NOTE

UNILATERAL NEGLECT IN ROUTE DESCRIPTION

E. BISTACH,* M. BROUCHON,† M. PONCET, and M. L. RUSCONTS

*Dipartimento di Psicologia Generale, Università di Padova, Italy; †U.R.A. Cognition et Mouvement, C.N.R.S., Marseille, France; ‡Service de Neurologie et de Neuropsychologie, C.H.U. Timone, Marseille, France; and §Istituto di Clinica Neurologica, Università di Milano, Italy

(Received 8 January 1993; accepted 23 April 1993)

Abstract—Route description was investigated in two patients suffering from left unilateral neglect. Both had evident difficulty with left turns. This finding suggests that the topological correspondence between represented environment and representational mechanisms in the brain is not confined to frozen (picture-like) perspectives.

IT HAS OFTEN been found that patients suffering from unilateral neglect have difficulty with the contralesional side of familiar visual arrays when asked to describe them from memory from a particular vantage point. In the case studies so far reported they were requested to describe town prospects [8, 10, 15, 16, 18], interiors [10, 18], or maps [2, 17, 19]. Defective forward and backward oral spelling of either the initial or terminal segment of words, depending on the side of the lesion, has also been observed in neglect patients [2, 3, 11] and is likely to be due to local impairment of an orthographic representation organized in much the same way as visual images. It is claimed that these findings support an analogue theory of mental representation [4, 6, 7]. Imaginal neglect in the description of well-known itineraries was first mentioned, though tangentially, by DUHAMEL and BROUCHON [14]. In consideration of its theoretical interest, it has been specifically investigated in the two cases reported in this note.

M.M. 54-year-old right-handed male with highest educational level. CVA on 25 February 1989. CT scan (November 1989) and MRI (October 1990): Large infarct in the territories of the right middle and posterior cerebral arteries. An early clinical report mentioned left hemiplegia, hemianopia and hypoaesthesia; total left-ear extinction on dichotic examination; severe unilateral neglect on unspecified routine tests; spatial dysgraphia and constructional apraxia.

The patient was re-examined during the first days of January 1991. His neurological impairment was unchanged, except for a very slight improvement in the hemiplegia, to the extent that he could walk, though with marked difficulty. He was totally anosognosic with respect to his constructional apraxia, which was still very severe. By contrast, he had become perfectly aware of his unilateral neglect. Actually, he claimed to have formed his own theory of the disorder; in his opinion this should not be defined as an inability to conceive the left side of his body and outer space, but as extreme difficulty in directing attention to that side, a difficulty that could only be overcome by strenuous voluntary effort. There was in fact an amazing dissociation between his normal performance on formal tests, such as line bisection and cancellation tasks, on which he knew he would fail, short of sustained self-control, and spontaneous, relaxed behaviour in everyday life. His wife reported, for example, that he often neglected food on the left side of his plate. Neglect was also dramatically revealed by a very simple task that he was given for the first time: on being asked to pick up a handful of coins spread over the table while keeping his eyes closed, he only collected coins from the right side. When one of the examiners asked him whether he had completed the task, he answered: "If you ask that, then I probably have not", and resumed his search up to the last coin. His description from memory of a landscape that was very familiar to him, i.e. the Marseille Vieux port as seen from La Canebière, was totally defective on the left (east) side of the imagined perspective. By contrast, he correctly reported from the right (west) side, and in the appropriate order, Rue de la République, "les beaux immeubles construits sur le Vieux port par Pouillon", the town hall and Fort-St.-Jean. He went on adding details—a famous church and the Evéché that could only be seen by turning right at the end of the harbour. As usual, mental reversal of the first perspective lead to recovery of previously omitted details from the east side of the harbour and neglect of those that had been

^{*}Address for correspondence: Professor Edoardo Bisiach, 22070 Lurago Marinone (Como), Italy.

reported from the opposite side in the first description, with the only exception of the town hall. In describing well-known itineraries in Marseille, he often failed when left turns were included. Here are two examples. (Numbers and letters refer to figures and their details, respectively).

From Obélisque de Mazargues (1a) to La Timone Hospital (1b)

I go in the direction of the traffic lights of Bd. Michelet (1c) and continue. At a certain point I find Bd. Rabatau (1d), I take Bd. Rabatau and go straight ahead to La Timone; that is, without having to turn.

From La Timone Hospital to Mazarques

I leave La Timone and take Bd. Baille (te). I go down to Castellanc (1f). After Castellane I take the Prado; I go down the Prado (1g) and arrive at Mazargues.

From Luminy (2a) to the David (2b)

I came from Luminy and have to cross the road that leads to Cassis. I go down to the Obėlisque de Mazargues (2c). Once I am at the Obėlisque de Mazargues, ... what shall I do? Let me think it over. The Obėlisque de Mazargues is at the beginning of Bd. Michelet (2d). I go down Bd. Michelet, and on and on. I arrive to the David. (One of the examiners points out that the last part of the description is not accurate enough and asks the patient to imagine himself giving directions to another examiner, who was a foreigner.) From Bd. Michelet you arrive at the rondpoint du Prado (2c). There you arrive at the Prado itself. You continue down the Prado until you find a statue disfigured by Medicine students: the David. (The patient is asked whether there are any turns in the last part of the route. He resumes his description with evident unease.) You turn into the Petit Prado . . . , no, no it's still Bd. Michelet. Keep straight on. You arrive at the rond-point du Prado . . . , let me think it over . . . , there is a sense giratoire. You must take the sense giratoire and at a certain point, on your left, there is the Petit Prado (2f). This will take you straight to David. OK! It is surprising how unnatural all that is. I don't think it was like that before my illness. Now I must think hard to make out places where I have spent my whole life! It is not spontaneous. It has nothing to do with the hemiplegia. It must be something else, but I don't know what.

From David to Luminy

I am at David. I continue along the *corniche* (2g). I go past the Restaurant La Mer; past la Vieille Chapelle (2h). I go up and up towards Bonneveine (2i). From Bonneveine I arrive at Bd. de Hambourg (2j). I go up Bd. de Hambourg. There is a *rond-point*. I go to Bonneveine and then to the Avenue de Mazargues (2k). Once I am at Mazargues, I go till the end. I turn into Bd. de la Concorde (2l), I arrive to the Obélisque de Mazargues, et là je suis sauvè! I turn right and arrive straight to Luminy.

A.S. 76-year-old right-handed woman. CVA on 16 November 1990. CT scan: large ischaemia in the district of the right middle cerebral artery, with partial sparing of the parietal region and basal ganglia. Left motor impairment with transitory anosognosia; left somatosensory deficit and hemianopia. Severe left neglect on cancellation tasks (87.5 left-sided omissions on DILLER and WEINDERG test [13]; 57.5 left-sided omissions on Albert's test [1]). The following is an abstract from an interview that took place on 15 January 1991. At that time, she had almost completely recovered from her motor impairment, but neglect was still present. In fact, she participated as an outpatient in several investigations in which she was very willing to cooperate. Her description of Milan itineraries that did not involve left turns was fluent and flawless, but when left turns were included, her performance was variable. In some instances, especially with short routes starting from her residence, she was perfectly accurate, while on some occasions she would hesitate before making the correct choice, or postpone the left turn until it was unavoidable, suggesting less appropriate alternatives. On other occasions, she would lose track of the route she was describing and get confused. Sometimes, her preference for right turns starting from the very beginning of her report resulted in the same phenomenon already observed in M.M.: if, after having described an itinerary from point a to point b she then had to describe one going from b to a, the latter was not the reversed replica of the former and the two paths, taken together, formed a roughly quadrangular itinerary.

From Via Ricordi (3a) to Piazza della Repubblica (3b)

I walk from Via Andrea Doria (3c) to Viale Brianza (3d) and from there to the Stazione Centrale (3c).... Then ... there is a street Through Viale Brianza to the Stazione Centrale; ... at that point ... (One of the examiners asks whether at that point she has to turn left or right.) I turn left, I place myself so as to have the front of Stazione Centrale at my back and from there I take Via Vittor Pisani (3f). There I am!

From Piazza della Repubblica to Via Ricordi

I go to the Stazione Centrale along Via Vittor Pisani. From the Stazione Centrale, I go to Via Vitruvio (3g), up to Corso Buenos Aires (3h) and on. There is Piazza Argentina (3i). I cross Piazzale Loreto (3j) and arrive at Via Ricordi.

From inside the Duomo (4a), through the main door of the cathedral, to the Ospedale Policlinico (4b)

I turn into Corso Vittorio Emanuele (4c) and walk in the direction of Piazza San Babila (4d). Then I turn right into Corso Monforte. At the cross-roads (4e), I turn right and walk towards Via Francesco Sforza (4f) until I get to the Policlinico.

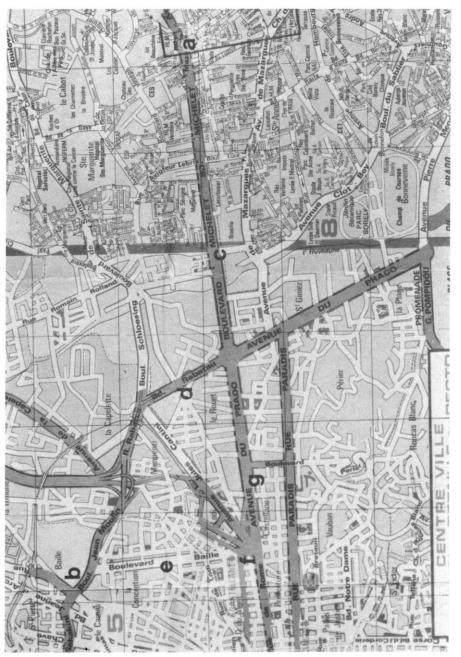


Fig. I. Route connecting Ooelisque de Mazargues and I.a Timone Hospital,

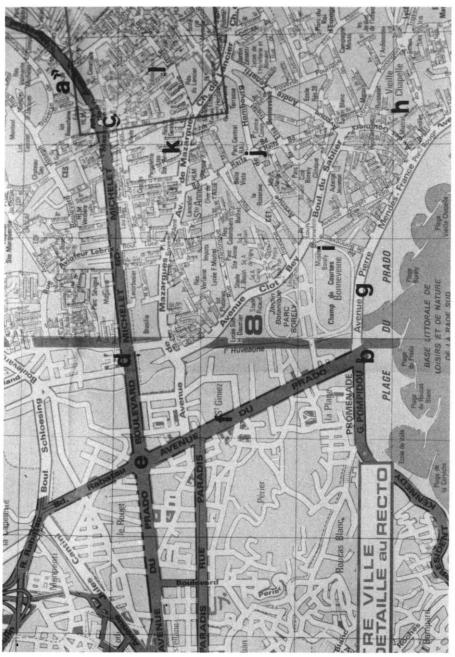


Fig. 2. Route connecting Luminy and David.

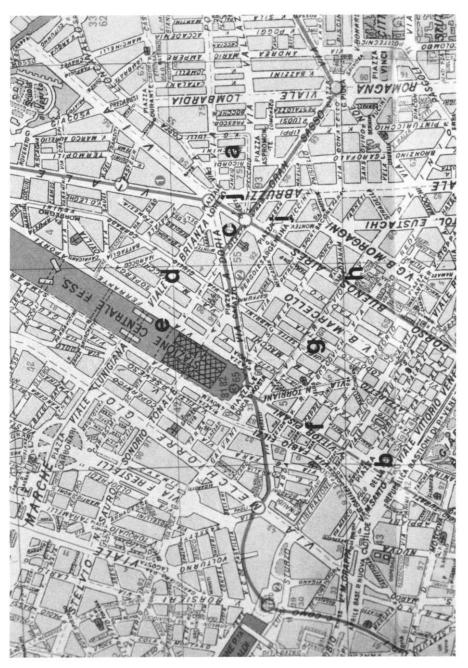


Fig. 3. Route connecting Via Ricordi and Piazza della Repubblica.

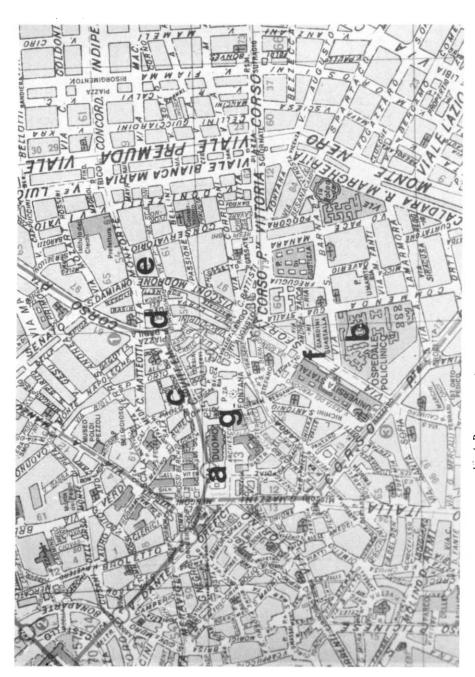


Fig.4. Route connecting Duomo and Ospedale Policlinico.

From the Ospedale Policlinico to the Duomo

I take Via Francesco Sforza. Then I leave it I don't remember . . . (she mutters incomprehensibly) Once again in San Babila. (One of the examiners asks how she gets to Piazza San Babila.) . . . I pass there . . . I find Piazza Fontana (4g). Then I cross Piazza Fontana and find myself at the Duomo.

Recognizing a definite preference for right turns in the descriptions of itineraries given by neglect patients is far from easy, due to the high frequency of more or less pronounced topographical disorientation of these patients [12]. However, the two cases reported in this note are, in our opinion, more than merely suggestive. Their "disorientation" only emerged when left turns had to be reported. Note that 10 normal subjects asked, as M.M., to describe the itinerary from Mazargues to La Timone never omitted the left turn at the end of Bd. Rabatau. The left turn required at the rond-point du Prado (2c) to get to David coming from Bd. Michelet was mentioned by M.M. only after prompting by the examiner. However, much more impressive is his illogical rightward departure from David and his entanglement in the labyrinth of streets on the left side of his intended direction in his attempt to make for Luminy. He appeared totally oblivious of the much more convenient path along the main roads he had previously reported while describing the reverse itinerary. His exclamation on arrival at the reassuring landmark constituted by the Obelisque de Mazargues, was very indicative of his relief from distress: no further left turns were required from there to his destination! As for A.S. it must be noted that the stretch from Via Ricordi to Piazza della Repubblica is in her immediate neighbourhood. Nonetheless, after her first correct choice, i.e. Via Doria, she made an illogical right turn towards Viale Brianza, thus emerging on the side of the Stazione Centrale. Then she hesitated. After prompting, she could remember that a left turn was required, but seemed to need to anchor herself momentarily to a landmark on her right (the front of the Stazione Centrale) before resuming her report. Her description of the route from the Duomo to the Policlinico was perfectly accurate but absurd. Indeed, the Milanese would laugh at such directions. Twenty control subjects, interviewed in deference to formality, only described routes through either Via Lagetto or the Università Statale (see Fig. 4). A.S.'s fluent and unhesitating report of the itinerary from the Duomo to the Policlinico was in sharp contrast with the report of the itinerary connecting those two landmarks in the opposite direction. Like M.M., she got lost as soon as she was confronted with the necessity of a left turn.

The inability of neglect patients to make an accurate description from memory of the contralesional side of a stationary visual array suggests that man's production of pictorial representations such as drawings originates in an inner representation the mechanism of which is itself characterized by analogue spatial features. It must be borne in mind that the phenomenon is not due to the fact that patients describe the visual array as they would perceive it given their disorder. Indeed, with few exceptions, of which M.M. is an example, neglect patients are totally unaware of this disorder. In spite of his keen introspection and self-analysis, M.M. was quite satisfied with his incomplete description of the Vieux Port and would never comment that, of course, he knew pretty well what he had left out in order to simulate his difficulty in directing attention leftwards. Mental representations implemented in topological neural maps similar to those known to implement early stages of sensory processing, however, might constitute the last step before the externalization of the mind's representational activity by means of drawings. Instructions relative to the imaginary vantage point, or in the case of country maps, the canonical orientation of what has to be described from memory, might force the generation of a quasi-externalized representation of this kind. Up-stream (or in parallel) with respect to this type of representation, or whenever this type of representation is not induced by particular task demands, cognitive representation of things such as landscapes, interiors, etc., might be thought to be organized in a non-analogue, i.e. linguistic or "abstract" code (whatever the latter might mean). The putative push towards a pictorial representation of a stationary array when a subject is asked to describe it from memory under the constraints of a fixed vantage point is arguably much weaker when the patient's task is to give verbal directions about how to go from one point of a town to another. Nonetheless, the behaviour of M.M. and A.S. suggests that their verbalization too was mediated by a representation in which analogue properties could be recognized and that representations with such properties, therefore, are unlikely to be special-purpose and located at the periphery of the cognitive machinery.

Further investigation is needed to ascertain whether phenomena such as those reported here are as reliable as those upon which the notion of imaginal neglect has so far been grounded. Furthermore, it remains unsettled whether the erratic reports given by our two patients when they had to deal with an area lying to the left of the starting direction of the itinerary they had to describe, indicates resort to acquired verbal routines in an attempt to compensate for the circumscribed inaccessibility of one side of an analogue visuospatial representation. The question of the extent to which any inference drawn from cases of imaginal neglect as regards the structure of cognitive processes can be generalized across individuals also remains open.

M.M. also showed neglect of the left side of a stationary perspective (Vieux port). Regrettably, we omitted to test A.S.'s performance on a similar task. This was unfortunate, since imaginal neglect of leftward turns might dissociate from imaginal neglect of the left side of unchanging perspectives. The former, but perhaps not the latter, might indeed depend on "premotor" rather than on "perceptual" neglect. Whatever might be the validity of such a distinction [9, 20], however, it is worth noting that whereas M.M. had no neglect on Tegnér and Levander's mirror-reversed line cancellation task [20]. A.S. displayed on this task a very consistent "perceptual" neglect [5].

Acknowledgements—This study was largely prompted by remarks made by Prof. Daniel Dennett during a discussion on imaginal neglect at an informal symposium held in Parma, June 1990. The last paragraph of the

Discussion was written in response to comments made with insight by an anonymous reviewer. M.M. and A.S. have been much more than subjects of a neuropsychological investigation; the incentive provided by their cooperation as persons is gratefully acknowledged. The investigation was supported by C.N.R. and M.U.R.S.T. grants to the first author.

REFERENCES

- 1. Albert, M. L. A simple test of visual neglect. Neurology 23, 658-664, 1973.
- BARBUT, D. and GAZZANIGA, M. S. Disturbances in conceptual space involving language and speech. Brain 110, 1487–1496, 1987.
- BAXTER, D. M. and WARRINGTON, E. K. Neglect dysgraphia. J. Neurol. Neurosurg. Psychiatry 46, 1073-1078, 1983
- 4. BISIACH, E. Language without thought. In *Thought without Language*, L. WEISKRANTZ (Editor), pp. 464-484. Oxford University Press, Oxford, 1988.
- 5. BISIACH, E. Perception and action in space representation: Evidence from unilateral neglect. In Current Advances in Psychological Science: An International Perspective. State of the Art Lectures presented at the 25th International Congress of Psychology (Brussels 1992). G. D'YDEWALLE, P. EELEN and P. BERTELSON (Editors). Lawrence Erlbaum Associates, Hove and London, in press.
- BISIACH, E. and BERTI, A. Dyschiria: an attempt at its systemic explanation. In Neurophysiological and Neuropsychological Aspects of Spatial Neglect, M. Jeanneron (Editor), pp. 183–201. North-Holland, Amsterdam, 1987.
- 7. BISIACH, E. and BERTI, A. Waking images and neural activity. In *Psychophysiology of Mental Imagery: Theory, Research and Application*, R. G. KUNZENDORF and A. A. SHEIKH (Editors), pp. 67–88. Baywood Publishing Co., Amityville, NY, 1990.
- 8. BISIACH, E., CAPITANI, E., LUZZATTI, C. and PERANI, D. Brain and conscious representation of outside reality. *Neuropsychologia* 19, 543–551, 1981.
- 9. BISIACH, E., GEMINIANI, G., BERTI, A. and RUSCONI, M. L. Perceptual and premotor factors of unilateral neglect. Neurology 40, 1278–1281, 1990.
- 10. BISIACH, E. and LUZZATTI, C. Unilateral neglect of representational space. Cortex 14, 129-133, 1978.
- 11. CARAMAZZA, A. and HILLIS, A. E. Spatial representation of words in the brain implied by studies of a unilateral neglect patient. *Nature* **346**, 267–269, 1990.
- 12. DE RENZI, E. Disorders of Space Exploration and Cognition. Wiley, Chichester, 1982.
- 13. DILLER, L. and WEINBERG, J. Hemi-inattention in rehabilitation: The evolution of a rational remedition program. In *Hemi-inattention and Hemisphere Specialization*, E. A. WEINSTEIN and R. F. FRIEDLAND (Editors), pp. 63–82. Raven Press, New York, 1977.
- DUHAMEL, J.-R. and BROUCHON, M. Sensorimotor aspects of unilateral neglect: A single case analysis. Cognitive Neuropsychology 7, 57-74, 1990.
- GEMINIANI, G. and BOTTINI, G. Mental representation and temporary recovery from unilateral neglect after vestibular stimulation. J. Neurol. Neurosurg. Psychiat. 55, 332–333, 1992.
- GOLDENBERG, G. The ability of patients with brain damage to generate mental visual images. Brain 112, 305-325, 1989.
- HALSBAND, U., GRUHN, S. and ETTLINGER, G. Unilateral spatial neglect and defective performance in one half of space, Int. J. Neurosci. 28, 173-195, 1985.
- Meador, K. J., Loring, D. W., Bowers, D. and Heilman, K. M. Remote memory and neglect syndrome. Neurology 37, 522-526, 1987.
- Rode, G. and Perenin, M. T. Caloric stimulation and representational hemineglect. Poster presented at the symposium Consciousness and Cognition: Neuropsychological Perspectives, St. Andrews, 1990.
- Tegnér, R. and Levander, M. Through a looking glass. A new technique to demonstrate directional hypokinesia in unilateral neglect. *Brain* 114, 1943–1951, 1991.