

Can mirrors alleviate visual hemineglect?

V. S. Ramachandran, E. L. Altschuler, L. Stone, M. Al-Aboudi,
E. Schwartz, N. Siva

Brain and Perception Laboratory, Center for Research on Brain and Cognition, UCSD La Jolla, CA, USA

Summary Following right hemisphere stroke, many patients display an indifference to objects and events in the left side of the world ('neglect'). Here, we describe a new technique that might help accelerate recovery from neglect. The patient sits at a table and a mirror is propped vertically on the patient's right side in the parasagittal plane, so that when the patient rotates his head rightward and looks into the mirror, he sees the neglected side of the world reflected in the mirror. Our question was: since the sensory information was now coming from the non-neglected left side, would this somehow make him overcome the neglect? In pilot experiments, two types of responses were seen: (a) In one subset of patients the presence of the mirror seemed to enhance the patients' awareness of the neglected field, so that they reached correctly for an object that was shown in the neglected field. Will repeated practice with this task accelerate recovery from neglect? (b) The second group of patients kept reaching into the mirror to grasp the reflection or kept groping behind the mirror ('mirror agnosia'). If the mirror was placed in the coronal position and the object placed behind their head, then some of these patients (from group B) reached correctly for the object. Quite apart from its obvious theoretical implications, we believe this technique might provide a new approach for the treatment of visual hemineglect.

INTRODUCTION

Hemispatial neglect is one of the most enigmatic syndromes in neurology and it usually occurs following a right hemisphere stroke (1–6). Patients tend to ignore everything on their left side even though they can see the same things perfectly clearly if their attention is drawn to them.

This paper is concerned with a new theoretical question. If a person looks into a parasagittally placed mirror propped vertically on his right side, how does he respond to the reflection of objects in the neglected side that are visible exclusively in the non-neglected (right) side?

RATIONALE

After chatting with the patients informally, we propped a mirror up vertically on the right side of the bed or

wheelchair with one experimenter (VSR) standing behind it. The mirror was 2 feet tall and held parallel to the sagittal plane so that its right edge was close to her right shoulder. She was asked to turn her head and eyes rightwards to look into the center of the mirror so she could clearly see the mirror reflection of the people/objects that were on the left side of the bed or wheelchair. It was quite clear that it was a mirror since it had a wooden frame and dust on its surface. Our question was: how would the patient react to objects seen only in the mirror? Would it help overcome her neglect of these objects since the sensory input was now coming from the right side, or would she ignore the reflection as well?

METHODS

We conducted this experiment on twelve patients with visual hemineglect caused by right cerebrovascular accident (CVA). To ensure that the patient knew she was looking in the mirror, one investigator stood on the patient's right behind the mirror and asked: 'What is this I am holding?' to which each patient replied 'a mirror'. Upon receiving a cue, a second investigator standing on the patient's left side held out a pen or candy bar toward

Received 20 August 1997

Accepted 8 September 1997

Correspondence to: V. S. Ramachandran, Brain and Perception Laboratory, Center for Research on Brain and Cognition, UCSD La Jolla, CA 92093-0109, USA. Phone: +1 619 534 6240; Fax: +1 619 534 7190; E-mail: vramacha@ucsd.edu

her so that it was well within the reach of the patient's nonparalyzed (right) hand but entirely within the neglected (left) visual field – about 8 inches below and to the left of the patient's nose. The experimenter then asked the patient, 'Do you see the pen?' and when she nodded and/or said yes, the experimenter added, 'Okay, reach out and grab the pen please.'

We found that, based on their response to the task, the patients fell into two groups:

- A. In some of the patients, the presence of the mirror actually seemed to help them overcome the neglect, i.e. when they were asked to retrieve the object, after some initial hesitation they reached correctly for the object into the left visual field. This observation raises an interesting clinical question: Can the mirror be used as a therapeutic device to increase the patient's awareness of the left side of the world so that he is permanently cured of neglect? Will repeated practice with this technique accelerate recovery of function? And, if so, would the 'cure' be task-specific or would it generalize to other day-to-day activities?
- B. In the second subgroup of patients we found, remarkably, that even though the patient knew she was looking into a mirror, she kept reaching for the mirror reflection of the object – apparently confusing the mirror reflection of the object for the real object! We have dubbed this syndrome 'mirror agnosia' or the 'looking-glass syndrome' (7). It is as though the patient is saying to himself: 'Since the reflection of the pen is on my right the object must be on my left, but since left does not exist on my planet the object is inside the mirror.' Intriguingly, when the patients were asked to describe where the object was, they often made absurd remarks such as: 'It's not in my reach', or 'It's behind the mirror'. Patient MR also tried groping behind the mirror on several trials claiming that 'the object is behind the mirror' or 'inside the mirror'. On some occasions, she tried to grope VSR's tie or belt-buckle while he stood behind the mirror. This happened continuously for about 20 seconds on any given trial. This syndrome was not seen in 6 control patients of comparable mental status with a left CVA, which suggests that the syndrome is probably a consequence of right hemisphere pathology.

A mental status check was performed routinely on these patients and it was clear that there was no component of dementia and that the patients were lucid in other respects, even though they failed the mirror task. This is a surprising result considering that even chimpanzees and toddlers have no difficulty in realizing that a reflection is not a real object.

As a control condition, we placed the mirror at arm's

length in front of the patients in the coronal plane. This time, when the candy appeared just behind and above the patient's right shoulder (but just outside the patient's visual field), the patient saw it in the mirror and her right hand went straight behind her to grab it. We may conclude, therefore, that what we are dealing with is not a general confusion with mirrors, nor an inability to reach for objects, or to understand and follow out instructions. However, this was true only of half of the patients in this subset (B). The other patients had mirror agnosia for the coronal condition as well; they kept trying to reach either into the mirror or behind it, often expressing surprise that they could not find the object.

In two patients, after we had shown that they reached correctly for the object in the coronal mirror, we gradually moved the mirror in an arc-like manner to occupy the parasagittal plane on their right side. As a result of hysteresis, these patients were now able to overcome mirror agnosia and reach correctly for the pen on the left side. Again, this raises the question of whether repeated training with this procedure increase the patient's awareness of the left side of the world, thereby accelerating recovery from neglect.

There are three possible interpretations of mirror agnosia that are not mutually exclusive:

- a. It may be a specific consequence of neglect: the mirror image is 'referred' or projected to the neglected side and therefore becomes neglected like everything else on that side;
- b. It may not be a specific consequence of neglect, although it usually accompanies neglect. Instead, it may be a striking manifestation of the subtle deficits in spatial coordinate systems that occur following parietal lobe lesions. Responding correctly to a mirror image requires the creation of a rather peculiar form of dual representation of 'mental diplopia' and this subtle ability may be compromised by the right parietal lesion. This would explain why some patients also reach repeatedly into the coronal mirror.
- c. Perhaps the incorrect response to the command 'Reach for the pen' is linked in some way to the literal-mindedness and difficulty with metaphorical language use that characterizes some right hemisphere patients. This seems unlikely, since the patients often looked genuinely surprised and frustrated at their inability; they certainly didn't give the impression of 'miming' the reaching response. Also, it wouldn't explain why some of the same patients reach correctly for the object seen in the coronal mirror. However, the issue needs to be addressed more carefully with reference to additional patients.

The reason for the variability across patients is unclear,

but we must bear in mind that neglect can arise from lesions in many different locations; parietal cortex, cingulate, thalamus, or even caudate nucleus. It is possible that only a subset of these will display mirror agnosia, whereas the others might actually benefit from the mirror.

CONCLUSION

Mirrors have been used before for studying neglect but usually in very complicated ways, e.g. Tegner, Bisiach and colleagues (8,9) adopted the ingenious procedure of using a pair of mirrors at right angles to each other placed in front of the patients (to avoid left/right reversal) and the patient was asked to perform a line cancellation task while looking in the mirror. Our own question, on the other hand, is much simpler: how does the patient react to reflections of objects in the neglected side, seen only in the non-neglected side? It is remarkable that, even though we have known about neglect for more than half a century, this simple question was never raised before. And the strategy we employ – using a parasagittal mirror – may not only prove to be a useful therapeutic tool for overcoming neglect (in some patients) but also raises interesting new theoretical questions. It is especially astonishing that for the patients in subset (B), even their 'propositional knowledge' about mirrors becomes selectively warped to accommodate the strange looking-glass world in which they find themselves trapped.

Mercifully, most patients with neglect recover within the first few weeks after stroke but, in a subset of patients, it can linger for months or even years. Furthermore, indifference to the left side of the world can make him oblivious to the extent of paralysis of the left arm. In the absence of visual feedback, patients are often unwilling

to partake in rehabilitation of finger movements and grip strength during the few critical weeks following a stroke. We are therefore investigating whether mirrors can be used to educate neglect patients into accepting the left side of the world. In addition to providing a novel approach to treating visual hemi-neglect, the mirror technique may also give us new theoretical insights into this fascinating disorder.

ACKNOWLEDGMENTS

We thank R. L. Gregory for getting us interested in the fascinating world of mirrors.

REFERENCES

1. Riddoch G. Visual disorientation in homonymous hemifields. *Brain* 1935; 58: 376–382.
2. Brain W. R. Visual disorientation with special reference to lesions of the right cerebral hemisphere. *Brain* 1941; 64: 224–272.
3. Critchley M. *The Parietal Lobes*. New York: Hafner, 1966.
4. Heilman K., Watson R. T., Valenstein E. Neglect and related disorders. In Heilman K., Valenstein E. (eds) *Clinical Neuropsychology*. Oxford: Oxford University Press, 1985: 243–284.
5. Kinsbourne M. Mechanisms of neglect. In: Halligan P. W., Marshall J. C. (eds) *Neuropsychol Rehab (Special Issue on Spatial Neglect)* 1994; 4: 151–153.
6. Halligan P. W., Marshall J. C. (eds) *Neuropsychol Rehab (Special Issue on Spatial Neglect)* 1994; 4: 99–240.
7. Ramachandran V. S., Altschuler E. L., Hillier S. Mirror agnosia. *Proc R Soc London B* 1997; 264: 645–647.
8. Tegner R., Levander M. Through a looking glass. A new technique to demonstrate directional hypokinesia in unilateral neglect. *Brain* 1991; 114: 1943–1951.
9. Bisiach E., Tegner R., Ladavas E., Rusconi M. L., Mijovic D., Hjaltason H. Dissociation of ophthalmokinetic and melokinetic attention in unilateral neglect. *Cerebral Cortex* 1995; 5: 439–447.