

The Alien Hand Syndrome

Clinical and Postmortem Findings

Gordon Banks, PhD, MD; Priscilla Short, MD; A. Julio Martinez, MD; Richard Latchaw, MD; Graham Ratcliff, DPhil; François Boller, MD, PhD

● Two patients had automatonlike movements of their left hands and arms (alien hand syndrome) following damage to the brain. Autopsy findings in one patient demonstrated gunshot wound damage to the medial frontal white matter bilaterally, as well as the corpus callosum, right basal ganglia, internal capsule, and thalamus. The other patient had a ruptured anterior communicating aneurysm, with subsequent resection of the right frontal gyrus rectus. We postulate that this syndrome is due to the combination of a partial callosotomy and mesial frontal lesions.

(*Arch Neurol* 1989;46:456-459)

Two patients had automatonlike movements and uncooperative behavior of the left arm and hand following brain injury. Similar cases have been referred to as the alien hand syndrome. The cause of the syndrome is uncertain, but it is considered, at least partly, to be a disconnection syndrome. Previously described cases have implicated the medial frontal lobes and/or anterior corpus callosum, but autopsy studies have been lacking in evidence. We describe herein the clinical and pathologic features of these cases and try to relate them to previously described cases.

REPORT OF CASES

CASE 1.—A 39-year-old (at the time of injury), right-handed woman had attended grade school and worked as manager of a

Accepted for publication Feb 15, 1988.

From the Departments of Neurology (Drs Banks, Short, and Boller), Pathology (Dr Martinez), Radiology (Dr Latchaw), Psychology (Dr Ratcliff), and Psychiatry (Drs Ratcliff and Boller), University of Pittsburgh; and Harmorville Rehabilitation Center, Pittsburgh (Dr Ratcliff).

Read before the 30th annual meeting of the American Academy of Neurology, Boston, April 10, 1984.

Reprint requests to Department of Neurology, University of Pittsburgh, 322 Scaife Hall, Pittsburgh, PA 15261 (Dr Banks).

snack bar until she suffered a gunshot wound to the head in 1971. The bullet entered the skull above the right orbit and traversed the brain. Surgical findings revealed destruction of the right orbital plate of the frontal bone with periorbital tissue pushing upward from the orbit. Both proximal anterior cerebral arteries were clipped to control bleeding. Postoperatively, the patient was blind in the right eye and had left hemiparesis and left hemianesthesia. A few months later, she noticed that her left arm began to move "on its own." The left hand would tenaciously grope for and grasp any nearby object, pick and pull at her clothes, and even grasp her throat during sleep. These autonomous left arm and hand movements tended to occur in bouts usually signaled when her hand did "silly things" such as scratching her knee. She slept with the arm tied to prevent nocturnal misbehavior. She never denied that her left arm and hand belonged to her, although she did refer to her limb as if it were an autonomous entity. She recovered her ability to walk, but the autonomous arm movements persisted unchanged until her death in 1983 due to metastatic adenocarcinoma of the breast.

We examined her for the first time in October 1983. She was alert, sitting with her left hand tucked into her right axilla. She was oriented for time, place, and person and was slightly euphoric. She was talkative and not aphasic, but she had a mild dysarthria. She could name objects and parts of objects presented visually, and she could identify objects placed in her right hand while her eyes were covered. Tactile naming was much poorer (at chance level) with her left hand. With her eyes still covered, she was asked to identify by touch a set of objects that had just been put in her hand. She did well when the objects were placed in her right hand but poorly when they were placed in her left hand. Auditory comprehension and calculation were normal, but she showed right-left confusion.

She performed gestures well, either spontaneously or on command (eg, "salute," "show how you would use a key"), with her right arm but not with her left one. Similarly, mirror movements were

impossible with the left arm.

Her memory was intact, but she had difficulty recognizing familiar faces. Spontaneous and copied drawings showed obvious left-sided neglect. There was optic atrophy on the right side with a Marcus Gunn pupil and no vision, palsy of the right trochlea, and decreased sensation over the right ophthalmic trigeminal distribution. She had a left hemianopia, weakness of the lower facial muscles on the left side, and a minimal to mild left hemiparesis.

Placed in the patient's lap, the left arm often moved to her right axilla. The patient claimed this movement was involuntary. The left hand tenaciously grasped objects and groped actively for objects to grasp, such as clothing and bed rails. These groping movements consisted of rapid opening and closing of the fingers while the hand crept forward.

The patient's legs were weak bilaterally. Her reflexes were brisker on the left side, with a left-sided Babinski's sign. She had no grasp on the right side and no suck, snout, or glabellar reflex. She had a left hemianesthesia.

Bone scan and spine films, as well as myelograms, revealed metastases in the upper vertebral bodies, which were thought to account for the right leg weakness. Chest x-ray films revealed metastatic lung lesions. Electroencephalograms, both awake and asleep, demonstrated groups of high-amplitude theta waves in the right frontal region. These slow waves were not associated with her hand movements. A head computed tomographic (CT) scan revealed bifrontal encephalomalacia, more pronounced on the right side, and lucency in the anterior part of the corpus callosum (Fig 1). A cerebrospinal fluid sample demonstrated the following values: leukocytes, $1 \times 10^6/L$ (a lymphocyte); protein, 1.87 g/L; and glucose, 4.7 mmol/L.

The patient was treated with radiation and chemotherapy. She died of cardiopulmonary arrest during an admission for chemotherapy 13 years after the gunshot wound.

CASE 2.—A 40-year-old right-handed, male, college-educated draftsman had complained of headaches, neck stiffness, nausea, and vomiting for one month and had been subsequently treated for "gastro-

enteritis." In July 1986, following a sudden increase in the severity of headache, he rapidly became comatose. On arrival at the medical center, he was unresponsive except for grimace to painful stimuli. He had a stiff neck, papilledema, and bilateral Babinski's signs. The brain-stem reflexes were intact. There was resistance to movement of all four extremities. Computed tomographic scans showed subarachnoid hemorrhage with blood in the lateral and third ventricles but none in the brain parenchyma. Angiograms revealed a large aneurysm of the anterior communicating artery at the junction of the right anterior cerebral artery, with spasm of the left anterior cerebral artery, middle cerebral artery, and distal internal carotid arteries. The following day, the aneurysm was clipped in the chiasmatic cistern along the right optic nerve. A "moderate amount" of the right gyrus rectus was also resected.

Following surgery, the patient developed a progressively dilating right pupil; a right temporal lobectomy was performed, in which a piece of anterior temporal lobe, measuring $4.5 \times 3.2 \times 1.5$ cm, was removed. By the next day, the patient was awake. He was moving all four extremities spontaneously, and he could follow simple commands with the right, but not the left, hand. He was also mute. Only after two weeks was he able to follow commands with his left hand. One month after admission, a ventriculoperitoneal shunt was placed through a left approach to alleviate progressive hydrocephalus.

He remained severely abulic, initiating neither activities nor speech for two months following admission. During the next month he improved markedly. He began to complain of difficulty getting his left arm and hand to obey him, especially

in tasks requiring bimanual cooperation. For example, while cutting meat at dinner, he had difficulty getting the left hand to relinquish the fork to the right hand. His left hand would sometimes pick up a food item and try to put it in his mouth while the right hand was attempting the same maneuver, resulting in a collision. Sometimes the left hand would pick up a cup and move it into the path of the right hand so as to interfere with eating. While playing checkers on one occasion, the left hand made a move that he did not wish to make,

and he corrected the move with the right hand; however, the left hand, to the patient's frustration, repeated the false move. On other occasions, he turned the pages of a book with one hand while the other one tried to close it; he shaved with the right hand while the left one unzipped his jacket; he tried to soap a washcloth while the left hand kept putting the soap back in the dish; and he tried to open a closet with the right hand while the left one closed it. He reported that usually he could eventually make the left hand coop-

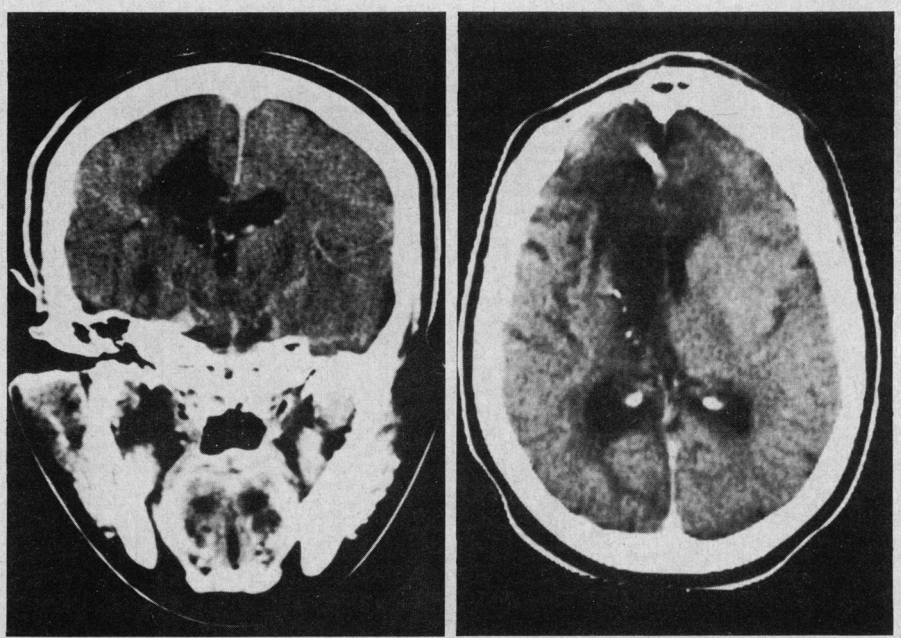
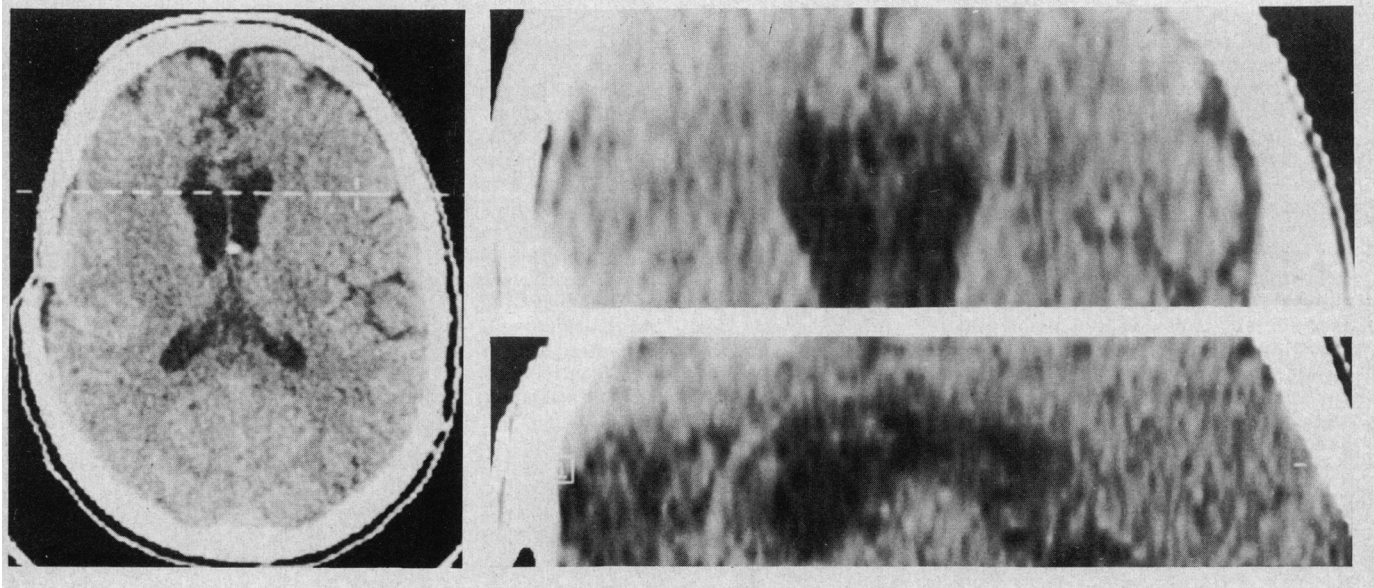


Fig 1.—Computed tomographic scans of case 1. Note area of low density (path of bullet) in coronal (left) and horizontal (right) views.

Fig 2.—Left, Computed tomographic (CT) scan of axial section showing damage to frontal lobes and corpus callosum (case 2). Dotted line indicates position of coronal section. Top right, CT scan of coronal section showing damage to corpus callosum (case 2). Bottom right, CT scan of sagittal section 5 mm right of midline showing damage to frontal lobe and corpus callosum (case 2).



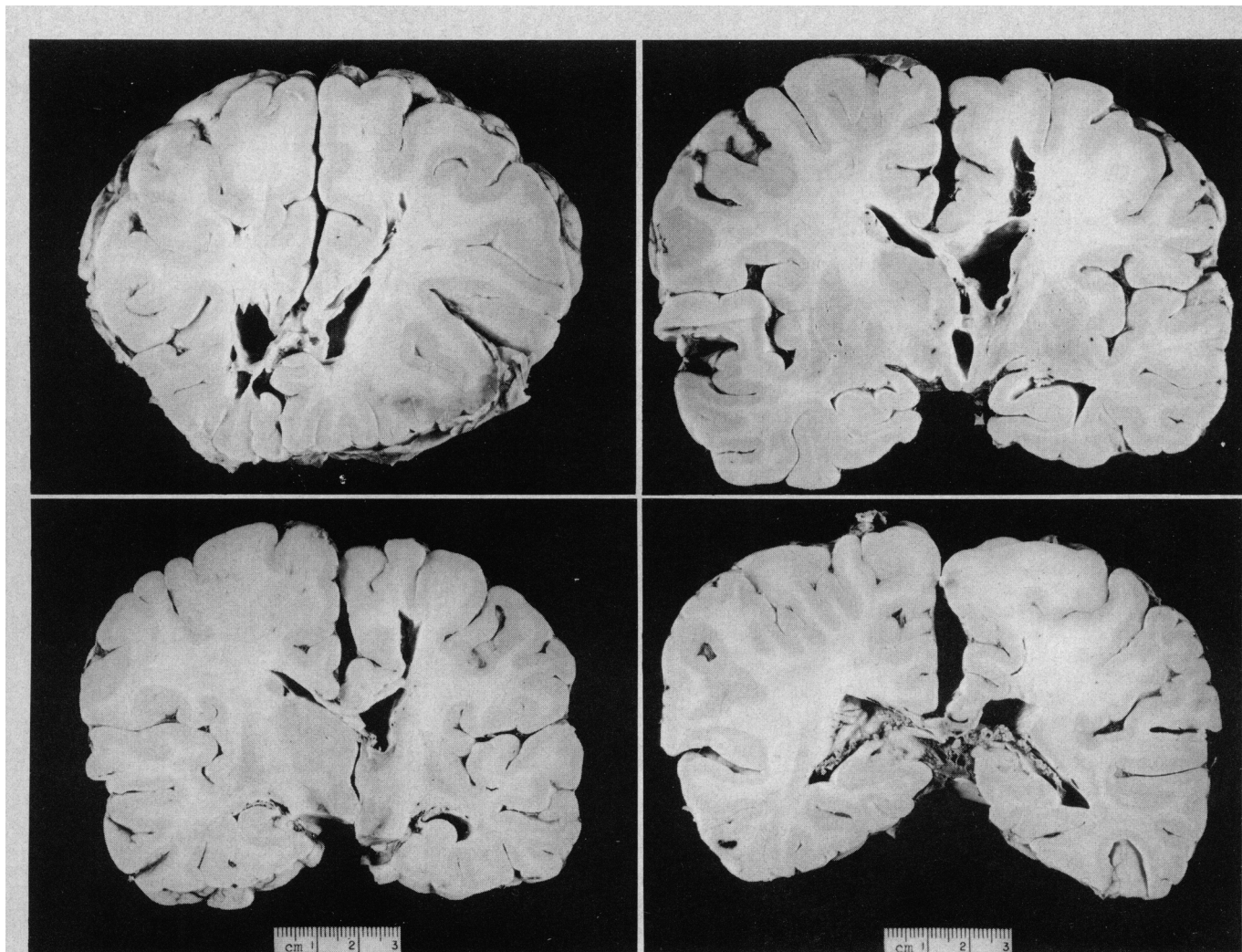


Fig 3.—Top left, Coronal section at level of genu of corpus callosum. Note extensive area of encephalomalacia, partially cavitated and involving right subcortical white matter extending to left side and passing through genu of corpus callosum. Top right, Coronal section at level of mamillary bodies. Note irregular cavity in right centrum semiovale with atrophy and degeneration of corpus callosum, right thalamic nuclei, portions of adjacent pyramidal tract, and dilation of right lateral ventricle. Bottom left, Coronal section at level of red nuclei. Area of encephalomalacia is evident in right thalamus. Corpus callosum is very thin, and cavity extends through subcortical white matter. Bottom right, Coronal section passing through splenium. Note extensive atrophy and degeneration of corpus callosum.

erate if he persisted with a task. It was noted that often while he was doing a task with the right hand, the left one grasped and manipulated nearby objects, which often hindered the work of the right hand. To a lesser extent, the left leg was also affected, once attempting to ascend while the patient was descending stairs.

When we examined him, his affect was flat, and he was inattentive and showed some motor imperistence. He was oriented to time and place but not to day of the week, and he could speak, name, understand, and read normally. He performed simple commands well with his right hand but had some difficulty showing how to use scissors or how to turn a key with the left hand; he could, however, show with some delay how to salute and to brush his teeth. When he was asked to put on a shirt held in front of him, the left arm thrust into the right sleeve. The patient said, "That is wrong." Asked why, he replied, "It will be

on backwards." However, he was unable to make the left arm withdraw for several moments. He did not have the feeling that the left arm did not belong to him. It was often easier for him to perform some tasks, such as repetitive tapping, with the left foot than with the left hand. There was no grasp, snout, or suck reflex, although he had a Myerson's sign. Visual fields and cranial nerve functioning were normal. He had no hemiparesis or spasticity. The reflexes were brisk bilaterally, with bilateral Babinski's signs. There was extinction to double simultaneous stimulation on the left side, and he had more difficulty identifying objects placed in the left hand than when placed in the right one, although he often did it correctly. His gait was slow and wide based.

A CT scan obtained four months following the hemorrhage showed radiolucent areas in the medial frontal lobes bilaterally as well as damage to the genu and

anterior portion of the body of corpus callosum (Fig 2).

PATHOLOGIC FINDINGS

The general autopsy findings in case 1 showed an infiltrating, well-differentiated adenocarcinoma of the left breast with metastases to the lung, liver, kidneys, adrenal glands, and lumbar vertebrae, as well as dissemination through the subarachnoid space.

Gross neuropathologic examination of the formalin-fixed brain sections revealed normal dura mater and blood vessels and both thickened and opaque basal leptomeninges. The volume of the right frontal lobe was reduced, and the right frontal pole showed a brown-stained area of cortical encephalomalacia. The right orbi-

tofrontal cortex, including the gyrus rectus, was shrunken and retracted, and it had a brownish discoloration extending 3.2 × 2 cm. Coronal sections demonstrated encephalomalacic cavities primarily involving the right subcortical white matter and extending into the left side through the genu of the corpus callosum (Fig 3, top left). The area of encephalomalacia became cavitated and formed a tract extending through the centrum semiovale, affecting mainly the right side of the corpus callosum and right thalamic nuclei (Fig 3, top right and bottom left), all the way to the subcortical white matter of the right occipital lobe (Fig 3, bottom right). The white matter adjacent to this tract was softened, but the nearby cortex appeared intact. The right caudate nucleus and internal capsule were largely destroyed with softening, brown discoloration and microcavitation extending into the region of the right pulvinar (Fig 3, top right and bottom left). The ventricular system was dilated more on the right than on the left side. The entire corpus callosum appeared shrunken and distorted, particularly at the level of the splenium (Fig 3, bottom right). Sections of the brain stem showed atrophy of the right cerebral peduncle and the right pyramidal tract.

The cerebral cortex was normal except at the tip of the right frontal pole where the entrance wound of the bullet was located. Microscopic examination revealed necrosis and cavitation in wide areas of subcortical white matter of the orbitofrontal cortex, portions of the right internal capsule, the right caudate, and right subependymal and periventricular white matter. The cingulate gyri were normal bilaterally. The genu and the splenium of the corpus callosum were infarcted and demyelinated, and the remaining areas of the corpus callosum were markedly demyelinated. The right superomedial thalamus was infarcted. The right internal capsule showed demyelination. The right hypothalamus contained a lesion characterized by necrosis, astrocytosis, axonal spheroids, and hemosiderin. The right optic nerve and the right corticospinal tracts were demyelinated. Bullet fragments were found in the head of the right caudate, putamen, and thalamus. Both anterior cerebral arteries were occluded with metallic clips. The leptomeninges contained widespread neoplastic cells with the same histopathologic features as the primary adenocarcinoma of the breast. This condition was

thought to result from propagation of the neoplastic cells from vertebrae and nonvertebral metastases¹ and not from an association with her neurologic symptomatology.

COMMENT

The involuntary movements of these two patients resemble those described in the North American literature as alien hand syndrome. *Alien hand* is a translation of the French *la main étrangère* used by Brion and Jedynak² to describe a "feeling of estrangement between the patient and one of his hands." For example, one of their patients (case 1), when trying to put on his shirt, would encounter his alien hand and try to move it out of the way, exclaiming: "Leave me alone, you prevent me from dressing." Failure of recognition also occurred when one hand was placed into the other in front of the patient with his eyes closed. After the patient died, autopsy findings revealed a callosal tumor extending bilaterally into the cerebral white matter. What was impaired was not the tactile sensation in the hand but "la reconnaissance de son appartenance" (the recognition of its belonging). No mention was made of involuntary movements.

Subsequently, Goldberg et al³ used the term *alien hand syndrome* to describe two patients with left medial frontal cortex infarction. These patients' arms spontaneously grasped and groped and could perform purposeful movements, but they seemed not to be under conscious control of the patients, who often used the left hand to restrain the right one. These investigators suggested that medial frontal cortex damage and callosal disconnection may contribute to the syndrome.

Several years before the article by Goldberg et al,³ Goldstein⁴ and Sweet⁵ described similar cases but had not labeled the syndrome. A similar phenomenon occurs in some patients who have undergone callosotomy, but in the majority of cases it subsides within a few weeks, thus suggesting that callosal damage alone is not sufficient for the occurrence of the alien hand phenomenon.^{6,7}

In our first patient, autopsy findings confirmed the clinical impression of bilateral frontal damage, more pronounced on the right side, and corpus callosum damage, with additional damage at the level of the right basal ganglia and thalamus. In the second patient, a CT scan showed bilateral mesial frontal damage as well as lesions of the corpus callosum.

The combination of lesions necessary to produce this syndrome is not certain. In other syndromes, such as alexia without agraphia, a unilateral lesion plus callosal disconnection are sufficient. Although both of our patients had bilateral frontal lesions, Goldberg et al³ reported patients who had no evidence of bilateral lesions, but there was no autopsy confirmation. Bilateral semiautomatic movements, which may mimic voluntary movements, are observed in patients with bilateral frontal lobe lesions. For example, Lhermitte⁸ has described "utilization behavior in patients with frontal lobe lesions, in which the patient compulsively grasps and purposefully uses objects placed in front of him or her, performing complex acts. Lhermitte thought this was an extension of grasping behavior and advanced an explanation involving release of parietal lobe activity in some respects reminiscent of Denny-Brown's theory of motor control.⁹ Neither of our patients demonstrated utilization behavior as defined by Lhermitte. It appears reasonable to postulate that in our cases, as in others, the syndrome was produced by the combination of partial callosotomy and mesial frontal lesions.¹⁰

This investigation was supported in part by Public Health Service grants AG03705-04 and AG05133-01 (Dr Boller, principal investigator) and by National Library of Medicine grant LM04431 (Dr Banks, principal investigator).

We thank Jason Brown, MD, who supplied relevant literature references; Charles Kowal, MD, and Lowell Lubic, MD, for letting us examine their patients; and Margaret Forbes, Annette Grechen, and Betsy Israel for their help in the preparation of the manuscript.

References

1. Kokkorisch P: Leptomeningeal carcinomatosis: How does cancer reach the pia-arachnoid? *Cancer* 1983;51:154-160.
2. Brion S, Jedynak CP: Troubles du transfert interhémisphérique. *Rev Neurol* 1972;126:257-266.
3. Goldberg G, Mayer NJ, Togliola JU: Medial frontal cortex infarction and the alien hand sign. *Arch Neurol* 1981;38:683-686.
4. Goldstein K: Zur Lehre von der motorischen Apraxie. *Z Physiol Neurol* 1908;11:168-187, 270-283.
5. Sweet WH: Sleeping intracranial aneurysm simulating neoplasm. *Arch Neurol Psychiatry* 1941;45:86-104.
6. Wilson DH, Reeves A, Gazzaniga M: Cerebral commissurotomy for control of intractable seizures. *Neurology* 1977;27:708-715.
7. Bogen JE: The callosal syndrome, in Heilman K, Valenstein E (eds): *Clinical Neuropsychology*, ed 2. New York, Oxford University Press Inc, 1985.
8. Lhermitte F: Utilization behavior and its relation to lesions of the frontal lobes. *Brain* 1983;106:237-255.
9. Denny-Brown D: The nature of apraxia. *J Nerv Ment Dis* 1958;126:9-32.
10. Brown JW: Frontal lobes and the microgenesis of action. *J Neurolinguistics* 1985;1:31-77.