

The Time Course of Visual Hemi-Inattention

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Summary. Twenty right brain-damaged patients and two left brain-damaged patients who showed neglect in the early stage of a stroke were reexamined at a mean time of 10.5 months. In four patients neglect was still as severe as on the initial examination and visual scanning was limited to the right space or even to its rightmost portion. Available CT scan findings suggest that in some patients thalamic lesions may play a critical role in the persistence of neglect. All the other patients improved with passage of time, but minor signs of hemi-inattention could still be demonstrated in the great majority of them.

Key words: Spatial disorder – Hemi-inattention – Hemispheric damage

Introduction

Neglect for visual stimuli in the space contralateral to the lesion is a symptom that frequently occurs in patients with unilateral hemispheric damage, especially those affected by right brain disease [8] in whom its incidence in the acute stage of disease has been reported to range from 31% [11] to 45% [7]. Its after effects may be so severe as to prevent the patient from taking cognizance of whatever happens in contralateral space, thus thwarting visual perception [10] and even visual memory [2]. In spite of the theoretical relevance of the disorder and of its practical implications for rehabilitation [6, 13], little is known about its change in relation to time. Gainotti [9] found that its incidence fell from 45% of vascular patients examined in the first month following a stroke to 20% of those assessed at a later stage of recovery. Although clinical experience would suggest that the most severe manifestations of neglect tend to subside, more subtle deficits are likely to pervade the patient's performances and to still be detectable long after the disease onset if sensitive procedures are used. Campbell and Oxbury [4] retested after 6 months six right brain-damaged patients who had presented neglect at an early post-stroke assessment and found that while the most striking signs of hemi-inattention were no longer apparent in four of them, all were still showing a preference for right-sided responses on a visual recognition test of the same magnitude as when they were first examined.

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The purpose of the present study was to evaluate to what extent hemi-inattention, ascertained in the acute stage of disease, recovered with passage of time and how many patients without clear signs of neglect still showed a preference for scanning the hemi-space ipsilateral to the lesion.

Materials and Methods

Subjects

Subjects of this research were patients with acute unilateral vascular disease admitted to the wards from November 1978 to June 1980 and who during the period of hospitalization were testable and found to show hemi-inattention. The assessment of neglect was made as soon as the physical condition of the patient permitted and the post-onset interval ranged from 1 day to 27 days. In total 43 patients with hemi-inattention were detected, 38 with right brain damage and 5 with left brain damage. We tried to reassess all of them 6 months or more from the onset of disease, but 21 patients were no longer available, either because they had died [17] or could not be traced [4]. Thus this research is comprised of 22 patients, 20 with right brain damage and 2 with left brain damage (see Table 1), 13 were male and 8 female, with a mean age of 67 years, S.D.: 9 years.

The mean post-onset time at which they were tested was 10.3 months (range 6 to 17 months). Unilateral location of lesion was ascertained on the basis of history, neurological examination and, when available, neuroradiological data (these included CT scan in 11 patients).

Assessment of Hemi-Inattention

As most patients were severely impaired when first examined, neglect could not be assessed with uniform criteria and we had to resort to a flexible procedure, choosing from tests that were appropriate to the patient's level of functioning. The following performances were required: 1) Pointing to 10 circles (diameter 5 mm) symmetrically arranged on a 20 cm × 30 cm sheet, 5 to the right and 5 to the left of the midline. 2) Pointing to a row of 7 girls and boys, shown in a 30 cm × 24 cm magazine photograph. 3) Reading a two-line full width newspaper headline (40 cm long). 4) Copying 8 drawings (a square, a diamond, a Greek fret, a cross, a clock, a face, a house, a daisy) separately presented one at a time. Of the 20 right brain-damaged patients 10 were given three tests and 10 four tests; both left brain-damaged patients were examinable only by pointing to circles. Neglect was considered to be present when the patient failed to point to a one or more stimuli lying to the side of lesion in tests 1 and 2, to read the initial words of the sentence in test 3, and the copy left-sided lines or details in test 4. With the exception of one left brain-damaged patient, hemi-inattention was very conspicuous in all patients (see later).

On the follow-up examination, 6 or more months later, all the previous four tests were given and, in addition, a visual matching test, in which the subject was handed a meaningful figure and requested to find its match on a board (34 cm × 42 cm) displaying 20 figures in four columns. There were four boards having a different arrangement of the same 20 figures, and they were presented in succession until all the 20 figures of each board had been searched, making a total of 80 matches, 20 for each column. If the patient was unable to match the figure in 15 s, an omission was scored and a 15 s searching time was arbitrarily assigned. One right brain-damaged patient could not be given this test, because he had serious difficulty in recognizing figures (apperceptive agnosia).

The reading test proved to be the test which more frequently produced omissions by right brain-damaged patients. It was, therefore, given a pivotal role in the assessment of unilateral neglect. The patient's performance was classified as indicating *severe neglect* if on the side contralateral to the lesion he neglected more than half of the headline words, or half of the words but had in addition unmistakable signs of hemi-inattention on at least two of the other tests, and *moderate neglect* if he neglected half of the words without other omissions, or less than half of the words, but had clear signs of omissions on at least one of the other tests. On the

Table 1. Hemi-inattentive patients' data

Case No.	Sex	Age	1st examination		2nd examination		CT localization
			Days post-stroke	Severity	Months post-stroke	Severity	
Right hemisphere patients							
1	F	70	8	Moderate	11	Moderate	Temporo-parietal
2	F	51	3	Severe	12	Subclinical	Lenticulo-capsular
3	F	59	1	Severe	8	Severe	Thalamic-capsular
4	M	78	1	Moderate	12	Mild	—
5	F	46	3	Severe	8	Mild	—
6	F	56	2	Moderate	10	No	—
7	M	60	8	Severe	15	Moderate	—
8	M	71	7	Severe	14	Severe	Medial temporo-occipital
9	M	75	10	Severe	7	Moderate	Lateral parieto-occipital
10	M	63	2	Moderate	17	No	—
11	F	68	1	Moderate	16	Mild	—
12	M	61	7	Severe	9	Mild	—
13	M	78	3	Severe	13	Severe	—
14	M	68	4	Moderate	8	Mild	Fronto-parietal
15	M	71	20	Moderate	6	Mild	—
16	F	86	6	Severe	8	Moderate	—
17	M	60	27	Severe	6	Subclinical	Fronto-temporo-parietal
18	F	72	3	Severe	8	Severe	Parietal and thalamic
19	M	69	7	Severe	9	Subclinical	Temporo-parietal
20	F	65	15	Moderate	9	No	—
Left hemisphere patients							
21	M	62	10	Moderate	13	No	—
22	M	73	24	Severe	8	Mild	Lenticular-capsular

first examination all right hemisphere patients fell in these two categories. Three other categories were added when the follow-up examination performance was assessed. *Mild neglect*, marked by omission of minor details on the drawing test and of no more than one figure on the visual matching test, *subclinical neglect*, when the only sign of hemi-inattention was a significantly longer searching time for figures lying on the contralateral columns, and *no neglect*, when no omission and no significant left-right lengthening of the searching time were observed. Mean searching time for the 40 figures lying in the first two columns was compared with that of the 40 figures of columns 3 and 4 with a *t*-test for paired data. Since 22 *t*-tests were carried out, we accepted as significant for each comparison only a $P < 0.001$, which corresponds approximately to a protection level of 0.95 for the whole set of comparisons.

Results

Table 1 shows the distribution of the patients in the various neglect categories. On initial examination, 12 right brain-damaged patients had severe neglect and 8 moderate neglect. On the follow-up examination 4 of the severe patients did not show any noticeable improvement and still fell in the same category, missing many stimuli lying in the contralateral space. An extreme example is represented by patient *n* 18, who 8 months after the stroke read only the last two words of the sentence, pointed to the most right stimulus of the pointing to circles and human figure tests and laboriously proceeded towards left-sided stimuli never going beyond the midline, and failed to find in 15 s not only all the figures of the matching test lying on the two first columns, but also those of the third column. Spontaneously, the patient kept his eyes and head mildly shifted to the right, but was able to make saccadic and tracking movements in any direction. Yet as soon as a display was presented, his gaze was irresistibly attracted by its most right side, no matter how far it was displaced to the right by the examiner, and his eyes moved to the left only slowly and following repeated incitement. CT scan showed two right brain infarcts, one at the parieto-occipital junction, the other in the posterior-lateral thalamus and the adjacent posterior limb and retrolenticular segment of the internal capsule. CT scan data were also available for a further two of the three severe hemi-inattentive patients and showed in one case a right thalamic hematoma and in the other a complete right posterior artery softening.

All the other patients improved their performance with passage of time, but 10 of them still presented with signs of neglect, which were moderate in 4 and mild in 6. Moreover, 3 of the 6 patients who no longer made omissions on the conventional tests, showed a significant increase in their searching time for the left-sided stimuli of the matching test, similar to all but one of those patients who made the omissions. Table 2 shows the mean time spent by each patient to search for the figures lying on the left (1 and 2) columns and on the right (3 and 4) columns and also gives, in brackets, the number of figures not found in 15 s. It follows from these data that a complete recovery in the ability to scan the contralateral space could be demonstrated in only 3 of the 20 right hemisphere patients. We attempted to determine whether the initial degree of neglect was related to the outcome of the deficit by assessing how many of the patients belonging to the five final groups had been originally classified as severely (S), or moderately (M) impaired. As shown by Table 3 no firm prediction can be made at the beginning

Table 2. Mean searching time and omissions (in brackets) of each patient in the left and right columns of the visual matching task

Subject	Left columns		Right columns		<i>t</i> (D.F.: 78)	<i>P</i>
	Mean	Omiss.	Mean	Omiss.		
<i>Right brain-damaged patients</i>						
1	10.01	(11)	7.36	(4)	−3.82	0.001
2	2.22	—	1.56	—	−3.33	0.001
3	6.61	(8)	2.24	—	−6.01	0.001
4	2.84	—	1.62	—	−4.89	0.001
5	2.10	—	1.77	—	−1.11	N.S.
6	3.16	—	2.91	—	−1.46	N.S.
7	3.65	—	1.80	—	−6.07	0.001
8	10.50	(19)	4.80	(1)	−4.37	0.001
9			Not testable			
10	1.57	—	1.83	—	−0.08	N.S.
11	4.46	(1)	2.03	—	−4.61	0.001
12	3.88	—	1.90	—	−7.31	0.001
13	13.46	(31)	6.19	(3)	−5.36	0.001
14	3.07	—	1.33	—	−6.56	0.001
15	3.02	(1)	1.79	—	−3.63	0.001
16	12.61	(29)	3.12	—	−8.00	0.001
17	4.19	(2)	1.97	—	−4.00	0.001
18	15.00	(40)	8.17	(11)	−6.93	0.001
19	4.57	(1)	1.70	—	−8.14	0.001
20	1.94	—	1.68	—	−0.30	N.S.
<i>Left brain-damaged patients</i>						
21	393	—	4.15	—	0.834	N.S.
22	4.71	(3)	8.09	(10)	2.977	0.003

Table 3. Number of patients of the five follow-up groups who had severe (S) or moderate (M) impairment on the first examination

Severe impairment	Moderate impairment	Mild impairment	Subclinical impairment	No impairment
4 S	1 M, 3 S	4 M, 2 S	3 S	3 M

of the disease on the evolution of hemi-inattention, except that a persistent severe impairment only occurs in patients with an initially severe neglect and a complete recovery only occurs in patients with an initially moderate neglect.

As mentioned above, only the pointing to circles test could be given on the first examination to the two left brain-damaged patients with right hemi-inattention. One patient missed all the five circles to the right, the other only one circle.

On the follow-up examination, all tests were administered, except the drawing test, because of severe constructional apraxia. Omissions were no longer detectable on the three conventional tests, but on the visual matching test the first patient failed to find 10 figures in the columns to the right and 3 in the columns to the left. The performance of the second patient was flawless.

Discussion

In keeping with the great majority of previous studies, neglect was found to be a rare occurrence in left brain-damaged patients, even when it was assessed in the acute stage of disease and the diagnosis relied upon an elementary task, such as pointing to circles. As a consequence only two left brain-damaged patients could be retested and therefore very little can be said on the evolution of right neglect.

More substantial data could be collected in right brain-damaged patients, whose hemi-inattention was found to have undergone, at a mean time of 10 months post-stroke, a wide range of outcomes, from complete recovery to unmodified persistence.

In more than one third of patients (8 out of 20) the deficit was still so disabling as to limit the ability to read a newspaper headline, in spite of the fact that the very nature of the task should have suggested a leftwards scanning in search of words completing the meaning of the sentence. One might have anticipated neglect to be more easily brought out by an unstructured test such as pointing to circles than by reading a sentence, but this was not the case in most of the patients, who tended to miss more leftward words than circles in the acute as well as in the chronic stage. It was amazing to see how ready these patients were to accept without question a text which clearly lacked coherence and from this we would suggest reading a full page headline as a convenient and speedy task for uncovering visual hemi-inattention in right hemisphere patients.

Of the eight patients with persistent disabling neglect four did not show any improvement 8, 14, 13, and 8 months, respectively, after onset of the disease and will probably remain affected by a permanent deficit, similar to that observed in the chronic cases previously described [13, 14]. In search of the variables responsible for the persistence of hemi-inattention it is worth stressing that the patient with the most severe deficit had two right hemisphere lesions, one encroaching upon the parieto-occipital junction and the other upon the posterior thalamus. The finding that this patient did not show the least improvement 8 months after the stroke, in contrast to other patients with parietal damage, suggests that the thalamus may have a great potential in compensating for parietal neglect and plays a crucial role in directing attention to the contralateral space, as has been pointed out by recent case reports of thalamic hemi-inattention [3, 12, 14]. We had a second patient with exclusively thalamic damage and he too showed a severe and persistent neglect, though not so profound as the patient with both parietal and thalamic involvement. Although any definite conclusion would be premature, the relation of thalamic lesions to recovery from neglect deserves careful consideration.

The remaining right hemisphere patients of our series improved spontaneously over time (none of them underwent rehabilitation programs); yet a

complete recovery could be shown in only 3 of them, the others still showing, on the follow-up examination, a certain amount of left neglect, or at least of right position preference. The matching test proved to be a precious instrument to bring out a tendency to linger over figures on the ipsilateral side by patients that were apparently free from hemi-inattention when confronted with conventional tests. While this finding may be of negligible relevance to daily behaviour, it deserves careful consideration by the neuropsychologist, because of its implication for the assessment of mental abilities with tasks implying visual scanning. In many studies a perceptual or memory deficit has been inferred in right brain-damaged patients from their poor performance on tests requiring selection of the correct item from an array of alternatives, without due regard to the possibility that failures may be contingent upon inadequate attention paid to stimuli on the left. This point has already been stressed by Gainotti and Tiacci [10] who showed that right hemisphere patients who failed to identify overlapping figures or to discriminate the size of two figures, also tended to neglect the figure lying on the left and to focus on that lying on the right. While it is relatively easy to uncover the presence of hemi-inattention when it produces patent omissions, milder cases with preferential inspection of stimuli lying to the right may go undetected and confound test results, especially when short limits of time are allowed for the response.

The data of this research are also relevant to rehabilitation medicine. On the one hand, they point out that spontaneous recovery may be expected in most patients with obvious signs of hemi-inattention at an early stage of disease and consequently emphasize the need for an adequate control group when assessing the proficiency of remediation programs. On the other hand, they show that in a minority of patients a severe neglect can persist profoundly hampering both daily activity and rehabilitation procedures [6, 15]. The problem with these patients is to make them aware of their deficit and of the existence of the left space, a task that may meet with insurmountable difficulty if, as suggested by a few studies [1, 2, 5], the impairment is not confined to perceptual scanning, but also involves internal representation of space.

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Received February 12, 1982