Pointing Straight Ahead: Reversed Patterns of Performance in Right-Brain-Damaged Patients with or without Extensive Parietal Lesion

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In order to study the effect of an extensive parietal lesion on the position of the egocentric reference in right-brain damaged patients, 33 unselected patients with

right hemisphere focal lesions and 22 normal controls participated in a straight-ahead pointing task. The results showed a significant effect of the presence of a right parietal lesion on pointing performance, with an ipsilesional deviation of the egocentric reference in patients suffering from a lesion involving extensively the parietal lobe and a contralesional deviation in patients with lesions that substantially spared the right parietal lobe. These results can help explain some dissociations between left neglect signs and ipsilesional deviation of the egocentric reference, and raise some questions about the links among lesion location, neglect signs and egocentric frame of reference.

Introduction

Right parietal lesions often induce unilateral neglect, characterized by a major difficulty in responding to stimulations in the contralesional hemispace (Heilman, Watson, & Valenstein, 1993). Recently, the hypothesis has been proposed that the crucial mechanism leading to neglect is the disturbed transformation of sensory input into a supramodal egocentric frame of reference (ER), causing in turn a deviation of this reference frame toward the side ipsilateral to the brain lesion (Karnath, 1994; 1996; Vallar, Antonucci, Guariglia, & Pizzamiglio, 1993).

The finding of an ipsilesional deviation of the subjective sagittal middle in left neglect was first demonstrated by Heilman et al. (1983) in five right-brain-damaged (RBD) patients with left neglect, and then replicated in one patient with a proprioceptive straight-ahead pointing task (Chokron & Imbert, 1995) and in three patients with a visual straight-ahead pointing task (Karnath, Christ, & Hartje, 1993). However, recent evidence suggests that the position of the egocentric reference is not a valid way of predicting the presence or absence of left neglect signs. Using a proprioceptive straight-ahead pointing task, we found that a deviation of the egocentric reference does not always lead to clinical symptomatology of neglect, and, conversely, that neglect signs are not always associated with a deviation of the egocentric reference (Chokron & Bartolomeo, 1997). Hasselbach and Butter (1997) tested five RBD patients in a visual condition. They found a rightward ER shift in two patients with extensive right parietal lesions, but not in three RBD patients whose lesions largely spared the parietal lobe, even though the latter patients showed left neglect signs.

Hasselbach and Butter (1997) concluded for an effect of the lesion site on the position of the subjective sagittal middle. They hypothesized that the crucial factor determining the ipsilesional midline shift in RBD patients was the presence of an extensive parietal lobe damage.

In the present study, we tested this hypothesis and submitted 33 unselected RBD patients to a proprioceptive straight-ahead pointing task, and examined its results in relation to the presence or absence of an extensive parietal lesion.

Method

Subjects. Thirty-three right brain-damaged patients and 22 age-matched control subjects free of neurological damage consented to participate in this study.

All subjects were right-handed as assessed by means of a laterality questionnaire (Dellatolas et al., 1988). The RBD patients were divided into two subgroups on the basis of the presence ($n = 18$) or absence ($n = 15$) of extensive parietal lesion. Table 8 reports patients' demographical and clinical data.

Procedure

Subjects were seated blindfolded in front of a large graduated table. Their trunk and head were aligned at 0°, the sagittal middle corresponding to the objective center of the table. Trunk and head positions were carefully monitored by the experimenter throughout the task.

Subjects were asked to point straight ahead with their right hand. They performed 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 subjects' arm was positioned at one of these starting points, from which they had to point straight ahead moving the arm along the table with the index fingertip always in contact with the table (see Chokron & Imbert, 1995). There was no time limit and the finger position was recorded when the subject estimated that his index 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; it carried a minus sign for leftward pointings and a plus sign for rightward pointings.

Results

a. Control subjects. Normal subjects tended to point slightly to the right of the objective sagittal middle with their right hand [+2.54°; $t(21) = 1.79$, $p = 0.09$], thus confirming previous results obtained with a group of younger subjects (Chokron & Bartolomeo, 1997).

b. Right-brain-damaged patients. Taken as a whole group, RBD patients made a rightward deviation (+2.34°), which proved to be nonsignificant neither relative to the objective middle [$t(32) = 0.90$, ns] nor relative to normal controls' results [$t(53) = -0.09$, ns].

An analysis of variance performed on data for these two subgroups and for control subjects revealed a group effect ($F = 5.03$, $df = 2, 52$, $p = 0.01$). Post hoc pairwise comparisons (carried out using Fisher's protected least significant difference) indicated a significative difference in performance between patients with extensive parietal lesions who deviated rightward

TABLE 8
Patients' Demographical and Clinical Data and Performance on the Pointing Straight Ahead (PSA) Task

Patient	Sex, age, years of schooling	Onset of illness (days)	Aetiology	Locus of lesion	PSA (degrees)
1	M, 70, 12	1588	Neoplastic	F	0
2	M, 75, 4	239	Ischemic	BG, P	+8
3	F, 51, 8	29	Ischemic	FP	+11
4	M, 62, 12	449	Haemorragic	TO	−12
5	F, 53, 7	76	Ischemic	FP	+4
6	M, 57, 5	129	Ischemic	FT, BG	−1
7	M, 55, 15	77	Haemorragic	FP	−11
8	M, 46, 6	111	Ischemic	TFP	+2
9	M, 63, 9	91	Haemorragic	FT	+4
10	F, 70, 11	169	Haemorragic	BG	−2
11	M, 76, 7	4	Ischemic	TO	+30
12	M, 53, 5	5	Haemorragic	IC, BG	−6
13	M, 61, 8	135	Traumatic	TP	+12
14	M, 67, 8	141	Haemorragic	FPT	+9
15	F, 70, 12	53	Ischemic	F(P)	−9
16	M, 65, 12	52	Haemorragic	T(P)	−12
17	M, 69, 7	151	Ischemic	FPT	+12
18	M, 68, 8	77	Ischemic	FP	+10
19	M, 46, 5	57	Ischemic	FPT	+6
20	M, 46, 5	113	Haemorragic	F	0
21	M, 77, 12	30	Ischemic	FP	+5
22	M, 43, 8	119	Haemorragic	IC, Th	−24
23	M, 67, 18	37	Ischemic	Th	+11
24	M, 53, 18	39	Ischemic	IC, BG	−32
25	F, 73, 8	244	Ischemic	FP	+15
26	F, 70, 12	52	Ischemic	TP	+4
27	M, 52, 9	153	Haemorragic	IC, Th	−10
28	M, 53, 12	75	Ischemic	BG, IC, P	+10
29	F, 72, 5	33	Haemorragic	FPT	+8
30	M, 40, 5	33	Ischemic	FTP, BG	−7
31	M, 60, 12	205	Ischemic	O	+1
32	M, 43, 11	44	Traumatic	TP	+4
33	M, 94, 6	70	Ischemic	P	+11

Note. F, Frontal; T, Temporal; P, Parietal; O, Occipital; Th, Thalamic; IC, Internal capsule; BG, Basal Ganglia; (P), Marginal parietal involvement.

(+6.24°, $SD = 11.79$) and patients without extensive parietal lesions who deviated leftward (−4.10°, $SD = 17.21$; $p < 0.05$). RBD patients with substantial sparing of the parietal lobe also differed from controls, who deviated rightward (+2.54°, $SD = 8.01$; $p < 0.005$). RBD patients with extensive parietal lesions, however, did not differ from controls. When compared with the objective midline, however, the rightward deviation of the parietal group

resulted to be statistically significant ($t = 2.24$, $df = 17$, $p < 0.05$) while the leftward deviation shown by the RBD group without extensive parietal lesion was not ($t = -0.92$, $df = 14$, ns).

Discussion

RBD patients with extensive right parietal lesion showed an ipsilesional shift of their ER, consistent with Hasselbach and Butter's (1997) finding of an association between right parietal lesions and rightward shift of the subjective midline. Interestingly, RBD patients with a substantial sparing of parietal cortex tended to exhibit the opposite pattern, i.e., a contralesional deviation of their ER, thus exhibiting a reversed pattern of performance. This effect of the intrahemispheric location of right hemisphere lesion on the ER position may explain the variability observed in straight-ahead pointing performance among left neglect patients (Chokron & Bartolomeo, 1997). In the same way, one could imagine that the location of the right hemispheric lesion may induce a specific pattern of disorder of space representation by determining the side and amount of deviation of the position of the ER. Future research is needed to establish the exact relationship existing among lesion location, presence of neglect signs, and ER position, and to examine the effects of experimental vestibular and proprioceptive stimulations on both leftward and rightward ER deviations.

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