Supplementary Material Online

Motor mapping of implied actions during perception of emotional body language

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Supplemental methods:

List of IAPS images used in experiment 1

Positive images:1601, 2000, 2070, 2080, 2091, 2092, 2165, 2311, 2340, 4002, 4220, 4290, 4572, 4608, 4658, 4659, 4660, 4664, 4800, 4810, 5470, 5621, 5626, 5628, 7325, 8032, 8080, 8200, 8280, 8320, 8330, 8370, 8400, 8465, 8490, 8540. Neutral images: 2480, 2570, 2840, 2880, 5390, 5500, 5510, 5532, 5534, 5731, 5740, 5800, 5900, 7000, 7002, 7004, 7006, 7009, 7010, 7025, 7030, 7034, 7035, 7040, 7060, 7090, 7100, 7140, 7150, 7175, 7190, 7205, 7217, 7233, 7235, 7491. Negative images: 2800, 2900, 3051, 3102, 3110, 3261, 3530, 3550, 6230, 6242, 6250, 6260, 6313, 6370, 6540, 6570, 6571, 6821, 9040, 9050, 9253, 9300, 9400, 9405, 9410, 9433, 9490, 9520, 9530, 9570, 9800, 9810, 9910, 9911, 9920, 9921.

Stimuli validation for experiment 2: Pilot studies 1-3

Since the aim of experiment 2 was to test whether perception and categorization of positive and negative emotional body stimuli modulate motor excitability, we decided to test MEPs modulation during perception of happy and fearful body expressions. Fear and joy are among the most studied emotions and few previous imaging studies have suggested that seeing fearful [S1] or happy [S2] bodies may increase activity in M1. Thus, in a preliminary phase of the study three raters selected a sample of 214 images from an initial pool of >1000 stimuli depicting emotional and neutral body expressions. Only stimuli that were categorized by at least 2 raters as realistic representations of joy, fear or neural expressions were included in the set. In all the emotional expression and neutral action stimuli, the selected pictures represented a whole-body movement with a clear involvement of upper-limbs (implied motion stimuli). In none of the stimuli the model interacted with objects or other individuals. To then validate the set of body expressions and to select the most representative stimuli, we performed two additional pilot studies. Lastly, a third pilot study was performed on the final set of stimuli to assess the amount of the perceived implied motion.

Pilot study 1: emotional intensity ratings

A first pilot study was conducted to assure that joy and fear were recognized more than other basic emotions such as sadness, disgust, angry and surprise. To this aim, 15 participants (8 men; mean age ± S.D.: 25.3y ± 2.7) were presented with the selected set of 214 emotional and neutral dynamic body expressions and were asked to rate the intensity of each body expression on the following six labels: happy, sad, disgusted, angry, afraid, surprised. Participants used an electronic 9-points Likert scale ranging from 1 (no emotion) to 9 (maximal intensity of the emotion). To avoid building up artificial correlations between the different

judgments, each rating was collected separately during successive presentation of the whole set of stimuli. The order of the different judgments was randomized across subjects. Based on mean intensity ratings we selected a pool of 167 stimuli which included 53 joyful, 56 fearful and 58 neutral expressions. For joyful images inclusion criteria were: i) high ratings in the "happy" scale (mean intensity > 6); ii) low ratings (< 4) in the other emotion scales (afraid, sad, disgusted, angry, surprised); iii) a spread >3 in the "happy" relative to the other emotion scales. For fearful images we used a similar procedure. This procedure ensured that the selected joy or fear stimuli conveyed appropriate and unambiguous basic emotional information. For neutral expressions the inclusion criterion was a low rating (< 3) in all the emotional scales.

Pilot study 2: emotion recognition task

Since the aim of the TMS experiments was to investigate neural correlates of emotional categorization, we conducted a further pilot study to select stimuli that could be well interpreted as positive, negative and neutral body expressions. To this aim, 27 participants (9 men, age: 26.5 y ± 3.5) were presented with the 167 stimuli selected in pilot study 1 and were asked to recognize, for each image, the depicted body expression as static, neutral, fearful or joyful. For each category we selected 13 stimuli with accuracy >75%.

Pilot study 3: implied motion ratings

In the TMS experiment 2 we planned to explore the excitability of the hand motor representation during the observation of stimuli selected in pilot study 1 and 2. Thus, we conducted a third pilot study to ensure that more implied motion was perceived in actors' hands in emotional (joy, fear) and neutral actions stimuli relative to static stimuli. Details are reported in the main text.

Control for baseline manipulation: behavioral control experiment 1 and 2

During baseline subjects held their eyes closed with the instruction to imagine watching a sunset at the beach [S3] while receiving TMS over M1. It was stressed to imagine a static scene, with no humans, animals or moving entities, and not to imagine self body movements (as this may increase motor excitability [S7,S8]). After each baseline block, subjects confirmed to have followed the imagery instructions. This procedure was used to minimize "task unrelated thoughts" [S6,S7] that may greatly vary across subjects and may also include motor imagery or arousing thoughts.

While the content of the imagery task was not arousing (and typically, imaging landscapes is used as emotionally neutral conditions in mood-induction studies [S8,S9]), nonetheless imaging a sunset may be a mild positive experience for some participants. Thus we checked whether the content of the imagery task may have induced some bias in the categorization of positive IAPS or body stimuli. To address the issue, we performed two additional behavioral experiments in which two groups of participants categorized IAPS (8 subjects, 4 men, mean age ± S.D.: 27.5 y ± 2.9) or emotional body stimuli (8 subjects, 4 men, age: 25.5 y ± 1.4) with no preceding imagery task. As shown in Supplementary Table 1, very similar accuracy for positive/joy stimuli (hit) and total number of positive/joy answers (hit + false alarms) were obtained in the TMS and control experiments (all comparisons using non-parametric Mann-Whitney U tests, $p > 0.25$).

These findings speak against the presence of a categorization bias induced by the baseline procedure in experiments 1 and 2.

Supplementary Table 1

	TMS experiment 1			Control behavioral experiment 1		
	Neutral	Positive	Negative	Neutral	Positive	Negative
Accuracy	92% ± 11	85% ± 15	96% ± 5	94% ± 12	82% ± 12	95% ± 6
N of responses	39.4 ± 7.5	32.6 ± 6.8	36.1 ± 1.3	42.4 ± 6.6	31.0 ± 6.6	34.6 ± 2.1

	TMS experiment 2				Control behavioral experiment 2			
	Static	Neutral	Joy	Fear	Static	Neutral	Joy	Fear
Accuracy	97% ± 4	92% ± 7	87% ± 12	92% ± 9	100% ± 1	98% ± 3	91% ± 9	96% ± 5
N of responses	25.7 ± 1.0	28.7 ± 5.7	24.5 ± 4.2	25.1 ± 2.7	25.9 ± 0.4	28.8 ± 3.4	24.4 ± 2.4	25.0 ± 1.4

Supplementary Table 1. Mean ± S.D. of accuracy (hit) and total number of answers (hit and false alarms) in each category of stimuli used in experiment 1 (top, left) and experiment 2 (bottom, left). The right side of the table shows data from the two control behavioral experiments.

Supplemental References

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[S4] Fadiga L, Buccino G, Craighero L, Fogassi L, Gallese V, Pavesi G. Corticospinal excitability is specifically modulated by motor imagery: a magnetic stimulation study. Neuropsychologia 1999;37:147-58.

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[S6] Binder JR, Frost JA, Hammeke TA, Bellgowan PSF, Rao SM, Cox RW. Conceptual processing during the conscious resting state: a functional MRI study. J Cogn Neurosci 1999;11:80-93.

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