



Research report

Mislocalization of tactile stimuli applied to the trunk in spatial neglect

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ABSTRACT

Introduction: In patients with spatial neglect, body perception and representation are impaired – especially the projection of the anterior body midline in anterior space (the subjective “straight ahead”). However, data on more lateral body parts and the posterior body surface are scarce. We explored deviations of the perception of different body points located to the left or right of the midline and on the anterior and posterior body surfaces, and their lesion correlates in right hemisphere stroke patients.

Methods: Nine patients with neglect (diagnosed with paper and pencil and behavioural tests) were compared with six non-neglect patients and 13 healthy controls. The subjects had to use a mannequin to designate the body location that had been stimulated by a blunt pencil tip. Four horizontally arranged series of locations were traced on the anterior and posterior body surfaces at shoulder and navel levels. Each horizontal series comprised five equidistant test points, from left to right and corresponded to eleven labelled points on the mannequin. Patient errors were confronted to their anatomic lesions (MRI).

Results: We found a significant ($p \leq .05$) rightward deviation of the left-side points and midpoint and a significant leftward deviation of the right-most point in neglect patients. Non-neglect patients and control subjects designated all the test points accurately. The body side (anterior or posterior) and the line (shoulder or navel) did not influence performance. Controls showed a definite reduction in variability for the midline points, which disappeared in neglect patients who showed a severe global increase of this variability. Errors depended on lesions centred on the intraparietal sulcus.

Conclusions: These observations were compatible with a complex bias in body perception–representation extending to various lateral body points, with a left to right gradient. The right parietal cortex likely participates in processing such information.

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1. Introduction

Body perception and representation play a main role in actions performed within the peripersonal space, which comprises a predominant anterior part, but also of a posterior part (Saj & Vuilleumier, 2007). The position of the body's midline is especially important and is controlled by the relatively symmetrical functioning of the posterior associative cortex involved in processing the multisensory information that arrives in each hemisphere (Jeannerod & Biguer, 1989).

Many researchers have attempted to analyse the medial egocentric reference after unilateral hemisphere damage and factors, which participate in the variability of this reference. In spatial neglect, an ipsilesional deviation occurs when pointing the index finger straight ahead of the body midline [subjective straight ahead (SSA), Heilman, Bowers, & Watson, 1983], and Jeannerod and Biguer (1989) suggested that the neglect signs demonstrated in perceptual-motor tasks and activities of daily living are a consequence of this deviation. Subsequent studies showed that the magnitude of the SSA deviation correlated with the severity of neglect signs, e.g., line bisection error, provided that the body position and visual environment were carefully controlled (Richard, Honoré, Bernati, & Rousseaux, 2004). It has also been suggested that the deviation is much the same for the body's anterior and posterior spaces (Vallar, Guariglia, Nico, & Bisiach, 1995). According to Saj et al. (2006), the SSA would also depend on the body part, with a rostrocaudal gradient. However, these different views have been discussed, especially the association with the other neglect signs (Bartolomeo & Chokron, 1999) and the presence of neglect in the peripersonal backspace (Viaud-Delmon, Brugger, & Landis, 2007).

It is important to bear in mind that the body midline is just one of the anchoring points of actions within the peripersonal space. Key points such as shoulders (from which arm movements originate) may also be important. Indeed, a previous study (Richard, Honoré, & Rousseaux, 2000) reported that neglect patients showed an ipsilesional deviation when pointing ahead of the contralesional shoulder and that the deviation was more severe than that of the body midline.

In neglect patients, several issues about the spatial organisation of body space perception and representations arise. One such question relates to the possible distortion of body space. Such a distortion has been suggested for the visual peripersonal space (Bisiach, Ricci, & Mòdona, 1996). Another question relates to the relative magnitudes of the bias for the anterior and posterior body spaces. Some authors have assumed that ipsilesional translation of the egocentric representation in neglect (Vallar et al., 1995; Richard, Rousseaux, Saj, & Honoré, 2004) would result in similar anterior and posterior deviations, whereas others have proposed that neglect is associated with an ipsilesional rotation of the egocentric reference (Ferber & Karnath, 1999) and thus less severe (or even opposite) errors for the posterior space than for the anterior space. A third question relates to a possible rostrocaudal gradient of the error. Indeed, Saj et al. (2006) required neglect patients to place a movable rod that could be simultaneously translated and rotated in alignment with the longitudinal axis of different body parts, and found more severe lateral deviation when the task was anchored to the

trunk than when anchored to the head. A fourth question relates to the anatomic correlates of such biases. Studies of errors in body centred tasks requiring the use of objects have emphasised the importance of relatively anterior parietal lesions involving the parietal post central gyrus, superior gyrus and supramarginalis gyrus (Committeri et al., 2007). However, there are no available data about relations between biases in body parts estimations and brain lesions.

Here, we addressed these questions by applying a novel experimental protocol evaluating the spatial localisation of tactile stimuli. The stimuli were applied to specific points distributed on horizontal lines located on the anterior and posterior body surfaces and on the upper and lower parts of the trunk. Our first hypothesis suggests an ipsilesional deviation of the estimate of the different body points, the severity of which would be subject to a contralesional–ipsilesional gradient. According to a second hypothesis (the global ipsilesional translation of body point estimates), the deviations for the anterior and posterior body surfaces would be equivalent. Under a third hypothesis (a rostrocaudal gradient in body estimate errors), one would expect the deviation to be more severe for the lower trunk than for the upper trunk.

2. Methods

2.1. Participants

Patients were recruited from the neurological rehabilitation unit at Lille University Hospital (Lille, France) after the acute phase for first-ever right hemisphere stroke (diagnosed by MRI). The study complied with the tenets of the Declaration of Helsinki. Volunteer subjects gave their written informed consent to participation in the study.

We excluded patients with bilateral lesions, those with past or present psychiatric, neurological or severe behavioural disorders and those unable to perceive tactile stimulation on the palm of the affected hand [i.e., sensory subscore of 2/2 on the National Institute of Health Stroke Scale (NIHSS), denoting severe somatosensory disorders]. We systematically explored tactile perception at the trunk level with a standardised procedure (see the section on pre-test procedures below), in order to check that stimulation could be perceived during the test itself. Patients had to be able to sit straight unassisted for the duration of the test (at least 25 min).

Patients were considered as suffering from neglect on the basis of abnormal performance in at least two out of three tests. Two tests investigated peripersonal neglect, line bisection (cut-off: mean deviation >11%; Schenkenberg, Bradford, & Ajax, 1980) and bell cancellation (cut-off: left minus right omissions >2; Gauthier, Dehaut, & Joannette, 1989). The third test explored peripersonal and personal behavioural neglect in activities of daily living [cut-off: >0 out of 30 on the Catherine Bergego (CB) behavioural scale (Azouvi et al., 2003)]. We also administered the Bisiach test of personal neglect (Bisiach, Pizzamiglio, Nico, and Antonucci, 1986) but only one patient showed a subnormal level of performance. Patients were also rated for the motor (arm), sensory and visual field NIHSS subscores (Brott et al., 1989).

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