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Agnosia for Mirror Stimuli: A New Case Report with a Small Parietal Lesion

Olivier Martinaud[1,*], Nicolas Mirlink[1], Sandrine Bioux[1], Evangéline Bliaux[1], Axel Lebas[2], Emmanuel Gerardin[3], Didier Hannequin[1]

[1]*Department of Neurology, Rouen University Hospital, Rouen, France*
[2]*Department of Neurophysiology, Rouen University Hospital, Rouen, France*
[3]*Department of Neuroradiology, Rouen University Hospital, Rouen, France*

*Corresponding author at: 1 rue de Germont, 76031 Rouen, France. Tel.: +33-2-32-88-87-40; Fax: +332-32-88-87-41.
E-mail address: olivier.martinaud@chu-rouen.fr (O. Martinaud).

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Abstract

Only seven cases of agnosia for mirror stimuli have been reported, always with an extensive lesion. We report a new case of an agnosia for mirror stimuli due to a circumscribed lesion. An extensive battery of neuropsychological tests and a new experimental procedure to assess visual object mirror and orientation discrimination were assessed 10 days after the onset of clinical symptoms, and 5 years later. The performances of our patient were compared with those of four healthy control subjects matched for age. This test revealed an agnosia for mirror stimuli. Brain imaging showed a small right occipitoparietal hematoma, encompassing the extrastriate cortex adjoining the inferior parietal lobe. This new case suggests that: (i) agnosia for mirror stimuli can persist for 5 years after onset and (ii) the posterior part of the right intraparietal sulcus could be critical in the cognitive process of mirror stimuli discrimination.

Keywords: Agnosia for mirror stimuli; Orientation agnosia; Dressing apraxia; Occipito-parietal lesion; Stroke

Introduction

Object recognition can be dissociated from the processing of object orientation. Lesions of the right posterior parietal lobe may be responsible for orientation agnosia, i.e., difficulty in evaluating the orientation of visual stimuli. Agnosia for mirror stimuli is the incapacity to discriminate an object from its mirror image. In all orientation agnosia and agnosia for mirror stimuli cases, the ability to recognize and name the objects is preserved, suggesting an independent process of object orientation. This dissociation is consistent with the two visual pathways theory (Goodale & Milner, 1992), with a viewer independent representation supported by the occcipitotemporal cortex (or ventral pathway), and a viewer dependent representation supported by the occipitoparietal cortex (or dorsal pathway). Eleven cases of patients with orientation agnosia have been published to date (Best, 1917; Cooper & Humphreys, 2000; Davidoff & Warrington, 1999; Fujinaga, Muramatsu, Ogano, & Kato, 2005; Harris, Harris, & Caine, 2001; Karnath, Ferber, & Bulthoff, 2000; Robinson, Cohen, & Goebel, 2011; Turnbull, Laws, & McCarthy, 1995; Turnbull, Beschin, & Della Sala, 1997; Vinckier et al., 2006), but mirror stimuli discrimination was only tested in five cases (Davidoff & Warrington, 1999; Harris et al., 2001; Turnbull et al., 1997; Vinckier et al., 2006). Among these five cases of orientation agnosia, four suffered from agnosia for mirror stimuli. Only three cases of isolated agnosia for mirror stimuli have been reported (Davidoff & Warrington 2001; Priftis, Rusconi, Umilta, & Zorzi, 2003; Turnbull & McCarthy, 1996). All three patients selectively failed in discriminating mirror stimuli, whereas they had no difficulty in discriminating orientations. At least one case suffered from the opposite pattern (Turnbull et al., 1997). This dissociation between orientation agnosia and agnosia for mirror stimuli suggests that discrimination of mirror stimuli and the discrimination of rotations may depend on relatively independent brain systems (Priftis et al., 2003). Anatomical correlations remain very imprecise as all of the lesions described to date are very large or bilateral.

In the present study, we report a case of sudden dressing apraxia, where tests showed difficulties in mirror stimuli discrimination. This case of agnosia for mirror stimuli is unique because it was associated with a small right parietal lesion.

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Case Report

A 75-year-old right-handed woman with 8 years of formal education, worked as an office employee. She had a past medical history of arterial hypertension. She presented with isolated dressing apraxia that had appeared suddenly. She was unable to orient her clothes and needed help from a neighbor to dress herself. Clinical neurological examination by a senior neurologist (OM) revealed no motor or sensitive deficit. She had no pyramidal, extrapyramidal, or cerebellar signs to explain her dressing apraxia. The ophthalmological examination, including a Goldmann kinetic perimetry, was normal.

Brain CT-scan at the acute stage revealed a recent small isolated right occipitoparietal hematoma (see Fig. 1A). No white matter lesions, microbleeds, tumors, or arteriovenous malformations were found in brain magnetic resonance imaging (MRI) (with axial 3DT1, T2, Flair, T2*, angio-MR and T1 with gadolinium) at the acute and the chronic stage (see Fig. 1B–C). Anatomical T1-weighted MRI images were linearly transformed into montreal neurological institute space using the statistical parametric mapping software. The hemorragic lesion affected the extrastriate cortex (Brodmann area (BA) 19) from coordinates $z = +16$ to $z = +40$, reaching the posterior part of the inferior parietal lobe (BA 7). This lesion extended from coordinates $y = -70$ to $y = -90$ until the angular gyrus (BA 39), involving the posterior part of the intraparietal sulcus. The width remained very fine, from $x = +30$ to $x = +35$.Lesion volume was evaluated to 4,817 voxels.

Methods

Two cognitive evaluations were conducted: 10 days after the onset of clinical symptoms, and 5 years later. She underwent a series of standardized cognitive tests (see Supplementary material online, Table S1), and an additional original experimental test designed to assess visual object mirror and orientation discrimination. The Mirror and Orientation Agnosia Test, a computer administered task. A set of nine drawings was selected from the Snodgrass and Vanderwart's pictures (1980): three animals (a bear,

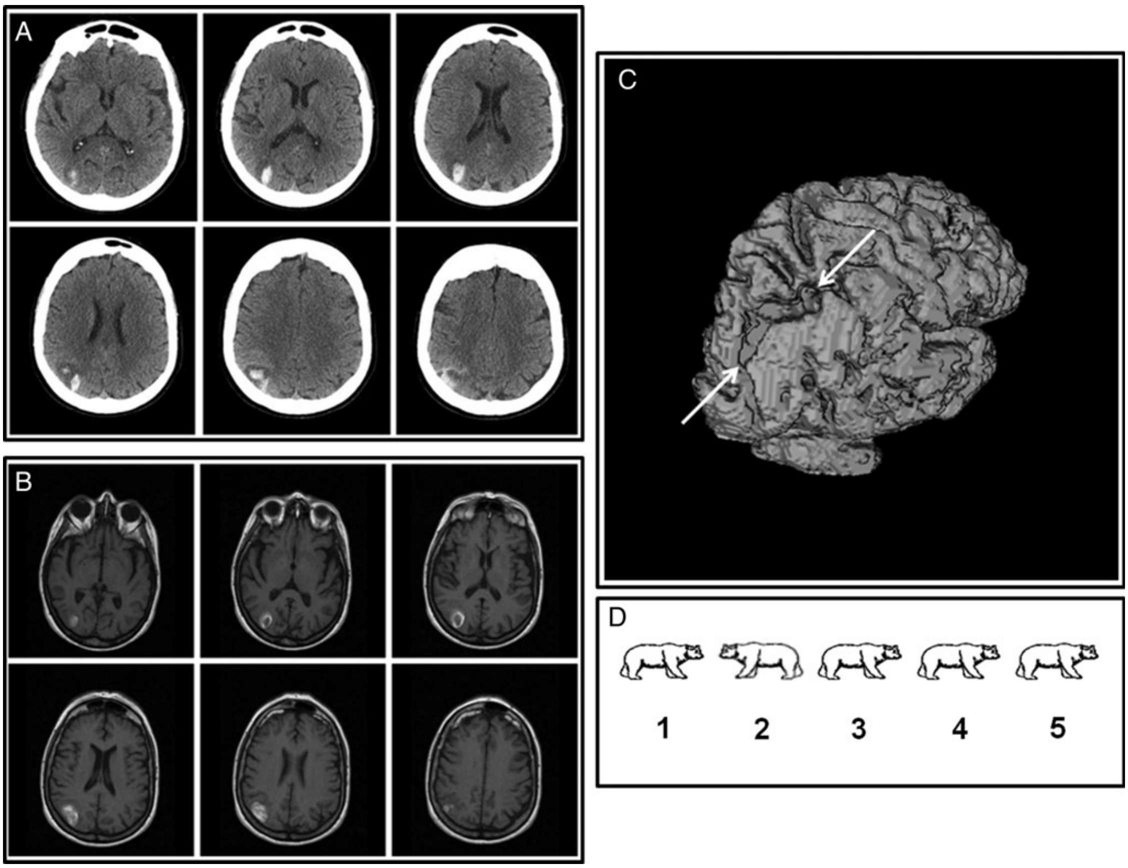

Fig. 1. Brain imaging of the patient. (A) Axial cerebral CT-scan at the acute stage showing spontaneous occipitoparietal hyperdensity. (B) T1 axial cerebral MRI at the chronic stage showing occipitoparietal high-signal intensity. (C) 3D reconstruction; white arrows show the beginning and the end of the lesion (light gray). (D) Example of stimuli for the mirror and orientation agnosia test in 'mirror' condition.

an elephant and a crocodile), three graspable objects (a clothespin, a knife and a pair of pliers), and three big objects (a desk, a bicycle and a chair). At the first assessment, our patient was presented with only one series of 45 trials (the "mirror" condition). At the second assessment, six series of 45 trials were used. Each trial included five drawings, horizontally aligned one next to the other (see Fig. 1D for example). One series corresponded to one condition of presentation. (i) In the "identity" condition, four of the stimuli were identical in the same canonical orientation, whereas the fifth stimulus, the target, was one among the two other drawings from the same category (e.g., four elephants and one bear or one alligator). This condition was the control condition to ensure that there was no visual agnosia. In the five other conditions, the five stimuli represented the same animal or object. Four distractors were presented in canonical view, whereas the target was: (ii) their mirror image, around its horizontal axis, in the "up-down" mirror condition; (iii) their mirror image, around its vertical axis, in the traditional "mirror" condition (Fig. 1D); (iv) rotated 90° clockwise in the "90°" condition; (v) rotated 180° clockwise in the "180°" condition. (vi) In the "45° + 90°" condition, all five stimuli were first rotated 45° clockwise, then only the target was rotated 90° clockwise. The target appeared with equal frequency in every spatial position, for a total of 45 trials (9 objects × 5 positions) for each condition.

The five stimuli were numbered, and they appeared in random order in the center of a screen. The task was to designate which stimulus was different from the others. Subject was asked to push the corresponding button out of five buttons. The next trial appeared as soon as the subject had pushed one of the buttons. There was no time limit. The answer and the time to answer were recorded, so that we could determine the accuracy (the rate of correct answers) and the mean reaction time (RT) for each condition. The same experimental tests were also administered to four healthy control subjects matched for age.

Patient's absolute errors and RT were compared with those of the four control subjects, using a modified *t*-test for small control group size (Crawford & Garthwaite, 2002).

Our patient gave her written consent. The study was conducted in accordance with the Declaration of Helsinki, following approval by an independent ethics committee.

Results

Results of our patient in standardized neuropsychological tests are represented in Supplementary material online, Table S1. At the initial stage, she performed very well in all cognitive tasks, implicating global efficiency, language, gestural praxis, verbal and visual memory. On the other hand, she presented difficulties with visuoconstructive praxis and visuospatial perception in all the tests of our battery, except the body parts naming test. She showed no mirror-reflection errors in copying or mirror confusions in reading or writing. Finally, categorical fluency was below the normal threshold, but there was no other evidence for a cognitive dysexecutive syndrome. Dressing apraxia was still present at this moment: she struggled to orient her clothes and was slower to dress. She could put the wrong arm in her wrong sleeve, but she began to spontaneously correct herself. Five years after, she had no more complaint about dressing. She showed still normal performances in global efficiency, language, gestural praxis, verbal and visual memory, although a slight decline was observed. However, she normalized several tests, including categorical fluency and several visuospatial perception tests. In fact, she failed essentially in the judging line orientation test and the Hooper visual organization test.

Results in the experimental tests are represented in Table 1. The mean age of the four control subjects, two women and two men, was 74.5 years (range 71–77 years). Their mean level of education was 12.7 years (range 9–17 years). Our patient presented difficulties in mirror discrimination in the first evaluation with a particularly long RT ($t = 12.67$, $p = .001$, two tailed). Interestingly, RT improved at the 5-year evaluation, but to the detriment of accuracy ($t = -3.194$, $p = .05$, two tailed). On the other hand, patient's performances were quite similar to the control subjects in all of the five other conditions.

Table 1. Experimental study in patient and four control subjects

Experimental test condition	Patient (10 days)		Patient (5 years)		Control subjects	
	Score	RT (*SD*)	Score	RT (*SD*)	Score (*SD*)	RT (*SD*)
Mirror	40	18,905* (10,958)	35**	5,286 (3444)	43.5 (2.38)	4,180 (1039)
Up-down mirror	ND	ND	43	3,039 (1161)	44.2 (0.96)	2,218 (451)
45° + 90°	ND	ND	43	3,325 (991)	43.7 (0.96)	2,795 (533)
180°	ND	ND	45	3,348 (1540)	43.7 (0.5)	2,284 (461)
90°	ND	ND	45	2,565 (681)	44.7 (0.5)	1,918 (301)
Identity	ND	ND	45	3,017 (728)	45 (0)	2,055 (304)

Notes: Score out of 45; RT, reaction time (ms); SD, standard deviation; ND, not done.
*$p = .001$; **$p = .05$.

In summary (i) our patient did not present a classical agnosic deficit since the "identity" condition was normal, and she had no relevant difficulties with usual tests; (ii) she presented mild visuopraxic and visuospatial deficits; (iii) she had no significant orientation agnosia because her scores in the three orientation conditions were normal, despite difficulties in the judging line orientation test; (iv) her agnosia for mirror stimuli was suggested by pathological RTs at the first evaluation, and its persistence by a pathological accuracy score at the second evaluation, in the "mirror" condition; (v) she suffered from a small isolated right occipitoparietal hematoma.

Discussion

Our patient was impaired in mirror discrimination and in several visuospatial tasks, whereas her performance was normal in other cognitive assessments, suggesting that she suffered from agnosia for mirror stimuli. However, our experimental design does not permit to paint a clear picture of the nature of our patient's deficit. For example, when reflections across object axes are unconfounded with reflections across extrinsic axes, neurologically intact individuals do not show any systematic tendency to confuse left–right extrinsic-axis reflections of objects, but instead tend to confuse reflections across object principal axes (Gregory & McCloskey, 2010). None of the nine individual stimuli of the mirror and orientation agnosia test was more impaired in our patient, which means there was no particular pattern to explain her agnosia for mirror stimuli.

Sudden and isolated dressing apraxia was the only clinical symptom reported by our patient, although the neuropsychological tests revealed certain other visuospatial difficulties. One could consider agnosia for mirror stimuli as a possible explanation for dressing apraxia. However, among the seven reported cases of agnosia for mirror stimuli (four with orientation agnosia), dressing apraxia was only described in two (Harris et al., 2001; Vinckier et al., 2006). These two patients, like our patient, spontaneously complained of dressing apraxia, but they suffered from posterior cortical atrophy. Considering the etiology and disease duration (respectively 5 and 3 years), it is difficult to conclude that agnosia for mirror stimuli is solely responsible for dressing apraxia in these two cases. Moreover, they also suffered from orientation agnosia. In the case of our patient, her dressing abilities have improved over time, just like her visuospatial perception in generally, while her agnosia for mirror stimuli was still present.

All reported agnosia for mirror stimuli patients had only a single evaluation, with the exception of one patient with Alzheimer's disease, who still presented agnosia for mirror stimuli at a second evaluation seven months after initial presentation (Harris et al., 2001). Another patient, who had presented with severe orientation agnosia 6 months after a bilateral occipital and parietal infarction, had normalized his performance 3 years later (Fujinaga et al., 2005). In our case, the results from the acute stage support the possibility of the presence of an agnosia for mirror stimuli. Despite a score just above the threshold of normality on the experimental test in the traditional "mirror" condition at the first assessment, her extraordinary long RT prompted us to perform a more comprehensive assessment 5 years later. At this time, she was less concerned by her difficulties, which could explain her pathological scores but with shorter RTs. In fact, she said to favor speed over accuracy. It is essential to take into consideration RT in the analysis of visuospatial performances, as it reflects the neuronal processes of recovery or the development of alternative cognitive strategies after a stroke.

Two limitations of our study are noteworthy: healthy controls were slightly younger than our patient, and mild cognitive decline was observed 5 years later (see Supplementary material online, Table S1). Despite this decline in cognitive performances, there was no evidence for vascular dementia since scores were still within the normal range, dependence did not increase, and no additional vascular lesions were found in brain MRI. She was still totally independent in all activities of daily living.

Agnosia for mirror stimuli was the consequence of bilateral parietal strokes in three cases (Davidoff & Warrington 1999, 2001; Turnbull & McCarthy 1996), voluminous strokes including the right parietal lobe in two cases (Priftis et al., 2003; Turnbull et al., 1997), and bilateral parietal atrophy in the two remaining cases (Harris et al., 2001; Vinckier et al., 2006). The right parietal lobe seems to be a critical node in the cerebral network of mirror stimuli discrimination. This hypothesis is congruent with the results of functional brain imaging studies on orientation processes, who have shown the involvement of the intraparietal sulcus (e.g., Niimi, Saneyoshi, Abe, Kaminaga, & Yokosawa, 2011; Tibber, Anderson, Melmoth, Rees, & Morgan, 2009). In contrast, our patient presented a very focal vascular lesion (see Fig. 1A–C) with less severe agnosia for mirror stimuli. We therefore suggest that the posterior part of the right intraparietal sulcus could play a major role in the cognitive process of mirror stimuli discrimination.

We present a new case of a very rare deficit, agnosia for mirror stimuli, associated with a very small right parietal hematoma. Interestingly, thorough neuropsychological assessment revealed that this deficit was still present 5 years later, supplying a possible major role of the posterior part of the right intraparietal sulcus.

Supplementary Material

Supplementary material is available at *Archives of Clinical Neuropsychology* online.

Conflict of Interest

None declared.

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