The influence of walking on encoding and sensorimotor alignment effects in spatial updating

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Spatial updating allows people to keep track of the self-to-object relations during movement. It has been suggested that spatial updating is enhanced by the link between allocentric and sensorimotor representations. Previous studies demonstrated that physical movement enhanced this link in remote environments – that is, real environments not perceptually accessible in a given moment, but only remembered – but not in described environments – that is, linguistically described environments never experienced before. However, previous studies considered rotation as physical movement, without examining other movements, such as walking. We investigated how walking affects spatial updating within described environments. Participants were asked to listen to a narrative describing an environment with eight objects inside; at the end of the description, the protagonist was described as turning 90° to the right or to the left (protagonist reorientation). According to the conditions, participants had to imagine the rotation, to physically rotate or to walk, imitating the protagonist's movement. Then, they performed a judgement of relative directions task, requiring to point to an object from an imagined perspective ("imagine facing X, point to Y"), where X and Y were objects described in the narrative. We manipulated both the Action required to participants (Imagine the rotation, rotate, walk conditions) and the Perspective (learning, testing and opposite-to-testing conditions) that is, the perspective that participants had to mentally adopt during the JRD trials. Spatial updating was evaluated in terms of accuracy and response times in different perspectives, and calculating the encoding and sensorimotor alignment effects. The encoding alignment effect refers to the ease of reasoning from a perspective that is aligned with the perspective from which the environment is encoded – that is, the learning perspective; the sensorimotor alignment effect instead refers to the ease of reasoning from a perspective that is aligned with the actual observer's perspective – that is, the testing perspective. We hypothesized a higher contribution of walking on spatial updating compared to both rotation and imagination of rotation. Moreover, we expected a flattening of the gap between encoding and sensorimotor alignment effects in walking condition. Results confirmed our hypotheses. Regarding response times, we found that in imagination of rotation and physical rotation conditions the encoding alignment effect was higher than the sensorimotor alignment effect, while in the walking condition this gap disappeared. Moreover, differently from the other conditions, in the walk condition the gap between performance observed in learning and testing conditions was eliminated. We interpreted these outcomes in terms of enhanced link between allocentric and sensorimotor representations, due to the multisensory pattern of information acquired by walking. Moreover, from methodological point of view, our study indicates that it is imprecise to refer to physical movement when considering only rotation, since we demonstrated that walking and rotation provide different information, which in turn determines different impacts on spatial updating.