# Feeling touches in someone else's hand

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Received 25 November 2001; accepted 7 December 2001

Cerebral damage may induce a delusional belief so that patients claim that their limbs contralateral to the side of the lesion belong to someone else (somatoparaphrenia). This disorder, which is not due to a general delirium, is frequently accompanied by the inability to feel tactile sensations in the 'non-belonging' part of the body. We report the unique case of a patient with somatoparaphrenia in whom dense tactile imperception in the left hand dramatically recovered when she was instructed to report touches delivered to her niece's hand, rather than to her own hand. We suggest that, through this verbal instruction, the mismatch between the patient's belief about the ownership of her left hand and her ability to perceive touch on it was transiently recomposed. This is evidence that apparently elementary deficits, such as hemianesthesia, and selective delusional behavior, such as somatoparaphrenia, may both originate from an impairment of the body image. *NeuroReport* 13:249–252 ( $\bigcirc$  2002 Lippincott Williams & Wilkins.

Key words: Body image; Ownership; Somatoparaphrenia; Spatial neglect

## INTRODUCTION

How do we know that our limbs are our own, and do not belong to someone else? Is there any relationship between this sense of ownership of body parts and our awareness of the sensory quality of our body? Under conditions of normal brain function, touches delivered, for instance, to our hands are reported as stimuli given to a part of our body. However, brain damage may disrupt tactile perception and, though less frequently, sense of ownership. This pathological state offers the unique opportunity of investigating the role of sense of body ownership in somatosensory awareness. The neuroanatomical functional organization of the brain is such that the inability to report touches delivered to one side of the body (hemianesthesia) is brought about by a lesion to the contralateral somatosensory parietal cortex [1–3]. In humans, when damage to the right hemisphere occurs, left hemianesthesia may sometimes be accompanied by a higher-order impairment of body awareness which, as tactile imperception, concerns the contralateral left side of the body. Patients may exhibit a delusional belief concerning the sense of ownership of body parts, claiming that their left limbs belong to someone else (somatoparaphrenia) [4].

We explored the putative relationship between tactile imperception in particular body parts and selective delusional behavior concerning those body parts in a right brain damaged woman who showed both hemianesthesia and somatoparaphrenia.

## **CASE REPORT AND METHODS**

F.B. was a 77-year-old right-handed woman who, on the 17th December 1999, sustained a stroke in the right cerebral hemisphere. A CT scan showed a right subcortical hemorrhage (Fig. 1). This lesion caused left-sided neurological deficits: hemiplegia, hemianaesthesia, and hemianopia. Gross spatial unilateral neglect for the left side of space [5,6] was found during the copy of various figures and on a number of tasks. On the line bisection test F.B. was asked to mark with a pencil the center of a 20 cm horizontal line, printed on an A4 page, centered on the mid-sagittal plane of her body. The patient made a dramatic rightward error, setting the subjective mid-point on the right end of the line (Fig. 2a). On Albert's cancellation test F.B. was asked to cross out 40 short lines printed on an A4 sheet. F.B. crossed out only six lines on the extreme right side of the sheet, spontaneously adding material, as right brain damaged patients sometimes do [7] (Fig. 2b).

As may occur in unilateral neglect, the patient firmly denied her left neurological deficits (anosognosia). Patients with unilateral neglect are not only unable to attend to stimuli in the extra-personal, contralesional space, but may also show difficulties in attending to and exploring the left side of their own body [8]. F.B. did not report any touch given to her left hand. When she was required to touch her left hand she was not able to reach it: she confined her search to the right side of her peri-personal space, randomly exploring for her left hand. The patient also



**Fig. 1.** Patient F.B.'s CT Scan of the right hemisphere lesion. The haemorrhage invades, from bottom to top, the putamen and pallidum, the posterior brachium of the internal capsule, the white matter underlying the cortex of the following strunctures: insula, superior temporal gyrus, parietal operculum, pre- and post-central gyri. R = right.



Fig. 2. Patient F.B.'s performance in (a) line bisection and (b) Albert's cancellation task [15]. Note on the right side of the sheet a drawing spontaneously made by F.B. while performing the cancellation task.

manifested a delusional behavior confined to her left hand, which she claimed to belong to her niece. Somatoparaphrenia, which may sometimes be associated with left unilateral neglect, was invariably observed over different days and became chronic along with the left hemianaesthesia, still being present 2 months after the acute cerebral accident. F.B. was nevertheless fully oriented in time and space and did not show any other sign of mental deterioration on the Mini Mental State Examination (score: 26/31) [9].

Following a preliminary assessment confirming F.B.'s complete inability to report touches delivered to her left hand, we explored the relationship between her tactile imperception and her selective delusion, using different verbal warnings. On each trial the examiner briefly touched the dorsal surface of F.B.'s hand with the index finger, and warned her that he/she was going to touch (a) her right hand, (b) her left hand, (c) her niece's hand. In the latter condition (c), the examiner touched F.B.'s left hand. The patient was blindfolded and instructed to say 'yes' when she felt a touch and 'no' when she did not feel any touch. Touches were delivered in a randomised fixed order. Catch trials, evenly distributed across the three verbal conditions, were introduced in order to monitor F.B.'s level of sustained attention and reliability of response. F.B.'s tactile perception was assessed in four sessions performed on two consecutive days.

Table I. Patient F.B.'s report of touches given to her left or right hand.

1	0		0
Side of tactile stimulation	Responses		(% correct)
	Yes	No	
24.12.1999/1			
Right hand	10	0	(100%)
Left hand	0	10	(0%)
Left hand (niece's hand)	7	3	(70%)
Catch trials	0	9	(100%)
24.12.1999/2			
Right hand	10	0	(100%)
Left hand	0	10	(0%)
Left hand (niece's hand)	7	3	(70%)
Catch trials	0	9	(100%)
25.12.1999/1			
Right hand	10	0	(100%)
Left hand	0	10	(0%)
Left hand (niece's hand)	10	0	(100%)
Catch trials	0	9	(100%)
25.12.1999/2			
Right hand	10	0	(100%)
Left hand	0	10	(0%)
Left hand (niece's hand)	8	2	(80%)
Catch trials	0	9	(100%)

## RESULTS

When F.B. was required to report touches delivered to her niece's hand, her tactile imperception dramatically recovered (Table 1). Immediately after the experiment, we asked F.B. how she could report touches on someone else's hand. Her response was initially elusive; however she eventually explained the phenomenon as follows (though adding Yes, I know, it is strange'): her absent-minded niece would always forget her hand on the patient's bed while leaving the hospital, so that F.B. used to take care of it until the niece came back to visit her again.

## DISCUSSION

Patient F.B.'s behavior sheds light on important aspects of a much debated issue in cognitive neuroscience [10]: the nature of the belief of ownership of body parts and its disorders. Body segments are mapped in an orderly fashion onto somatosensory and motor cortices. Their representations are resistant to the absence of the corresponding physical objects as illustrated by the vivid persistent perception of an amputated body part in the phantom limb syndrome [11,12]. Somatoparaphrenia may be considered the opposite phenomenon: a limb, although still part of the body, is felt as if it were not belonging to the body itself.

F.B.'s spared ability to perceive tactile stimuli, provided that these were referred to someone else's body, was evidently based on the survival of some elementary somatosensory cortical functions, perhaps of the kind mapped in primary or secondary somatosensory cortices [1,2]. The behavior of our patient, however, shows that these sensory representations are not sufficient to generate the sense of ownership of the touched limb. F.B.'s recovered ability to report touches on the affected left upper limb, following verbal instructions coherent with her delusion, is, under some respects, similar to the phenomenon of allochiria [13] which, like somatoparaphrenia, may be associated with the syndrome of spatial unilateral neglect. Patients with tactile allochiria perceive touches contralateral to the side of the lesion, but refer them to the ipsilateral side of their body [14]. Patient F.B. reported left-sided touches only when, prompted by the examiner, she delusively referred them to someone else's body image. In both conditions, conscious tactile perception would occur only when the disrupted representation of one side of the body is replaced by a preserved image: that of the unaffected side in allochiria, or, as in patient F.B., the delusional image of a body part of another person.

The transient remission of F.B.'s tactile deficit via an interplay with her somatoparaphrenic delusion demonstrates that somatosensory awareness involves a crucial contribution from a higher-level representation of the body, including basic beliefs, such as ownership.

## CONCLUSION

The nature of the belief of ownership of body parts is a major issue in cognitive neuroscience of consciousness. Limb representation can survive to the absence of the corresponding physical objects, as in the phantom limb syndrome. In a different syndrome, somatoparaphrenia, one can observe the opposite phenomenon: a limb, although still part of the body, is felt as if it were not belonging to the body itself rather it is vividly felt as belonging to someone else. Somatoparaphrenia is frequently associated with hemianaesthesia and unilateral neglect.

In this paper we describe the unique case of a patient with somatoparaphrenia and phenomenological hemianeasthesia who was very accurate in reporting tactile stimuli when these were delivered to what she believed to be someone else's hand. Our experiment provides evidence that elementary somatosensory representations are not sufficient to give rise to a sense of ownership, rather both, elementary tactile perception and sense of ownership; rather, both elementry tactile perception and sense of ownership must depend on a more abstract/higher level body image.

## REFERENCES

- 1. Roland PE. Exp Brain Res 66, 303-317 (1987).
- 2. Pause M, Kunesch E, Binkofski F and Freund HJ. Brain 112, 1599–1625 (1989).
- Paulesu E, Frackowiak R and Bottini G. Maps of somatosensory systems. In: Frackowiak R, ed. *Human Brain Function*. San Diego: Academic Press; 1997, pp. 183–242.
- 4. Gerstmann J. Arch Neurol Psychiatry 48, 890-913 (1942).
- Heilman KM, Watson RT and Valenstein E. Neglect and related disorders. In: Heilman KM and Valenstein E, eds. *Clinical Neuropsychology*, 3rd edn. New York: Oxford University Press; 1993, pp. 279–336.
- 6. Vallar G. Trends Cogn Sci 2, 87-97 (1998).
- 7. Rusconi M, Maravita A, Bottini G et al. Neuropsychologia in Press (2002).
- Bisiach E, Perani D, Vallar G and Berti A. Neuropsychologia 24, 759–767 (1986).
- 9. Folstein MF, Folstein SE and McHugh PR. J Psychiatric Res 12, 189–198 (1975).
- Bermudez JL, Marcel A and Eilan N. The Body and the Self. Cambridge, MA: MIT Press, 1995.
- Weinstein S. Neuropsychological studies of the phantom. In: Benton AL, ed. Contributions to Clinical Neuropsychology. Chicago: Aldine Publishing Company; 1969, pp. 73–106.
- Frederiks JAM. Phantom limb, phantom limb pain. In: Vinken PJ, Bruyn GW, Klawans HL and Frederiks JAM, eds. *Handbook of Clinical Neurology*. *Clinical Neuropsychology*. Revised series 1, vol. 45. Amsterdam: Elsevier; 1985, pp. 395–404.
- 13. Obersteiner H. Brain 4, 153-163 (1882).
- Bisiach E and Berti A. Consciousness in dyschiria. In: Gazzaniga MS, ed. The Cognitive Neurosciences. Cambridge, MA: MIT Press; 1995, pp. 1331–1340.
- 15. Albert ML. Neurology 23, 658-664 (1973).

Acknowledgements: The present investigation was inspired by an informal clinical observation reported to E.B. by Professor M.W. van Hof, of the Erasmus Universiteit Rotterdam. This study was supported in part by grants of Bracco spato G.B. and MURST grants to E.B. and G.V.We are grateful to Eraldo Paulesu for his comments on an earlier version of the manuscript.