How dependent are the update of control and prediction during adaptation to visuomotor rotation?

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Perception and Action in Complex Environments

INTRODUCTION

- **Prediction** turns motor commands into expected sensory consequences[1].
- **Control** turns desired consequences into motor commands.
- People can learn to predict the consequences of their actions before they can learn to control their actions [2].
- Update of prediction is faster than update of control [2].

Learning to predict → ? → Learning to control

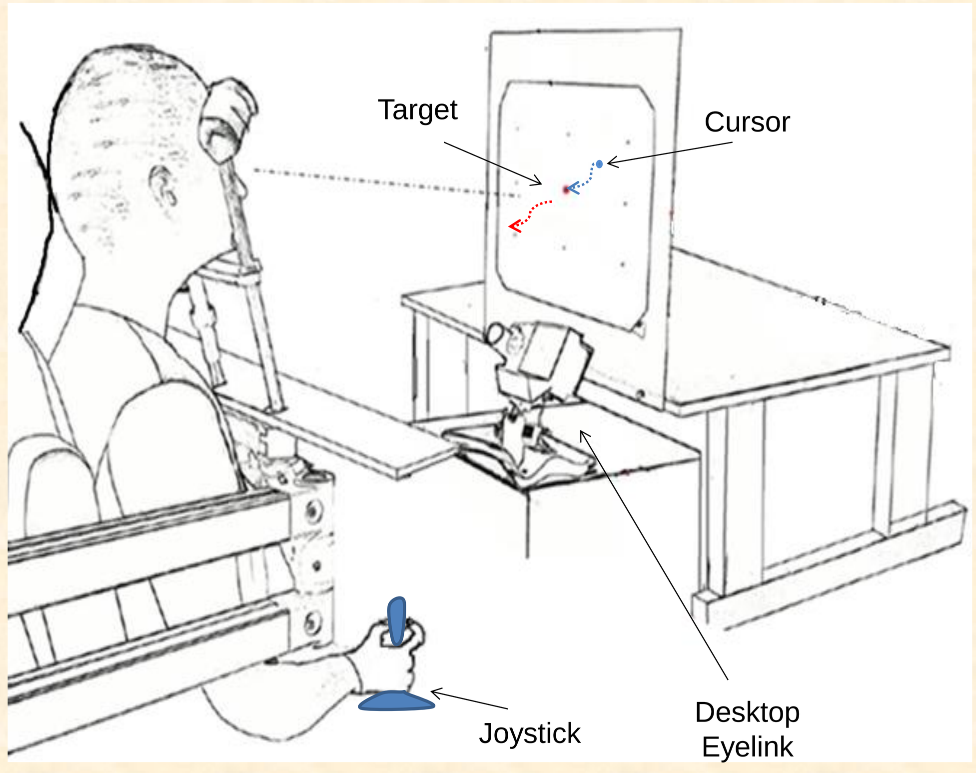
Learning to control → ? → Learning to predict

- ***GOAL : to explore how the update of prediction might influence the update of control, and vice versa.***
- ***HOW : by investigating the transfer of learning between two visuomotor tasks both requiring adaptation to a 90° rotation.***

METHOD

- Two groups of 7 participants (mean age = 29.5, all right handed)

EXPERIMENTAL SETUP



PREDICTION TASK

- This task was used to probe the ability of participants to predict visual consequences arising from their hand actions
- Participants had to track with their eyes a self-moved cursor whose displacement was driven by a joystick [3].

CONTROL TASK

- This task was used to probe the ability to move a cursor with the hand along a specified 2D trajectory, which resulted from the combination of several sinusoids [4].
- Participants had to move the joystick so as to bring the cursor as close as possible from the moving target [5].

UPDATE in PREDICTION and CONTROL

- For both tasks, we introduced a 90° counter-clockwise visuomotor rotation altering the mapping between hand movements and their visual consequences on the screen (i.e. cursor motion).

EXPERIMENTAL DESIGN

Group 1

Predict 0° 10 trials (PRE)	Control 0° 10 trials (PRE)	Predict 90° 40 trials (learning)	Control 90° 40 trials (learning)	Control 0° 1 trial (POST)	Predict 0° 1 trial (POST)

=?

Group 2

Control 0° 10 trials (PRE)	Predict 0° 10 trials (PRE)	Control 90° 40 trials (learning)	Predict 90° 40 trials (learning)	Predict 0° 1 trial (POST)	Control 0° 1 trial (POST)

Transfer is assessed through the group comparison

RESULTS

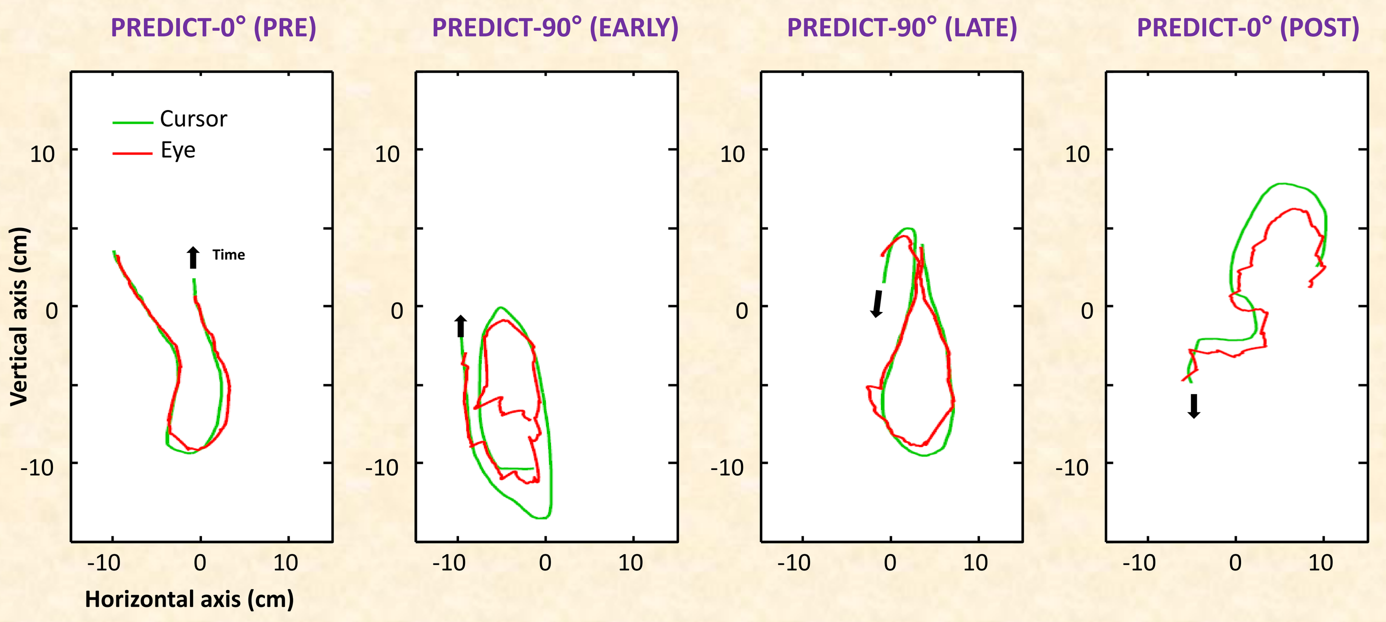


Fig. 1: Typical PREDICT trials from the same subject at various stages (only 2.5 sec are displayed out of 10s). Initial eye tracking is altered by the 90°rotation, but then improves across trials. Note also the after-effect.

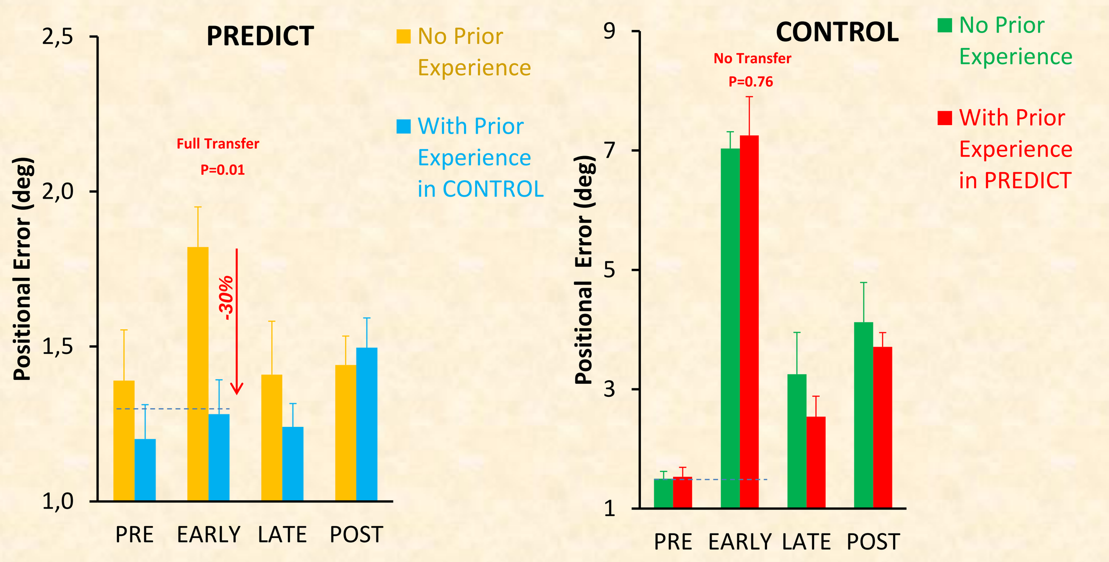


Fig. 3: Positional error between eye and cursor in PREDICT and between cursor and target in CONTROL. Prior experience strongly reduced positional error in PREDICT, but not in CONTROL.

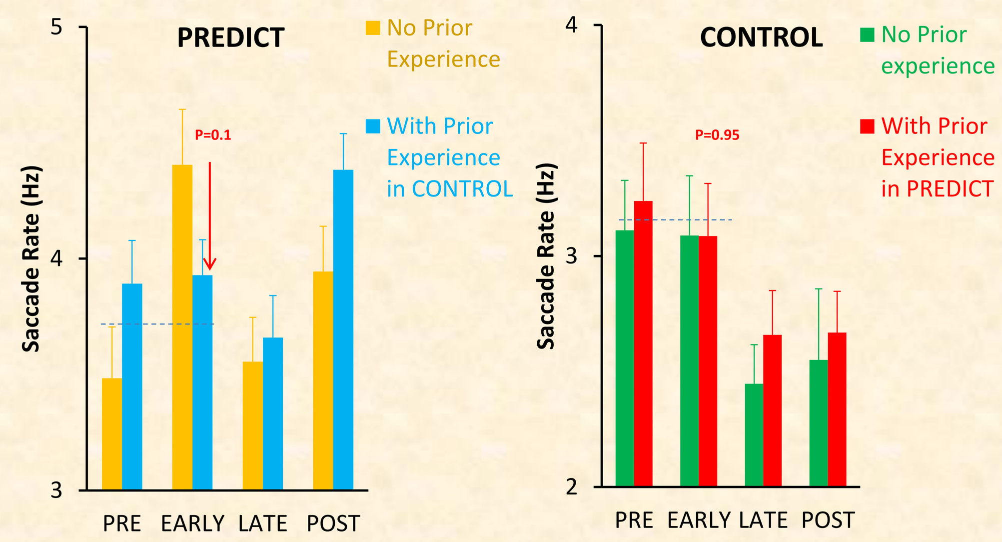


Fig. 5: Saccade rate during PREDICT and CONTROL tasks. Prior experience helped to somewhat reduce the saccade rate in PREDICT but not at all in CONTROL.

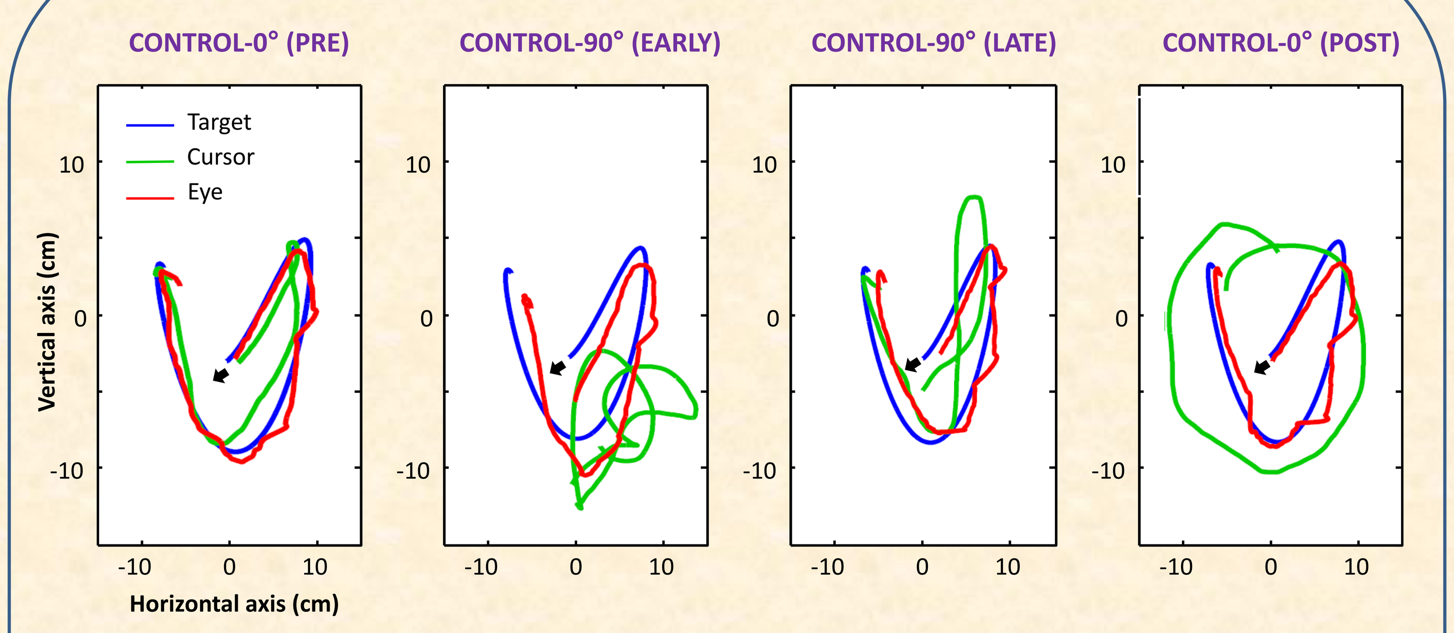


Fig. 2: Typical CONTROL trials from the same subject at various stages of the experiment (only 2.5 sec are displayed out of 10s). Initial hand tracking is altered by the 90°rotation, but then improves across trials. Note also the after-effect.

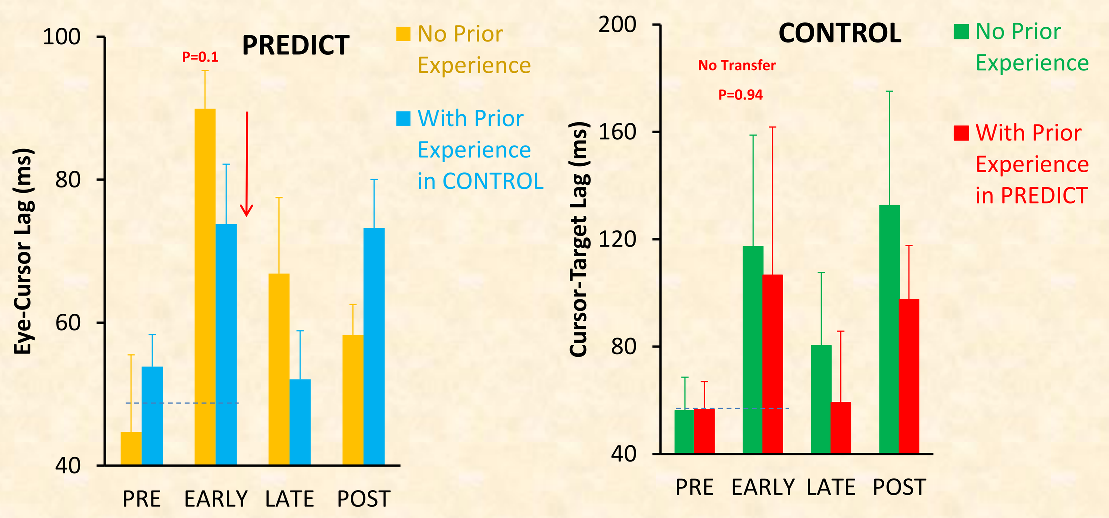


Fig. 4: Temporal lag between eye and cursor in PREDICT and between cursor and target in CONTROL. Prior experience tends to reduce the temporal lag in PREDICT, but not in CONTROL.

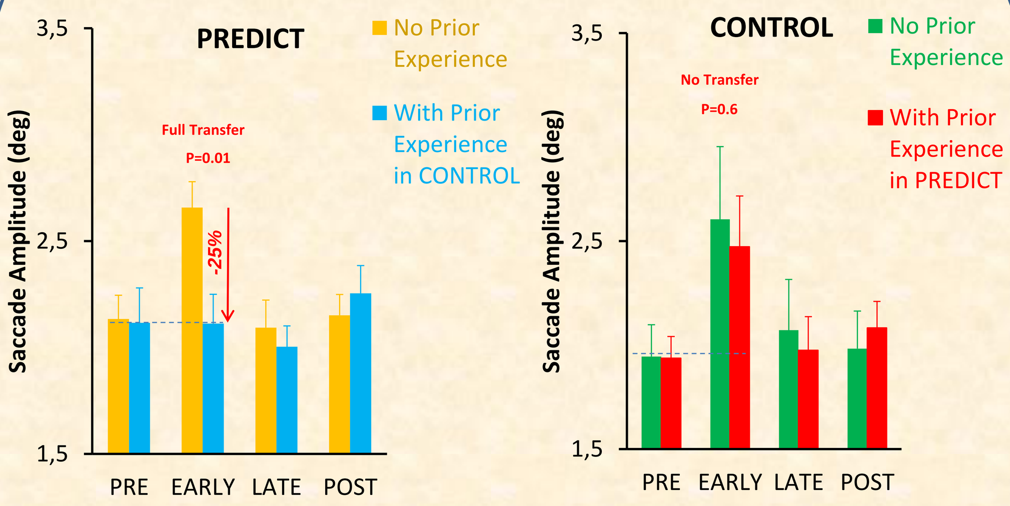


Fig. 6: Saccade amplitude during PREDICT and CONTROL tasks. Prior experience helped to strongly reduce the amplitude of saccade PREDICT, but not in CONTROL.

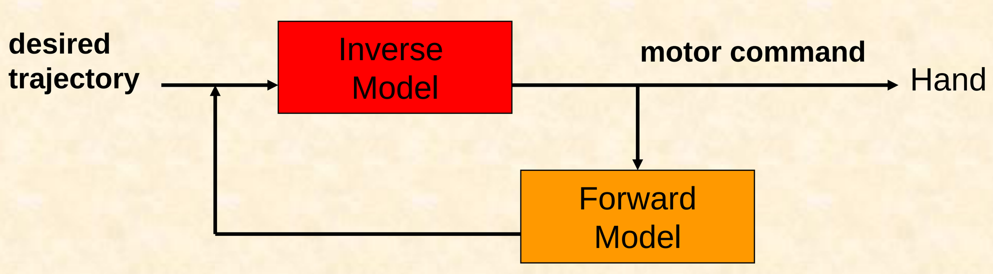
CONCLUSION

Preliminary results suggest the existence of an **asymmetrical transfer** such that prior experience in the CONTROL task benefited to performance in the PREDICT task, but not the other way around.

Group 2: Learning to control → + Learning to predict

Group 1: Learning to predict → X Learning to control

✓ A possible scheme to account for these results is that visuomotor adaptation in our CONTROL task requires both the update of a forward and an inverse model [6], whereas adaptation in our PREDICT task relies solely on the update of a forward model.



✓ At a more general level these results emphasize that our ability to predict movement consequences can be improved without necessarily improving our ability to control movement.

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