Correlation between the Position of the Egocentric Reference and Right Neglect Signs in Left-Brain-Damaged Patients

Sylvie Chokron*,† and Paolo Bartolomeo†,§

**Laboratoire de Psychologie Expérimentale, CNRS, ep617, UPMF, Grenoble, France; †Service de Neurologie, Fondation Opthalmologique Rothschild, Paris, France; †Inserm Unit 324, Paris, France; and §Neuroscience Department, Hôpital Henri Mondor, Créteil, France*

Fourteen control subjects and thirty left-brain-damaged (LBD) patients with or without neglect performed a straight-ahead pointing task with their left hand while blindfolded. Results showed a significant correlation between the position of the egocentric reference and the presence of right neglect signs. We discuss here the egocentric hypotheses of spatial bias.

Introduction

Egocentric body coordinates such as the sagittal midline have been proposed to act as a reference for ballistic movements in extracorporeal space (Jeannerod, 1988; Jeannerod & Biguer, 1987; Jeannerod & Biguer, 1989). Jeannerod and co-workers have proposed that in normal conditions, where the sensory inputs (vestibular, somatosensory, visual) which contribute to the activity of the involved brain areas are distributed symmetrically, the egocentric reference is aligned with the body midline and splits personal and extra-personal space in two equal halves (Jeannerod & Biguer, 1987; Jeannerod & Biguer, 1989; Ventre, Flandrin & Jeannerod, 1984). When a unilateral lesion damages one of the neural structures which processes these inputs, the egocentric reference would deviate toward one direction, thus producing a directional bias in spatially oriented behavior. Based on this hypothesis, some authors have recently proposed that the crucial mechanism leading to unilateral spatial neglect is the disturbed transformation of sensory input into a supramodal egocentric frame of reference (ER), causing in turn a deviation towards the side ipsilateral to the brain lesion (Karnath, 1994a; Karnath, 1997; Karnath, 1994b; Vallar, Bottini, Rusconi & Sterzi, 1993; Vallar, Guariglia & Rusconi, 1997). However, recently we collected evidence that the position of the egocentric reference is not a valid way of predicting the presence or absence of left neglect signs (Bartolomeo & Chokron, in press; Chokron & Bartolomeo, 1997; Chokron & Bartolomeo, 1998). Confirming Hasselbach and Butter (1998), we found that the crucial factor determining the ipsilesional midline shift in RBD patients was the presence of an extensive parietal lesion (Chokron & Bartolomeo, in press). Theoretically, the egocentric hypotheses of neglect above mentioned above should account for the presence of both left *and* right neglect signs, but in reality, studies investigating the position of the ER in neglect patients have focused on right-brain-damaged patients, left-brain-damaged patients tested showing no sign of neglect and serving as a control group. Nevertheless, by asking left- as well as right-brain-damaged patients to adjust a luminous line to their subjective visual vertical, subjective horizontal and in relation to an obliquely oriented reference line, Kerkhoff and Zoelch (1998) showed that patients with left-sided as well as those with right-sided neglect showed a significant contraversive tilt of the three spatial orientations in most cases.

The present experiment was thus designed to study the position of the ER in left-brain-damaged patients whether suffering or not from right neglect signs. For this purpose, we asked 30 unselected left-brain-damaged patients to perform a series of visuo-motor tasks to assess the presence of right neglect signs as well as a straight ahead pointing task to record the position of their ER.

Method

Subjects. Control subjects: Fourteen normal subjects free of neurological damaged, (7 men, 7 women; mean age = 55,1 years). Patients: Thirty left-brain-damaged patients, (21 men, 9 women; mean age = 55,2 years). Table 1 reports patients' demographical and clinical data.

All subjects were right-handed and their handedness was determined using the Dellatolas' questionnaire (Delatollas et al., 1988). Control subjects and patients were matched according to their age and school level.

Procedure

Neglect assessment. The patients were submitted to a battery of paper and pencil visuospatial tests including an overlapping figures task, a line cancellation test, the As cancellation test, the Bells test, a line bisection task, and a landscape drawing task (see Bartolomeo and Chokron, in press, for exact procedure and corresponding references).

According to Bartolomeo, D'Erme, & Gainotti (1994), to obtain a quantitative measure of spatial bias in each component test of the visuospatial battery, we computed laterality scores for each of the neglect tests and each patient. The obtained laterality scores permit us to separate neglect from nonneglect patients (for the exact procedure, see Bartolomeo, D'Erme, & Gainotti, 1994, and Bartolomeo & Chokron, in press).

Pointing straight ahead (PSA). The subject was seated blindfolded in front of a graduated table, trunk and head aligned at 0°, the sagittal middle corresponding to the objective centre of the table. The task was to point straight ahead with the right (nonhemiplegic) hand. There were 16 trials, four with each of the four starting positions: 30° or 15° left (−30°, −15°) or right (+30°, +15°) of the objective center of the table. Before each trial, the subject's arm was positioned at one of these starting points, from which he or she had to point straight ahead, moving the arm along the table (see

TABLE 1
Patients' Demographical and Clinical Data

Patient	Sex, age, years of schooling	Onset of illness (days)	Lesion
1	F, 29, 7	922	FTPO
2	F, 57, 5	731	F
3	M, 78, 8	51	Nonapparent
4	F, 81, 5	36	IC, Th
5	F, 70, 12	51	FT
6	M, 57, 7	297	FT, BG, Insula
7	M, 57, 15	702	FP, IC
8	M, 40, 7	547	F
9	F, 56, 5	52	FTP
10	M, 25, 15	402	FT
11	M, 39, 12	217	FTP
12	M, 47, 15	120	P
13	M, 65, 5	181	FTP
14	M, 52, 14	180	BG, P
15	M, 88, 16	245	FTP
16	F, 28, 16	942	FTP
17	M, 28, 15	130	FT
18	M, 42, 8	14	P
19	M, 57, 8	65	FTP
20	M, 82, 15	511	P
21	M, 45, 12	2563	BG, IC, P
22	F, 77, 5	32	Nonapparent
23	M, 43, 9	647	BG, WM
24	M, 46, 5	1204	IC, FP
25	M, 64, 5	430	FTP
26	M, 68, 18	55	Nonapparent
27	M, 62, 15	122	FTP
28	F, 48, 12	21	FTP
29	M, 73, 7	163	TPO
30	F, 59, 9	114	BG, TP

Abbreviations. F, frontal; T, temporal; P, parietal; O, occipital; IC, internal capsula; WM, white matter; BG, basal ganglia; Th, thalamus.

Chokron & Imbert, 1995). There was no time limit and the answer was recorded when the subject estimated that his index finger was pointing ''straight'' ahead. The pointing error was measured to within half a degree, by determining the distance between the pointing position and the objective center, and carried a minus sign for leftward pointings and a plus sign for rightward pointings.

Control subjects' pointing straight ahead (PSA) performance was compared to the objective midsagittal plane with a two-tailed *t* test, while brain-damaged subjects' performance was compared both with a two-tailed *t* test to the objective midsagittal plane and to control subjects' performance.

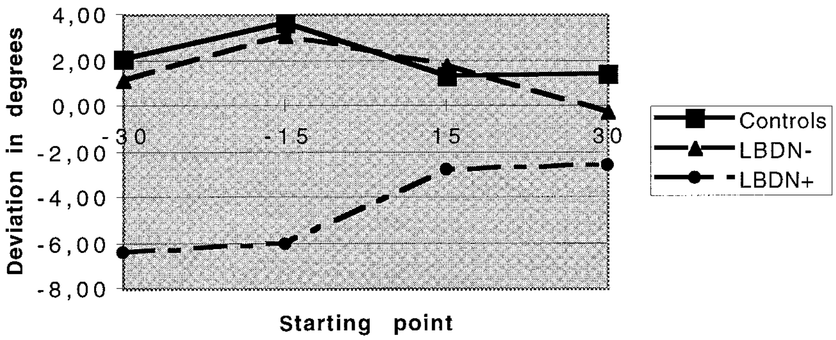

FIG. 1. Straight ahead pointing (in degrees) in normal controls, left-brain-damaged patients with and without right neglect.

Results

1. Control subjects. The mean deviation when pointing straight ahead with the right hand was toward the right but did not differ significantly from the objective sagittal middle ($m = +2.54°$, $SD = 6.11$ $t_{13} = 1.28$, ns) (Fig. 1).

2. Left-brain-damaged patients. According to their laterality score, patients 5, 6, 9, 13, 18, 22, and 29 were found as presenting right neglect signs (LBDN+), (mean score $= -0.138$), while the remaining patients did not show significant signs of right neglect (LBDN−) (mean score $= -0.019$). When pointing straight ahead, LBDN+ patients showed a significant leftward deviation compared to controls' but not to the objective middle ($m = -4.47$ $SD = 6.72$, t/controls $= 2.17$; $p < .05$; $t/0 = 1.75$; ns) (see Fig. 11). Like controls, but unlike LBDN+ patients, LBDN− patients showed a nonsignificant rightward deviation ($m = -1.41$; $SD = 8.60$, t/controls $=$ 0.76; ns; $t/0 = 0.80$; ns), (see Fig. 11).

The deviation observed in LBDN+ patients differed significantly from the one found in LBDN− patients ($p = .02$), and a significant correlation was found between the presence of right neglect signs and the position of the egocentric reference ($r = 0.52$; $p < .05$).

Discussion

Seven out of the 30 left-brain-damaged were found to present right neglect signs according to their laterality score. Although right neglect in left-brain-damaged patients is often described as being far less frequent than left neglect after right brain damage, studies are still needed to ascertain whether this asymmetry is the result of a right hemisphere superiority for visuospatial skills as it has been widely proposed or if the assessment of neglect signs requires specific testing in left- and in right-brain-damaged patients. The main finding here was the presence of a significant correlation between the position of the ER and the presence of right neglect signs in LBD patients with a significant leftward deviation in right neglect patients.

As mentioned in the Introduction, neither a systematic leftward deviation nor a positive correlation between the position of the ER and left neglect signs were found in RBD patients in our previous studies (Bartolomeo & Chokron, in press; Chokron & Bartolomeo, 1997; Chokron & Bartolomeo, 1998).

The fact that this correlation appears to be statistically significant in right neglect patients confirmed previous findings showing that these patients are not exempt from spatial distortions as Kerkhoff and Zoelch recently showed (Kerkhoff & Zoelch, 1998). But as these authors proposed, we cannot infer from this correlation that there is necessarily a causal link between the position of the ER and the presence of right neglect. Rather, we can hypothesize that neglect signs in RBD patients are part of a more complex and variable syndrome than what is present in LBD patients. While left neglect patients should exhibit neglect signs in different frames of reference (Hillis & Rapp, 1998), as well as no deviation, a leftward deviation or a rightward deviation of their ER (Bartolomeo & Chokron, in press; Chokron & Bartolomeo, 1997; Chokron & Bartolomeo, 1998; Farne, Ponti, & Ladavas, 1998), right neglect patients may perhaps exhibit a more uniform syndrome that includes a spatial bias defined in egocentric coordinates as we have shown here. Nevertheless, more experiments investigating the link between the position of the ER and the expression of neglect signs are needed to assess the role of the egocentric frame of reference in spatial biases in right- as well as in left-brain-damaged patients.

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Age Effects in a Computational Model of Memory

Patrick Conley and Curt Burgess

University of California, Riverside

Previous research demonstrates that semantic priming is relatively unaffected by age (Chiarello, Church, & Hoyer, 1985; Howard, 1988). To determine how age might affect representations in the HAL model of memory, the authors gathered text from older and younger adults and generated a global co-occurrence matrix for each. An analysis demonstrated that, as in humans, there was little difference in measures of semantic priming between memory matrices constructed from the two corpora. However, the authors discovered that semantic word neighborhoods gener-