When mentally simulated action interferes with motor control processes during a hand laterality discrimination task

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Introduction: The use of implicit motor imagery during visual shape discrimination was revealed by recent studies (Parsons & Fox, 1998; Tucker & Ellis, 1999). Imagined and executed actions share the same neural substrate (Decety, 1996). Then, the mental simulation of a hand movement used during a shape laterality discrimination task should be more difficult to execute when this hand is engaged in a motor task. To test this hypothesis, we experimentally varied the hemisphere activated by the motor control of the manual response.

Method: Forty nine young women volunteered to participate. Displayed items represented left and right hands that were vertical or rotated (Fig. 1). The task consisted in clicking on left or right mouse down whether the item displayed on the computer screen was a left or a right hand. Each hands items were randomly displayed in each visual hemifields for 125 ms. Before each trial, subject was instructed to hold the mouse either with her right hand or with her left hand. Reaction time and accuracy were recorded for each subject.

Fig. 1. The rotation angles of right and left hands items.

Hypotheses: 1) Performances should vary with the hands items rotation angle; 2) The subject should mentally simulate the rotation permitting her own hand to be in the same position as the displayed hand item. Consequently, the biomechanical difficulty characterising the mentally simulated hand movement should influence the performances. More precisely, it would be quicker to execute a -135° right hand rotation than a 135° one, and conversely when executing a left hand rotation; 3) The covert simulation of the hand rotation should be more difficult to execute while this same hand is clicking on the mouse.

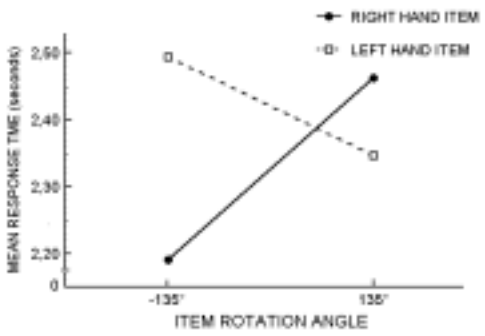

Fig. 2. Hand item and rotation angle interaction.

Fig. 3. Hand item and manual response interaction.

Results: 1)The hand item rotation angle had a significant effect on the response time (Fs(4, 192)=13.81, ps < .00001) and on the number of correct responses (Fs(4, 192)=9.50, ps < .00001): the greater the rotation angle, the longer the response time and the smaller the number of correct responses. 2)After a left-hand item display, RTs (Fig.2) were longer when the item was -135° rotated than when it was 135° rotated and conversely (Fs(1, 48)= 4.50, ps < .039). 3)After a right-hand item display, participants gave less correct responses (Fig.3) when they used their right hand to click on the mouse rather than their left hand and conversely (Fs(1, 48)=4.48, ps < .039).

Discussion: The performances varied with the item angle *:* thus, participants resorted to some mental rotation process. Hypothesis 2 was confirmed : the awkwarder the mentally simulated hand movement, the longer the response time. This result suggests that the mental rotation process used by subjects corresponded to the mental simulation of the movement permitting to place her own hand in the same position than the displayed. This results seems to fit mirror neurons theory (Rizzolatti & Arbib, 1998). The participants produced worse performances when both motor response and covert movement concerned the same hand. This suggests that the cerebral activations correlated with the hand rotation mental simulation were principally contralateral and interfered with the manual motor control processes that simultaneously occurred in the same hemisphere.

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