decety, J. (2000). New aspects of motion perception: selective neural encoding of apparent human movements. Neuroreport, 11(1), 109-115.