

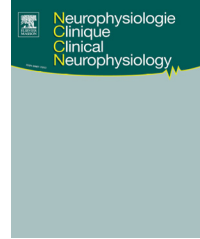


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REVIEW/MISE AU POINT

# Body representations and brain damage



## *Représentations corporelles et lésions cérébrales*

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Spatial representations;  
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**Summary** We review changes in body representation in patients with brain hemisphere damage and discuss their relationship with impaired limb movements in peripersonal space, navigation between objects/obstacles and control of the body's general posture and balance. The egocentric representation of the body's median sagittal axis (considered as the main zone around which movements are anchored) has been studied in most detail. This reference is distorted in patients with spatial neglect and involves a combination of ipsilesional translation and contralesional tilt. There are clear links with the patients' difficulties in egocentric tasks, activities of daily living and postural control. In both healthy subjects and patients, this reference axis can be modulated by somaesthetic, vestibular and visual stimulations; these phenomena have been used in rehabilitation programmes to reduce disease-induced deviations. A few studies have analyzed other lateral body reference (at the shoulders, in particular). These references were found to be more severely affected than the body midline (notably on the contralesional side). The severity of the distortion was related to the presence of lesions that mainly affected the parietal, somatosensory and multimodal association cortex (notably around the intraparietal sulcus) and, to a lesser extent, the middle temporal and frontal dorsolateral premotor cortex. These convergent results suggested that patients (notably those with neglect) have a complex distortion of the body schema and the perceptive representations of the body, that does not simply correspond to poor awareness of the contralateral hemicorpus.

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### MOTS CLÉS

Représentations spatiales ;

**Résumé** Nous avons revu les modifications des représentations corporelles chez les patients avec lésions hémisphériques cérébrales et discuté leurs liens avec l'action des membres dans l'espace péripersonnel, la navigation entre les objets/obstacles et le contrôle de la posture et de l'équilibre. La représentation égocentrée du plan sagittal médian du corps (considérée

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## Schéma corporel ; Négligence spatiale

comme la principale zone d'ancrage de l'action) a été la plus étudiée. Ce plan de référence montrait une distorsion chez les patients avec négligence spatiale, avec l'association d'une translation ipsilésionnelle et d'une inclinaison controlésionnelle. Il y avait des liens clairs avec les difficultés des patients dans les tâches égocentrées, les activités de vie quotidienne et le contrôle postural. Chez les personnes normales et les patients, cette référence était modulable par des stimulations somesthésiques, vestibulaires et visuelles ; ces phénomènes ont été utilisés dans les programmes de rééducation, pour réduire les déviations pathologiques. Quelques études ont analysé d'autres plans de référence latéraux (en particulier aux épaules). Ces plans étaient plus sévèrement affectés que le référentiel médian (notamment du côté controlésionnel). La sévérité des distorsions était liée à des lésions qui affectaient surtout le cortex pariétal, somatosensoriel et associatif polymodal (notamment dans la zone du sillon intrapariétal), et à un degré moindre le cortex temporal moyen et frontal prémoteur dorsolatéral. Ces résultats convergents suggèrent que les patients (notamment négligents) ont une distorsion complexe du schéma corporel et des représentations perceptives du corps, qui ne correspondent pas à une simple méconnaissance de l'hémicorps controlatéral.

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## Introduction

The brain elaborates representations of the body space and extrapersonal space. The possible perturbation of these representations by brain damage has given rise to much debate, and several types of representation have been considered. Humans are thought to elaborate spatial maps that specify the position of the different parts of the body-in space and the relative position of objects. This is so that they can maintain balance, navigate between obstacles and seize and manipulate objects. Although these processes generally occur in a non-conscious, automatic way, they can also be consciously controlled when a difficulty arises. Representations that concern the median part of the body are important, as well as the position of key points associated with arm movements (such as the shoulders). Focal damage to the brain hemispheres has always provided important information on the role of cortical and sub-cortical structures in information processing and on the relationships between disorders (with both association and dissociation), e.g. between the damage to body representations and the impairments observed in clinical or ecological tasks.

Lesions in the right hemisphere (and notably in the temporoparietal and insular zones) have been most extensively studied with respect to spatial and body representations, since the consequences are often very obvious and easily quantified. These lesions are notably associated with spatial neglect, defined as a failure to report, respond or orient toward contralesional stimuli [38]. This multifaceted syndrome includes severe body representation disorders. The corporal part of the syndrome has been known since the early 20th century [2] and, in its most obvious aspects, features neglect of the contralesional body (referred to as hemiasomatognosia) of variable severity. These observations have stoked debate on the mechanisms underlying awareness of the body and has also stimulated interest in the "body schema" concept. However, as we shall see below, the distortions provoked by hemisphere lesions (notably right-side lesions) are much more complex than simply being unaware of a hemicorpus.

## The median body reference

The median axis of the body supposedly has a special role in body references, notably in terms of limb movement within the peripersonal space and posture. The egocentric reference was initially defined as an internal representation of a virtual plane that is superimposed on the body sagittal (which divides the body and the adjacent space into two parts) [41,42]. This plane is considered important for the actions at the upper limbs. This hypothesis is also linked to the fact that the corresponding information (at least in somaesthesia) is treated bilaterally by central systems, with strong connections through the corpus callosum [21]. But within this plane, the body axis (also called the Z-axis) was considered by other authors as the main median body reference. In fact, the body axis would be important for posture.

Many paradigms have been used to study the subjective position of this reference. Most studies have analyzed the subjective straight ahead (SSA), which is the projection from a point in the plane (generally in the trunk midline) towards the space in front. Other studies have evaluated the general orientation of the Z-axis.

## Studies in healthy subjects

In healthy subjects, the SSA is very close to the objective straight ahead and the difference in position is very small under standard evaluation conditions (i.e. in the sitting position). A slight leftward deviation when pointing with the right index in right-handed subjects was described in the earliest studies [11,37,42,51]. The right-handed healthy subjects showed a strong trend to point to the left of the zero position with the right hand [42]. This error was more significant when pointing in dark than when looking at a visual target placed in front of them. With the left hand, the errors were low and variable but there was no systematic leftward deviation. The leftward deviation of pointing has been linked to the leftward deviation in horizontal line

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