

Body Context and Posture Affect Mental Imagery of Hands

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Abstract

Different visual stimuli have been shown to recruit different mental imagery strategies. However the role of specific visual stimuli properties related to body context and posture in mental imagery is still under debate. Aiming to dissociate the behavioural correlates of mental processing of visual stimuli characterized by different body context, in the present study we investigated whether the mental rotation of stimuli showing either hands as attached to a body (hands-on-body) or not (hands-only), would be based on different mechanisms. We further examined the effects of postural changes on the mental rotation of both stimuli. Thirty healthy volunteers verbally judged the laterality of rotated hands-only and hands-on-body stimuli presented from the dorsum- or the palm-view, while positioning their hands on their knees (front postural condition) or behind their back (back postural condition). Mental rotation of hands-only, but not of hands-on-body, was modulated by the stimulus view and orientation. Additionally, only the hands-only stimuli were mentally rotated at different speeds according to the postural conditions. This indicates that different stimulus-related mechanisms are recruited in mental rotation by changing the bodily context in which a particular body part is presented. The present data suggest that, with respect to hands-only, mental rotation of hands-on-body is less dependent on biomechanical constraints and proprioceptive input. We interpret our results as evidence for preferential processing of visual- rather than kinesthetic-based mechanisms during mental transformation of hands-on-body and hands-only, respectively.

Citation: Ionta S, Perruchoud D, Draganski B, Blanke O (2012) Body Context and Posture Affect Mental Imagery of Hands. PLOS ONE 7(3): e34382. doi:10.1371/journal.pone.0034382

Editor: Ramesh Balasubramanian, McMaster University, Canada

Received: November 24, 2011; **Accepted:** March 1, 2012; **Published:** March 30, 2012

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Funding: This work was supported by the Swiss Federal Institute of Technology Lausanne (EPFL). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

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Introduction

Mental imagery is a cognitive task commonly used in daily life, during which, even in the absence of sensory stimulation, inner mental representations are activated and possibly determine an almost-perceptive experience [1]. A special class of mental imagery is mental rotation - the ability to mentally rotate representations of two- or three-dimensional objects (e.g. shapes, letters, numbers, etc.), or bodily stimuli (e.g. hands, faces, bodies, etc.) (review in 2,3). The investigation of mental rotation of body parts is classically performed by visual presentation of a body part followed by judgments of its laterality [4]. During such mental rotation participants tend to imagine their own body part as moving towards the stimulus [5]. The response times (RTs) required to align a rotated stimulus to the vertical follow a psychophysical profile that is progressively increasing RTs for stimuli presented from 0° to 180° and progressively decreasing RTs for stimuli oriented from 180° to 360° [6]. Moreover, mental rotation of body parts is sensitive to proprioceptive information, leading to longer RTs for judging the laterality of stimuli oriented in anatomically difficult positions [5,7,8]. In addition several studies showed that if participants keep their hands in more awkward postures during mental rotation of hands, their performance is slower with respect to when their hands are kept in more natural postures (e.g. 9). This posture effect is highly

specific because it is present only in the mental rotation of stimuli representing the body segment whose posture is manipulated and not for other body parts, e.g. for hands but not feet [10,11]. The influence of biomechanical constraints and proprioceptive information relative to posture on mental rotation, leads to the idea of an embodied cognitive processing that is classically referred to as motor imagery [12]. The embodied nature of motor imagery is further supported by many studies that adopted different approaches such as neuroimaging (e.g. 13), transcranial magnetic stimulation (e.g. 14), clinical work (e.g. 15,16) and empirical investigation (e.g. 17), and that consistently showed that mental rotation of body parts shares neural mechanisms with movement planning and execution.

Despite the consistent findings on the relationship between stimulus orientation and RTs in the mental rotation of body parts, several studies reported that mental rotation of stimuli representing whole-bodies is less dependent on stimulus orientation, that is the orientation-dependent profile of RTs is less pronounced or even absent for this class of stimuli [18,19,20,21,22,23]. However, similarly to studies investigating mental rotation of hands, even in studies using whole-body stimuli participants are generally asked to judge the lateralization of a particular body part (usually one hand or one arm). In this view, the whole-body stimuli that have been tested in mental rotation studies can be seen as a variant of the hand stimuli, because they still contain only one arm/hand

Body In Context

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