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

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Skilled motor behaviour relies on the brain learning both to control the body and predict the consequences of this control (Flanagan et al., 2003). Prediction turns motor commands into expected sensory consequences, whereas control turns desired consequences into motor commands. Using a single task requiring to hold and transport an object with unusual dynamics, Flanagan and colleagues (2003) have shown that subjects can learn to predict adequately the load force resulting from their hand motion before they can actually learn to control adequately hand trajectory. This observation was interpreted as evidence that the update of prediction precedes control in motor learning. Here, using two separate tasks, we explored in more detail how the update of prediction might influence the update of control, and vice versa. To achieve this goal we investigated the transfer of learning between two visuomotor tasks both requiring adaptation to a 90° rotation. In the first task subjects had to track with their eyes a self-moved target whose displacement was driven by random hand motion (see also Landelle et al., 2016). In the other task subjects had also to move the hand but this time they were required to move a cursor so as to track an externally moving target (see also Ogawa & Imamizu, 2013). The first task was designed to test the ability of subjects to predict novel visual consequences arising from their hand actions (PREDICT task). The second task was designed to monitor their ability to control a cursor along the desired direction (CONTROL task). In a pilot study two groups of 6 participants were tested. The first group performed one block of 40 trials in the PREDICT task followed by another block of 40 trials in the CONTROL task. The second group performed these two blocks but in the opposite order. Based on a comparison between groups, our preliminary results suggest an asymmetrical transfer of learning between the two tasks. Namely although prior experience in the CONTROL task enhanced performance in the PREDICT task, prior experience in the PREDICT task did not improve performance in the CONTROL task. Based on these observations we conclude that 1) the update of prediction seems mandatory when updating control, and 2) the update of prediction can be performed in isolation. A possible scheme to account for these results is that visuomotor adaptation in our CONTROL task requires both the update of a forward and inverse model (Wolpert & Kawato, 1998), 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 the need to improve our ability to control movement.

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