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Case report

Is surface dyslexia in Chinese the same as in alphabetic one?

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Cognitive neuropsychology has made great contributions to our understanding of the neural basis of language since Broca's seminal work;[1] the primary neural circuitries for language processing have been documented. Unfortunately, these achievements were almost exclusively from studies on alphabetic languages.[2] Recent behavioral and imaging studies suggest that the neural network involving processes of Chinese is not entirely identical to that in alphabetic languages.[3-5] In the present study, reading performance in a dyslexic patient, whose native language is Chinese, was systematically examined by a series of cognitive neuropsychological experiments, and theoretical implications of this study was discussed in comparisons with studies in dyslexic patients who use alphabetic scripts.

CASE REPORT

The patient was a native Chinese speaker (education years: 12), male, 55 years old, and right handed. He had a percutaneous transluminal coronary angioplasty (PTCA) operation due to coronary artery stenosis six months ago. Physical examinations showed no remarkable abnormality in consciousness, orientation or memory. His articulation was normal and no deficit was found in his both visual field. MRI delineated an infarction in the left parietotemporal region (Fig.).

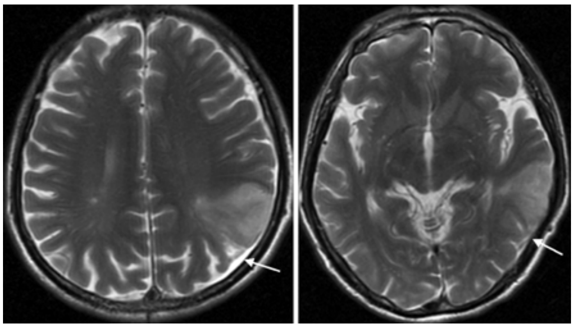

Fig. T_2-weighted MRI showing an infarction in the left parietotemporal region.

The patient received conventional neuropsychological assessment eight days after hospitalization. His speech was hesitant and less fluent along with frequent semantic and phonetic errors; and he had severe naming impairment. However, his auditory-verbal comprehension was intact (Table 1). The patient had impairments in picture naming, and word repetition and reading (particularly in reading low frequency words), whereas his writing ability and semantic knowledge remained relatively normal. We therefore conducted a set of cognitive tests to examine the effects of several linguistic factors on reading performance of this patient.

Frequency effect: 40 characters were divided into two groups, the high frequency group (20 characters, 1000−2000 per million) and low frequency group (<100 per million). Structure effect: 60 characters were chosen, 20 with left-right structure, 20 with up-down structure, and 20 with encircled structure. Stroke number effect: 40 characters were divided into two groups, the small (20 characters, stroke number ranging 4－6) and large number group (stroke number ranging 9－12). Regularity effect: 40 phonograms were selected, with 20 regular and 20 irregular characters respectively.

Each character was printed on a white card of the same size and was presented to the patient for 1 minute. The patient was asked to read them loud and then to make up a phrase or a sentence with a character he just read. A trial was marked as wrong, either if the patient read the character in a wrong pronunciation or no response was made within 1 minute (Table 2).

The data were analyzed with SPSS. There were no significant effects of frequency, structure, and stroke number (P>0.05, for all three effects), but the regularity effect was significant (P<0.01). Therefore, the regularity effect was further analyzed in terms of error ratio and reaction time. For regular characters (pronunciation of a character is the same as that of the phonetic component), reading error was only 10%, but this was as high as 70% for irregular characters. And the reaction time was also remarkably different: 2 seconds and 19 seconds on average for regular and irregular characters respectively.

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Table 1. Result of conventional neuropsychological testing

Test	Score
Mini mental state examination	25/30
Boston naming test	16/60
Spoken word repetition	3/20
Oral reading	
High-imageability/high-frequency words	15/20
High-imageability/low-frequency words	10/20
Low-imageability/high-frequency words	12/20
Low-imageability/low-frequency words	9/20
Writing	
Copying	20/20
Dictation	20/20
Spontaneous writing	20/20
Semantic knowledge	
Word-picture matching	20/20
Sentence-picture matching	16/20

Table 2. Results of cognitive tests in reading Chinese characters

Test	Accuracy (score)	χ^2 test
Frequency		
Low-frequency	45% (9/20)	
High-frequency	75% (15/20)	P>0.05
Structure		
Up-down	60% (12/20)	
Left-right	55% (11/20)	
Encircled	50% (10/20)	P>0.05
Number of strokes		
4—6 strokes	70% (14/20)	
9—12 strokes	60% (12/20)	P>0.05
Regularity		
Regular	90% (18/20)	
Irregular	35% (7/20)	P<0.01

Among the 180 characters tested, 72 were read in wrong pronunciation and 38 no response within 1 minute. There were three main error types. The first was regularization error (18%), i.e., a character was read as its phonetic component, e.g. 娱 ‘yu’ was read as 吴 ‘wu’. The second was initial consonant error (19%), e.g., 科 ‘ke’ was read as 各 ‘ge’. The third was phrasing error (13%), e.g., 理 ‘li’ was read as 发 ‘fa’ (‘li-fa’ is the pronunciation of a common two-character word, meaning ‘haircut’).

DISCUSSION

The hypothesis of dual-route reading holds that the conversion from a printed word to its pronunciation is achieved through two routes: a lexical route and a sublexical route, by means of grapheme to phoneme conversion (GPC). If the lexical route is damaged or blocked, pronunciation exclusively relies on the sublexical route, resulting in regularization errors, a typical characteristic of surface dyslexia.[6]

Since there is no GPC rule in Chinese script,[5] and reading in Chinese solely relies on lexical route,[7] some researchers argue that surface dyslexia might not exist in Chinese. However, this patient demonstrated typical regularization errors, a critical feature of surface dyslexia. Similar results have also been reported.[2,8] The converging evidence thus points to the existence of surface dyslexia in Chinese, although regularization error in Chinese and alphabetic languages might not be completely comparable. Patterson et al[9] thus called this error as legitimate alternative reading of components (LARC).

Although modern Chinese writing system has no GPC rules, more than 80% characters are phonograms, in which the phonetic component provides some clues of its pronunciation. However, only about one third phonograms are regular. It is thus reasonable to assume that when reading a phonogram, its pronunciation competes with that of the phonetic component. If a phonogram is regular, there is no competition. But if it is irregular, competition happens. Since occurrence frequency of the phonetic component is usually higher than that of the phonogram, activation of the pronunciation of the phonetic component is easier than that of character,[10] and Chinese dyslexic patients are prone to make LARC errors. An important theoretic implication of this study is, therefore, that the nature of surface dyslexia in reading Chinese might be substantially different from that in alphabetic reading. Another interesting finding of this study is that frequent initial consonant errors happened in the patient. Whether this is one of typical characteristics or an exception of Chinese, surface dyslexia is suggested to be further investigated.

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