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ORIGINAL ARTICLE/ARTICLE ORIGINAL

# Functional neuro-anatomy of egocentric versus allocentric space representation

## *Neuro-anatomie fonctionnelle des représentations des espaces egocentrique versus allocentrique*

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**KEYWORDS**
Egocentric;
Allocentric;
fMRI

**Summary**
*Introduction.* — The functional neuroanatomy of the egocentric and allocentric representations of space remains poorly studied with neuroimaging. Here we aim to determine brain structures subserving two different kinds of spatial representations centred on the main axis of either the body or the external scene.
*Method.* — Sixteen healthy participants evaluated the alignment of a bar relative to the middle of their body (Ego) or relative to another stimulus (Allo) during functional MRI. In a control task (Ctrl), they had to judge the colour of the bar.
*Results.* — Correct response rates and response times were similar in the three tasks. fMRI data revealed a predominant role of the right hemisphere in the egocentric task (Ego vs. Allo): selective activity was found in the occipital, superior parietal, and inferior frontal cortices, as well as in the precuneus and supplementary motor area. On the left side, the insula, thalamus, and cerebellum were also activated. Conversely, the allocentric task (Allo vs. Ctrl) showed selective activity centred on the left temporal gyrus.

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*Discussion*. — This study demonstrates a right hemisphere dominance for representations centred on the longitudinal body axis, but more left-sided activity for scene/object-centred representations of space. These new data shed light on the unique role of several regions involved in spatial perception and help better understand spatial deficits in patients with right hemispheric lesions.


**MOTS CLÉS**
Egocentrique ;
Allocentrique ;
IRMf

**Résumé**
*Introduction*. — La neuroanatomie fonctionnelle des représentations égocentrique et allocentrique de l'espace reste très peu étudiée en neuroimagerie. Ces représentations ont généralement été étudiées séparément, alors que certains travaux suggèrent qu'elles sont liées. L'objectif de ce travail était de déterminer les structures corticales impliquées dans des représentations spatiales centrées sur l'axe principal du corps ou d'une scène.
*Méthode*. — Seize participants sains ont effectué une tâche demandant de juger l'alignement d'une barre avec l'axe de leur corps (Ego) ou avec un autre stimulus (Allo), durant une session d'IRM fonctionnelle. Dans une tâche contrôle (Ctrl), les participants avaient à juger la couleur de la barre.
*Résultats*. — Les taux de bonnes réponses et les temps de réponse étaient similaires dans les trois tâches. Dans la tâche égocentrique (Ego vs. Allo), l'hémisphère droit a montré une activité spécifique, notamment dans les cortex occipital, pariétal supérieur et frontal inférieur, ainsi que dans le précuneus et l'aire motrice supplémentaire. Du côté gauche, l'insula, le thalamus et le cervelet montraient une activité spécifique. La tâche allocentrique (Allo vs. Ctrl) était caractérisée par une activité centrée sur le gyrus temporal gauche.
*Discussion et conclusion*. — Ce travail démontre une dominance de l'hémisphère droit pour les représentations centrées sur l'axe longitudinal du corps. La représentation centrée sur des objets implique davantage l'hémisphère gauche. Ces nouvelles données éclairent l'organisation cérébrale du traitement de l'information spatiale ainsi que les déficits spatiaux survenant après des lésions cérébrales droites.


## Introduction

Our perception of space is based on the integration of signals from vestibular, visual, and somatosensory systems. These signals allow the awareness of the position and displacements of our body and body parts, as well as of the location of objects in extra-personal space. Several reference frames may co-exist to code for these spatial representations, anchored onto different body segments (eg. centred on the head, trunk, or limbs). An egocentric reference is involved when the position of objects is defined relative to the body. An allocentric reference comes into play when objects in the environment are located relative to their spatial configuration within a scene. In this case, their position does not depend on the body.

Beside neuroanatomical studies in stroke patients (see [22], in this issue), a few fMRI studies in healthy volunteers [10,11,28,31] have searched for cortical regions involved in this egocentric process by asking participants to manipulate spatial information in terms of body-centered coordinates. These tasks were more or less directly inspired by the literature on neglect — a common disorder following right hemispheric damage — which is characterized by impaired awareness of space on the contralateral side of the body or sometimes on the contralateral side of objects. In several of these studies [10,11,28], the authors used visual stimuli. For example, the participants had to judge the location of a stimulus relative to their body. They tracked a horizontally moving bar and reported when it intersected their body midline [28]. Other studies used verbal descriptions of spatial relations either with respect to the listener in order to induce an egocentric spatial coding, or without any body-centered relations in order to induce an allocentric coding [31]. However, no study offered a direct comparison of non-verbal allo- and egocentric tasks using the same stimuli. The aim of the present fMRI study was therefore to identify and compare the cortical networks underlying the processing of egocentric and allocentric spatial relations in human. The egocentric task was anchored to the longitudinal axis of the body, a reference largely discussed in the literature devoted to spatial neglect [22,25].

## Methods

### Participants

Sixteen healthy volunteers (mean age: $25.7 \pm 5.8$; 6 males and 10 females) were recruited from the general population and paid for their participation. All participants signed an informed consent according to procedures approved by the local ethical committee. Exclusion criteria were: past history of cerebral disease, epilepsy, head trauma, or major psychiatric illness; visual acuity below 20/40; left handedness; claustrophobia, pregnancy, or contraindication to magnetic field exposure (pacemaker, metallic prosthesis, dental apparatus, etc); addiction or any drugs interfering with neuronal activity or cerebral blood flow.