Neuroscience Letters 656 (2017) 114–119

Contents lists available at ScienceDirect

Neuroscience Letters

journal homepage: www.elsevier.com/locate/neulet

Research article

Hemispheric asymmetries in the processing of body sides: A study with ambiguous human silhouettes

Daniele Marzoli[a,*], Alessandra Pagliara[a], Giulia Prete[a], Gianluca Malatesta[b], Chiara Lucafò[b], Caterina Padulo[a], Alfredo Brancucci[a], Luca Tommasi[a]

[a] Department of Psychological Sciences, Health and Territory, University of Chieti, Via dei Vestini 29, I-66013, Chieti, Italy
[b] Department of Neurosciences, Imaging and Clinical Sciences, University of Chieti, Via dei Vestini 29, I-66013, Chieti, Italy

HIGHLIGHTS

- Both hemispheres notoriously show a processing advantage for contralateral body parts.
- We tested whether a similar effect is found with ambiguous human silhouettes.
- Stimuli were perceived as right-handed more often when presented to the right visual field.
- Each hemisphere is biased to perceive contralateral hand actions in ambiguous human bodies.

ARTICLE INFO

Article history:
Received 8 February 2017
Received in revised form 23 June 2017
Accepted 15 July 2017
Available online 18 July 2017

Keywords:
Handedness
Human body
Ambiguous figures
Divided visual field paradigm
Lateralised embodiment

ABSTRACT

When required to indicate the perceived orientation of pictures of human silhouettes with ambiguous front/back orientation and handedness, both right- and left-handed participants perceive the figures more frequently as right-handed than as left-handed, which seems to indicate an attentional bias towards the right arm of human bodies. Given that past research exploiting the divided visual field paradigm indicated a processing advantage for contralateral body parts in both hemispheres, we tested whether human silhouettes with ambiguous handedness presented in the right visual field would be interpreted more frequently as right-handed compared with those presented in the left visual field. We confirmed the expected lateralised embodiment of ambiguous human bodies, in line with previous studies showing that right and left limbs are processed faster and/or more accurately when presented in the right and left hemifield, respectively.

1. Introduction

The issue of hemispheric asymmetries in motor representations and embodied cognition (which refers to the involvement of the sensory-motor system in cognitive processes [1]) has received increasing attention in the last decades, and neuroimaging studies indicate that hand action representations are differently lateralised in right- and left-handed individuals not only for execution [e.g.,2–4], but also for observation, imagination, verb reading and tool sound hearing [5–10]. Besides imaging evidence, some clues of lateralised motor representations come from behavioural research, which suggests that body-specific representations [9,10] are involved not only for one's own movements but also for somebody else's movements. For example, we showed that during the imagination of others' actions, right-handed movements were visualised more often by right-handers than by left-handers, and vice versa for left-handed movements [11–14]. However, regardless of participants' handedness, a perceptual and attentional bias towards the right-side of others' body is found in tasks involving mainly visual representations. For example, observers anticipate better the outcomes of right- rather than left-handed movements [15], perceive a larger proportion of ambiguous human silhouettes as performing right- rather than left-limbed movements [16–18], and perceive a point-light walker containing equal motion cues to each

* Corresponding author.
E-mail address: d.marzoli@unich.it (D. Marzoli).

http://dx.doi.org/10.1016/j.neulet.2017.07.027
0304-3940/

side (and thus ambiguous with regard to its lateral direction) more often as right-facing than as left-facing, an interpretation assuming that the right limbs of the walker are in the foreground [19].

As described above, the picture appears rather complex, and further studies should investigate in more detail when the processing of others' body laterality is affected by the observer's sensory-motor system (embodied cognition; e.g., see studies showing that the representation of others' body is biased towards one's own dominant hand in both right- and left-handers [12–14]) and when it is not (disembodied cognition; e.g., see studies showing that both right- and left-handers exhibit a bias towards the right hemibody of others [15–19]). In this regard, a subtle and promising way to investigate hemispheric asymmetries in motor representations is the comparison of bodies and body parts presented in the right visual field (RVF) with those presented in the left visual field (LVF). For example, although point-light walkers do not elicit embodied processing when presented in the center of the visual field (their perceived direction not being affected by observers' handedness [19]), they seem to elicit some kind of embodiment when presented in the lateral visual field [20]. Indeed, rightward-facing point-light walkers are better recognized than leftward-facing walkers in the right visual field, whereas leftward-facing walkers are better recognized than rightward-facing walkers in the left visual field. In order to explain this lateralised facing effect, de Lussanet et al. [20] suggested that, given that both the visual system and the motor-somatosensory system 1) contribute to the perception of body movements, and 2) exhibit a contralateral organization, then the visual perception of body stimuli would benefit if both representations are located in the same hemisphere. In other words, when a point-light walker faces away from the observer's fixation, the side of the visual cortex processing the stimulus matches the side of the sensory-motor cortices processing the hemibody seen in the foreground, which would foster a lateralised embodiment of the observed body.

The study by de Lussanet et al. [20] indicates that each hemisphere contains better visuo-motor (embodied) representations for the contralateral side of the body than for the ipsilateral side, which is in line with other studies using the divided visual field paradigm. Indeed, participants show faster reaction times for right and left hands presented to the ipsilateral hemifield/contralateral hemisphere than for those presented to the contralateral hemifield/ipsilateral hemisphere [21]. Similarly, callosotomy patients judge the laterality of both left- and right-hand stimuli more accurately and faster when the stimulus hands are presented to the ipsilateral hemifield/contralateral hemisphere rather than to the contralateral hemifield/ipsilateral hemisphere (healthy controls show similar results for reaction times and an analogous but not significant trend for accuracy [22]).

Following the line of reasoning of de Lussanet et al. [20], we hypothesised that human silhouettes with ambiguous handedness (because of an ambiguous front/back orientation) presented in the RVF would be interpreted more frequently as right-handed compared with those presented in the LVF. In line with findings on point-light walkers, we expected that flashing a stimulus in one hemifield would activate hemisphere-specific embodied representations (thus biasing perception in favour of the hand controlled by and represented in the contralateral hemisphere) compared with flashing the stimulus in the other hemifield. In order to test our hypothesis, we devised an experiment in which participants were required to indicate the perceived orientation (front or back view) of pictures of ambiguous human silhouettes performing one-handed manual actions presented either to the RVF or to the LVF. Moreover, although the experiment and stimuli were not specifically designed to this purpose, a secondary aim of our study was to test whether the effect of hemifield differed between females and males (see Supplementary material and the associated Data in Brief article [23]).

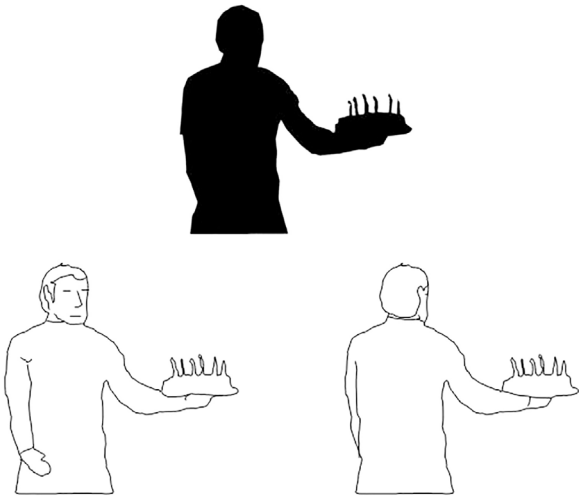

Fig. 1. Top: example of silhouette presented in the experiment. Bottom left: left-handed interpretation (person seen from the front). Bottom right: right-handed interpretation (person seen from the back).

2. Materials and methods

2.1. Participants

One hundred and fifty-three participants (76 females and 77 males) were recruited. All participants had normal or corrected-to-normal vision, and none reported motor-related deficits. Given that 15 participants (2 females and 13 males) who reported awareness or suspicion about the experimental hypotheses or manipulations were excluded, the final sample consisted of 138 participants (74 females and 64 males; age: 19–52).

2.2. Stimuli

We used the same stimuli as in Marzoli et al. [16], consisting of 26 silhouettes of female and male persons performing one-handed manual actions (such as smoking, drinking from a glass/bottle, holding something, waving a flag, and so on) printed in black against a white background, and their mirror images. The original silhouettes (obtained by editing photographs and line drawings taken from the Web) were selected with the constraints that 1) the action was clearly represented on the figure's right or left side (from an observer's perspective) and 2) the figure's orientation (front or back view) was ambiguous (see Fig. 1 for an example). Each original silhouette was mirrored horizontally in order to obtain a right-sided (from the observer's perspective) action (congruent with a right- or left-handed action if perceived as a back- or front-facing figure, respectively) and a left-sided action (congruent with a left- or right-handed action if perceived as a back- or front-facing figure, respectively). Moreover, 26 silhouettes of female and male persons who were not performing one-handed manual actions (e.g., holding objects with both hands or not performing actions; see Fig. 2 for an example) and the respective mirror images were used as catch trials (i.e., trials that were not analysed because the front/back orientation of the figure was associated with neither a right- nor a left-handed action). At a viewing distance of 57 cm, stimuli measured, on average, 6.8° horizontally and 10.7° vertically.