Implicit Coding of Observed Kinematics: the Case of Lifting Object with Different Weights.

NEUROLAB

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Introduction

It is assumed that action observation elicits the motor representation that is evoked during execution of the same action on the basis of data indicating the sharing of muscle specificity and temporal pattern during both observation and execution tasks (Fadiga et al., 1995; Kilner et al., 2004 ; Borroni et al., 2005 ; Montagna et al., 2005). There is now some indication (Pobric et al., 2006) that force required to execute the action is also coded during observation. What information is used by the observers to code force? Hamilton et al. (2007) reported that kinematics cues could be used to estimate the weight of an object during observation of its lifting. However it is not known if these information is sufficient or if it requires visual cues and if it can be modulated by explicit cognitive cues.

Using single pulse Transcranial Magnetic Stimulation (TMS), we tested the following questions :

- **Is motor cortex facilitation during action observation modulated by the amount of force required to accomplish the action even when no explicit visual weight-related cues are present?**
- **Is this modulation influenced by explicit cognitive information?**

Methods

Subjects

- 8 Right handed subjects

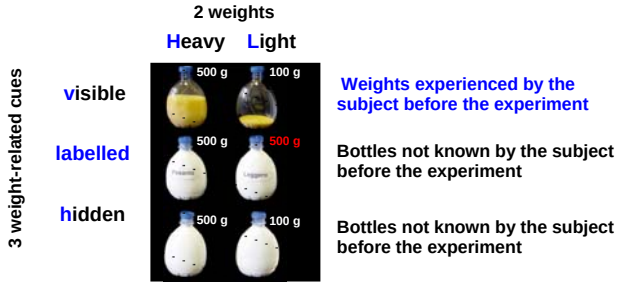
Task

- Observation of a real, natural object-lifting action performed with right hand by a fully visible actor (+ lift-related sound detection task)

Initial position | Grasping phase | Lifting Phase

Experimental design

- Six target bottles : 2 weights x 3 weight-related cues



Weights experienced by the subject before the experiment

Bottles not known by the subject before the experiment

Bottles not known by the subject before the experiment

- Ten presentations for each bottle (random order)
- Subject's eyes closed during inter-trial time

Stimulation & Recordings

- Single pulse TMS during the lifting phase (203 ± 90 ms after finger-bottle contact)
  - 7 cm diameter figure of 8 coil
  - Location: FDI representation in primary motor cortex
  - Orientation : 45° backward and leftward
  - Intensity : 120% motor threshold
- MEPs recording from FDI (First Dorsal Interrosseus)
  - 2 mm Ag-AgCl surface electrodes (tendon-belly bipolar disposition).
- Thumb and index kinematics recording (Minibird 800; Polhemus)

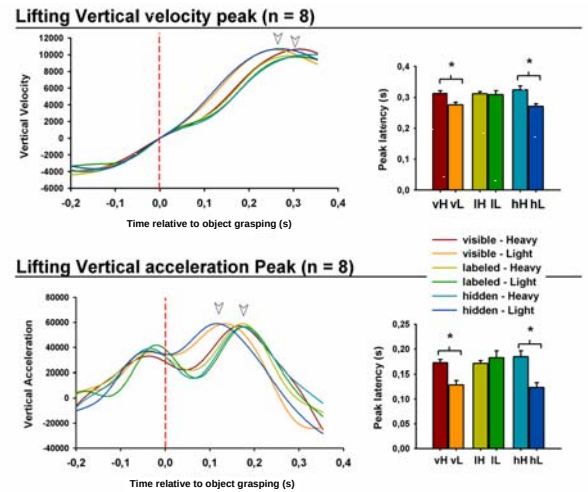
Results

Subjective reports

- All subjects were aware of only 5 bottles (2 visible, 2 labelled, 1 hidden)
- No consistent reports about hidden bottles weight
- No consistent reports about labelled bottles weight

Subjects were not aware of the real weight of "hidden" and "labelled" bottles.

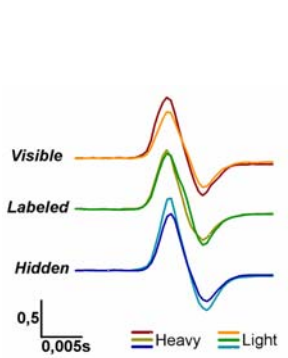
Kinematics analysis



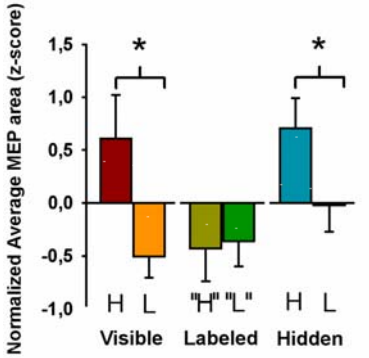
Weight-related kinematics cues are present in the movement of the actor : Velocity and acceleration peak latency occurs earlier (40-50 ms) when a light object is lifted.

MEPs analysis

- MEPs area computed over 21 -36 ms after TMS pulse
- Checking for small EMG background / MEP area ratio
- MEP area normalization (z-score) for grand average



Single subject's MEPs



Grand average (N=8) of normalized MEP area (: p<0,05 ; Wilcoxon signed rank test)*

When visual weight-related cues are fully available (Visible condition) observers' MEPs amplitude is modulated according to the weight of the objects.

This modulation is present also when visual weight-related cues are not available (Hidden condition).
In this condition, however, subjects were not able to explicitly report any weight difference between the two hidden bottles. Consequently, MEPs modulation should result from an implicit processing of weight information given by the kinematics of the movement.

When visual weight-related cues are not available and the kinematics of the movement is the same (two heavy objects), observers' MEPs amplitude is not modulated by the cognitive information (Labelled condition) and, moreover, it is not congruent with the kinematics of the movement: Force coding is abolished when incongruent (kinematics vs cognitive) information is present.

Conclusions

Our results show that, in the observer, the corticospinal system implicitly processes the difference in kinematics present during the lifting of objects of different weight.

The presence of conflicting cognitive and kinematics information seems to abolish this implicit processing of movement kinematics.

Borroni et al. (2005) *Brain research, 1065*, 115-124.
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