Does interlimb transfer of sensori-motor adaptation depend on visual feedback?

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Introduction

Humans can adapt their reaching behavior to various perturbations such as prismatic deviations, visuomotor rotations or velocity force fields. However, it is unclear whether/why adaptation generalizes to the non-exposed limb.

Here we hypothesized that **generalization may depend on the visual context.** Indeed, interlimb transfer has been observed without vision of the limb or even with an indirect visual feedback of the limb (e.g., a cursor) [1, 2] while no transfer has been found with vision [3, 4]. The underlying processes may rely on **credit assignment issues**, i.e. the source of errors [5].

We thus expected that, **without visual feedback** but not with visual feedback, **after-effects may be found on the non-exposed left hand (LH)** after adapting with the right hand (RH) to a velocity-dependant force field created by a rotating platform. We suggested that the absence of vision of the hand trajectory may enhance the association of the trajectory errors to external causes.

Hypothesized relationship between visual context, credit assignment and generalization

Vision	No Vision
Vision ⮟ Deviations associated to **internal cause** ⮟ Adaptation is effector dependent	No Vision ⮟ Deviations associated to **external causes** ⮟ Interlimb transfer

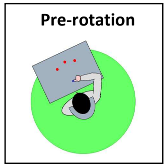
Methods

Two groups of young, right handed adults had to reach to flashed targets on a rotating platform:

- **Group with full vision**
  N=10, 5 males 5 females;
  mean age : 24,6 years
- **Group without vision** (in darkness)
  N=10, 5 males 5 females;
  mean age : 23,3 years

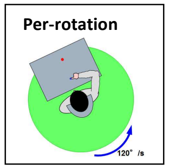
Experimental Conditions

Pre-rotation



1- Right-Hand
2- Left Hand
(30 trials each)

Per-rotation

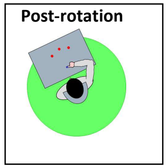


3 - Right-Hand
(100 trials to a single target)

+ **6 -Questionnaire**

(Relative to credit assignment)

Post-rotation

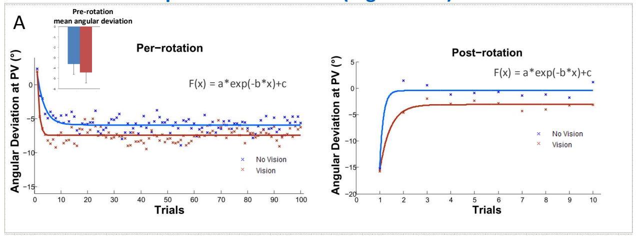


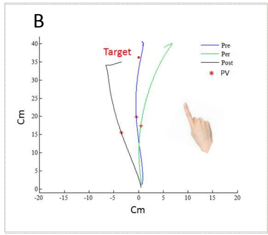
4- Left Hand
5- Right-Hand
(30 trials each)

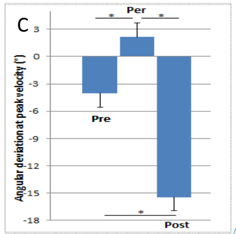
Assessment of the adaptation and transfer via the analysis of the **angular deviation at peak velocity** as the **Coriolis force** is proportional to the arm velocity.

Results

1- Adaptation assessment (Right Hand)



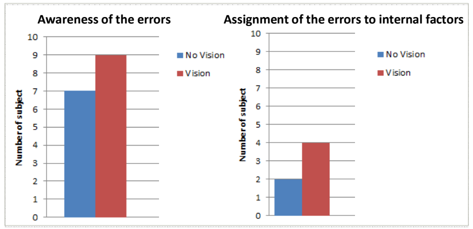




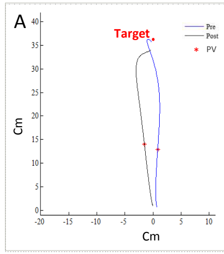
Reaching direction of the RH in each rotation phase

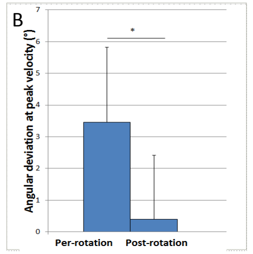
A) Evolution of the initial direction of reaching movements in both groups in Per- and Post-rotation phases.
B) Top view of trajectories for one subject (S5, No vision group): a representative trial in the Pre- and first trial in the Per- and Post-rotation phase.
C) Mean initial direction (at peak velocity) differed in Pre- (all trials), Per- (first trial) and Post- (first trial) rotation phase (p<.001). There was no significant effect of Group and no significant interaction.

3- Credit assignment of the errors early in the Per



2- Interlimb transfer assessment (Left Hand)





Reaching direction of the LH in Pre- and Post-rotation phases

A) Top view of trajectories of the LH for one subject (same as in Fig. 1): a representative trial in the pre- and the first trial of the post-rotation phase.
B) Mean initial direction (at peak velocity) of the LH differed between pre- and post-rotation phase (p<.05). There was no significant effect of Group and no significant interaction.

Discussion

Results showed that, in both groups, initial movement direction of the LH differed between pre- and post-rotation, indicating a significant (although limited) transfer from the RH to the LH.

In both groups there was a significant shift of the initial direction of the RH between pre- and post-rotation. This indicates that the RH adapted but there was little or no transfer at all from the LH to the RH in post-rotation.

While almost all subjects assigned their errors to external factors (i.e., the rotation), more subjects without vision assigned their errors to internal factors than subjects with vision. However vision did not seem to influence the generalization of sensorimotor adaptation. We are currently analysing further the adaptation process, for multiple kinematic parameters, as it may influence the amount of interlimb transfer, which was quite variable from subject to subject.

References

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