# Crossed Aphasia in a Chinese Bilingual Dextral

Robert S. April, MD, Peter C. Tse, MD

• A persistent nonfluent aphasia following a right cerebral Infarction developed in a 54-year-old right-handed Chinese man. Computerized axial tomography localized the lesion in the distribution of the right middle cerebral artery. The speech and language dysfunction was greater for performances in Chinese than in English, despite the fact that the patient was born in China, was schooled in Chinese until age 7, and spoke Chinese at home and in his business.

It is suggested that early learning of Chinese, an ideographic language based on visual spatial percepts, might have been critical for the establishment and maintenance of language dominance in the right hemisphere.

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In the small number of reported cases of crossed aphasia in dextrals,<sup>1-13</sup> exceptions to a fixed relationship between aphasia and left hemisphere lesions have been given the following explanations: personal ambilaterality and/or familial sinistrality<sup>5,6,12</sup>; possible bilateral hemispheric dysfunction<sup>2-4,10-13</sup>; and long-standing brain dysfunction from acquired epilepsy or infantile brain trauma.<sup>2,3,8,12</sup> Two case reports have documented a single right hemisphere lesion at autopsy<sup>7.11</sup> and one other by computerized axial tomography (CT).<sup>9</sup> This report describes another case. It is of special interest because it is the first reported example, to our knowledge, of crossed aphasia in a Chinese and English-speaking dextral. It has relevance to the study of aphasia in nonalphabetical languages, aphasia in polyglots, as well as to the problem of atypical cerebral organization for language.

## **REPORT OF A CASE**

The patient was a 54-year-old Chinese man who ran a family laundry business in New York City until the present illness. He was born near Canton, China, where he went to elementary school. At age 7 he came to the United States and finished both elementary and high school in New York City. When he was 17, he returned to China to visit his native village. Before the trip, he studied the Chinese language in New York City in daily classes for three years; when in China, he went to language classes daily for three months. During that one-year visit he married, and brought his wife and her mother to the United States, where they settled. He established a laundry shop in New York City, employed 16 Chinese workers, and kept the account books in Chinese. His mother-in-law always lived with his family; because she spoke only Chinese, the family usually spoke Chinese at home. The patient's seven American-born children speak both Chinese and English, but do not read or write

Chinese. The patient's premorbid Chinese writing demonstrated a fluent usage of the written language.

In October 1975, he suffered sudden left hemiparesis and aphasia. The first detailed examination of his language and speech was done in another hospital, where hesitant, partial, nonfluent speech with agrammatism was described. On April 28, 1976, he was admitted to New York Medical College Center for Chronic Disease. Results of general physical examination were unremarkable; blood pressure was 130/80 mm Hg.

#### **Neurologic Examination**

The patient was alert, cooperative, and aphasic. There was left hemiparesis with hyperreflexia and a left Babinski sign. The hemiparesis included the lower face and was greatest in the left upper limb. Confrontation disclosed a left visual field defect. On gaze movements to the left, the eyes lagged behind the head. Face-hand test showed displacement of perceived stimuli from the left hand to the left face. One observer noted transient right-left disorientation.

## **Laboratory Studies**

Results of hemogram, urinalysis, and blood chemistry studies were normal except for diabetes mellitus, which was controlled by diet alone. Chest roentgenogram, electrocardiogram, skull x-ray films, and radioisotope brain scan were normal. Pure tone audiogram showed normal thresholds in either ear. A CT scan showed a large region of encephalomalacia in the distribution of the right middle cerebral

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From the Department of Neurology, New York Medical College.

Reprint requests to Department of Neurology, New York Medical Center for Chronic Disease, Roosevelt Island, NY 10044 (Dr April).



Computerized tomograms, without contrast enhancement, showing extensive encephalomalacia of right cerebral hemisphere in distribution of middle cerebral artery. Irregular areas of decreased density on left are artifacts that were not confirmed by density matrix.

artery, involving the frontal, temporal, and parietal lobes with secondary dilation of the body and anterior horn of the right lateral ventricle. The densities over the parenchyma of the left hemisphere, the position of midline structures, and the shape of the left lateral ventricle were normal (Figure).

## Electroencephalogram

There was diffuse slow activity down to 3 Hz in all right-sided leads. Alpha rhythm was not observed on the right. Left-sided alpha rhythm had an average frequency of  $8\frac{1}{2}$  to 9 Hz. No abnormal activity was seen in left leads. This pattern did not change over the next eight months.

#### **English Speech and Language**

The original examination revealed sparse, hesitant spontaneous speech. It was composed of short, agrammatic, incomplete phrases, verbal hesitations, pauses, and severe word-finding difficulty. The patient gestured with the right hand to compensate for his desultory speech.

Verbal comprehension was relatively preserved-that is, he could follow simple three-step commands and answer "yes-no" questions correctly. He had difficulty with commands containing more than three steps.

He was able to indicate object pictures, actions, letters, colors, and body parts correctly on verbal instruction. Ability to name colors and objects from pictures was relatively preserved. Some of his errors were "spoon" for fork, "brella" for umbrella, and "shoe" for horseshoe. He was able to correct his errors, particularly those within the same category,-such as, "spoon...uh...no...fork."

Repetition was fair with no impairment of single-syllable words. However, there was slowness, hesitancy, and mild impairment for simple phrases-such as "yesterday" for "a year yesterday"-and complete inability to repeat even short phrases correctly. He could not spell words aloud.

Reading comprehension for very simple sentences was unimpaired. Matching written words to objects or to spoken words, or matching spoken words to one of a group of written words, was usually done correctly.

Reading of simple sentences aloud was slow, hesitant, and erroneous. He skipped small words, read slowly and made many omissions, hesitations, and repetitions. He had much less trouble reading single words, but still made omission errors-such as "termine" for "determine"-and some paraphasias-"potato" for "tomato."

Writing of numbers or letters to dictation was minimally impaired. He also had difficulty with automatic writing, viz, the numbers 1 to 20. Writing of single words to dictation was impaired. This contrasted with his penmanship, which was coordinated and fluid. His right-hand orientation during writing was noninverted. Copying of letters, geometric figures, Greek letters, and Bender-Gestalt designs showed no impairment. He drew freely and was able to complete incomplete figures with ease.

Written arithmetic performance-including written addition, multiplication, and fractions-was poor. He had no trouble making correct change in a concrete situation involving money.

#### **Chinese Speech and Language**

Schuell's test (Minnesota Test for the Differential Diagnosis of Aphasia) was administered in Chinese by one of us (P.C.T.). English performance in general, and on Schuell's test in particular, was better preserved than Chinese.

Spontaneous aphasic utterances were made in English, not Chinese. When addressed in Chinese, he first responded in English and then attempted to speak Chinese. The responses were usually mixtures of Chinese and English speech. Chinese utterances were single words or short phrases, always accompanied by gestures. He could not say his wife's given name intelligibly and made errors in naming objects and body parts. On some occasions he used a substitute word related in meaning to the correct one. For example, he said "sky" instead of "sun," "house" instead of "window," "hand" instead of "finger," and "car" instead of "ship."

He repeated single Chinese words correctly. His sentence repetition was extremely impaired. He omitted connecting words in the sentence. For example, he said "pass home" for "I'm going home for a weekend on pass," "today fine" for "today

Arch Neurol-Vol 34, Dec 1977

Crossed Aphasia-April & Tse 767

Neuropsychologic Test Scores						
<u> </u>	8/3/76	9/14/76	9/15/76	10/21/76	11/2/76	11/15/76
WAIS (raw scores) Digit span					2	
Digit symbol	5					
Picture completion	11					
Block design	8		• • •			
Picture arrangement	12		· · ·	•••		
Object assembly	12					
Performance IQ	74					
Raven's Coloured Matrices			20	26		
Benton's Visual Retention A				1		
B				1		
С				9		
Purdue Pegboard, right hand, 30 sec			12			
Symbol digit modalities Written	- <b>.</b> .			2		• • •
Oral				0		
Pointing				6		
Peabody Picture Vocabulary Raw		99	•••		• • •	
Ceiling		113				
Errors		14				
Design copying			Good			
Double simultaneous stimulation		••••	• • •			Normal (left face-right hand)
Color naming	•••		• • •	Minimally impaired		
Color recognition	•••	• • •	• • •	Good		
Singing				Good melody		
Facial recognition				Good		
Recognition of nonspeech sounds				Good		

is a fine day," and "sit wheelchair" for "I'm sitting in a wheelchair."

The pitch and rhythm of his Chinese speech cannot be described in detail because of its paucity. Moreover, speech was phonetically inaccurate and hardly intelligible. His family had difficulty understanding him in Chinese. Hence, proverb testing could not be done. He often laughed in response to humorous Chinese proverbs but was unable to explain why or to describe the humor. After humming the melody of a Chinese nursery rhyme accurately, he sang the words hesitantly and nonfluently.

Written Chinese was severely impaired. Before the present illness he had kept his account book in neat, well-written Chinese characters. However, when tested, the patient made errors in writing his own name. He wrote only some simple words to dictation. He made many errors in sentence copying. The graphic errors included omission of strokes, erroneous strokes, mistakes of sequence, and direction of strokes.

Word comprehension was tested with a list of Chinese school words. He read eight

of 33 correctly, but understood 13 others that he could not read. When a picture illustrating the general meaning of the word was shown, he could read 14 words and understand 25. When the 33 words were read to him in multiple-choice form, he chose 27 correctly. In summary, there was more difficulty in reading aloud than in comprehending written Chinese. Oral presentation of the words further increased comprehension. He made correct gestural responses to commands and questions in Chinese.

## **Neuropsychologic Testing**

The patient was strongly right-handed. A questionnaire for hand preference was adapted from that used by Hécaen, which asks for hand preference on 22 common tasks. The patient indicated premorbid right-handed preference for each. The questionnaire was given to each of his seven children, aged 23 to 37. All were exclusively right-handed. There was no history of left-handedness in the family.

Standard neuropsychologic tests were administered. The results are summarized in the Table. The language subtests of the Wechsler Adult Intelligence Scale (WAIS) could not be done because of aphasia; hence, scores are given from the performance subtests alone.

Some performances merit emphasis, namely, Raven's scores (20 and 26) and impaired visual retention. The latter could not be explained by the left visual field defect alone. In addition to omitting objects on the left, he made errors in figures from the right (intact) part of the visual field. Equally complicated figures were copied directly without error.

Attempts were made to determine the patient's preferred ear for perception of dichotic phonemes. The interpretation of the results was made difficult by the high error rate of the performance. This difficulty in performing the test to criteria obscures the trend toward left ear preference disclosed in the data. Six of his seven children were tested and all showed unequivocal right ear preference.

There was no ideomotor apraxia. Simple learned movements were done well to command. Imitation of the examiner's gestures was performed correctly. Repetitive oral-buccal movements showed some dyspraxia, but articulation was, in general, normal except for decreased vocal amplitude. He was able to recognize faces and showed no spatial disorientation or problems in dressing.

### **Hospital Course**

The patient was observed and tested repeatedly for eight months. He had daily speech therapy. Improvement was observed in repetition of phrases and sentences, oral reading of words and sentences, automatic speech, conversational ability, and verbal responses to simple questions. Sentence length increased and language became more descriptive. Rightleft orientation was normal. He still had difficulty with simple numerical problems and on a qualitative level was agrammatic, nonfluent, and showed Broca's aphasia with severe left hemiplegia.

In January 1977, he suddenly went into coma and showed signs of rostrocaudal deterioration of brain stem function. A lumbar puncture demonstrated clear, colorless, acellular fluid with opening pressure of 115 mm  $H_2O$ . Despite several days of support of vital functions and treatment of pneumonitis, the patient died on Feb 22, 1977. Permission for postmortem examination was not given.

## COMMENT

The patient described in this report was right-handed and had neither familial sinistrality nor evidence of early brain damage or seizure disorder. Therefore, his aphasia could not be explained as an example of shifted sinistrality or the influence of familial ambilaterality.<sup>5.7</sup> We conclude that the aphasia was the result of an unusual pattern of lateralization of hemispheric language function.

Can aphasia be the result of the demonstrated single right hemisphere lesion alone? This relationship has been demonstrated unequivocally in other anatomically confirmed case reports.<sup>7,9,11</sup> Our patient had neither clinical, EEG, nor CT evidence of left cerebral abnormality. These data would strengthen the hypothesis that the right hemisphere was his dominant one for language.

We cannot exclude the possibility of some bilateral representation of language. However, as Wechsler<sup>9</sup> has stated, if language were bilaterally represented in a patient, one might expect greater recovery of speech and language than we observed in the present case. The nature of recovery of function after a brain lesion is poorly understood at this time,<sup>14</sup> but recovery of speech and language is relatively more complete in aphasic sinistrals than in dextrals.<sup>15,16</sup> It has been postulated that there is incomplete unilateral dominance for speech and language in sinistrals.<sup>16,17</sup>

How do the neuropsychologic performances-especially the low nonlanguage scores-relate to the single right hemisphere lesion? Do they indicate some left (nondominant) hemisphere dysfunction as well? The Raven's Coloured Progressive Matrices (RCPM) has been used as a test of nonverbal intelligence in adult aphasic patients and others.18 Its strong spatial component has led to criticism of its unqualified value as a test of nonverbal intelligence alone.<sup>19</sup> Our patient scored 20 and 26 on this test on two different occasions. These scores compare well with those generated by Kertesz and McCabe's patients.<sup>18</sup> It is not clear if the RCPM scores correlate with the languagespeech abnormality alone or whether they reflect a spatial disorder due to the topographic relationship of the lesion apart from its major disruption of language function. In this regard, the relatively low WAIS performance scores and the low RCPM scores would support the diagnosis of constructional apraxia, even though free drawing and figure copying were intact. Some investigators relate constructional apraxia to lesions in the parietal lobe of the nondominant hemisphere.<sup>20-22</sup> Others relate it to bilateral lesions.23-25.

Kertesz and McCabe<sup>18</sup> did not present independent neurologic data to exclude the possibility of bilateral lesions in their typical left-hemisphere aphasics. Our patient's scores were in the range of those of their Broca's aphasics. Thus, our patient's RCPM and his typical aphasic performance appeared to be compatible with a single lesion of the language zone—in this case, on the right, not the left.

We do not know why RCPM scores are low in aphasics. Perhaps aphasics have a related disturbance in problemsolving functions of the dominant hemisphere and not specific disturbances in visual-constructional function. Milner<sup>19</sup> has suggested that more could be learned if comparisons were made between RCPM scores of aphasics with constructional apraxia and nonaphasics with corresponding right hemisphere lesions with constructional apraxia. Typical (noncrossed) aphasics without severe comprehension deficits generally perform relatively well on tests of nonlanguage reasoning.26-29 Case reports of crossed aphasia in dextrals describe varving difficulty with visual-constructive tasks. In summary, one might interpret our patient's nonlanguage performances as supporting either incomplete right cerebral dominance for visual-spatial functions or as a problem-solving difficulty associated with aphasia.

We conclude that our patient had one right cerebral lesion responsible for aphasia and no left hemisphere lesions. We base this on the aphasic performance, the mild impairment of nonlanguage tasks, the normal sensorimotor status of the right hand, the electroencephalogram, and the CT scan. His nonfluent aphasia with minimum comprehension deficit resembles other cases of crossed aphasia in dextrals<sup>1-13</sup> and also in left-handed adult aphasics and children with acquired aphasia.<sup>17</sup>

The data also suggest that the patient was relatively right cerebral dominant for language. This is the first example, to our knowledge, of crossed aphasia in a Chinese and English-speaking dextral and, like other cases of crossed aphasia, bears witness to the independence of lateral organization of different hemispheric functions. Although handedness and language-brainedness usually segregate together, contralateral to the dominant side for nonlanguage functions,<sup>30-32</sup> this is not an absolute relationship and admits infrequent deviation from the mode.<sup>33</sup> The explanation for this deviation, exemplified by reported cases of crossed aphasia, is now known. Neither is it known why the aphasic disturbances are so similar in crossed aphasia.

Wechsler,<sup>9</sup> who described crossed aphasia in an illiterate dextral, speculated about the relationship between

Arch Neurol-Vol 34, Dec 1977

not learning to read and write and development of inverted cerebral dominance. Looking for possible developmental influences that might have affected our patient's cerebral organization, we might speculate that his original experience in the Chinese language was a significant factor. Chinese is an ideographic, nonalphabetical language that presents visualspatial elements to the reader. Recognition of characters and their rerepresentation for speech might weight more heavily on geometric spatial factors than do similar recognition and rerepresentation of English words. If true, then it is possible that right language dominance is related in part to these influences of the original language experience. Thus, we have a right-handed patient with aphasia from a right cerebral lesion

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with greater preservation of English than Chinese and some deficits in nonlanguage performance tasks. In our patient, this might also be related to sharing of both the semantic and the spatial linguistic systems in the dominant right hemisphere. If these linguistic factors were the major determinants of inverted cerebral organization, one would expect to see many cases of crossed aphasia in Chinese patients. Unfortunately, the literature on Chinese aphasics is very small. To our knowledge, only Alajouanine et al<sup>34</sup> described Chinese aphasic performance in linguistic detail. The paucity of crossed aphasic patients of any language origin suggests that other factors must play equally important roles.

It has been asserted that aphasia in polyglots is associated with less severe

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