Dyslexia has a language barrier

Readers of Chinese use different parts of the brain from readers of English, write Brian Butterworth and Joey Tang

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Alan's parents are English, but he was born and grew up in Japan. He would pass as a native speaker of either language. What brought Alan to the notice of Taeko Wydell, an expert on Japanese reading, and Brian Butterworth, was that he was severely dyslexic, but only in one language. In the other, he was probably in the top 10% of readers of his age.

New research by US and Chinese scientists challenges our interpretation of how it is possible to be dyslexic in one language but not another. It shows that readers of Chinese use a different part of their brains to readers of English.

The study, led by Li Hai Tan and reported in Nature, may unexpectedly tell us some key things about how dyslexia affects the brain. Brain functioning, and indeed structure, is moulded by experience. Learning a regular spelling system such as Italian creates differences in brain organisation compared to learning highly irregular English. Italian has 26 rules to learn, which takes about six months; English takes longer because there are many irregularities (and several hundred rules). In Chinese 3,500 characters are needed to read the equivalent of the Daily Mail and about 6,000 characters to read books.

The second main difference is that in English each linguistically distinct sound, or phoneme, maps to a single letter. For example, the three phonemes in "bat" map on to three letters. If one letter is changed it makes a new word. A Chinese character maps to a whole syllable. In Putonghua, the national language of China, there are about 1,800 distinguishable syllables; each syllable can have several meanings and each meaning is typically represented by a distinct character.

How will these differences be reflected in brain organisation? Learning Chinese creates specific demands on the areas for remembering visual patterns. English readers make more use of areas for phoneme processing.

This ability to analyse syllables into phonemes is the key problem in dyslexia. Dyslexics have difficulty segmenting the word "that" into three separate sounds - so fare much worse in learning English than Chinese.

Reported prevalence of dyslexia is much higher in English (about 5-6%) than Chinese. I surveyed 8,000 schoolchildren in the Beijing region, with Yin Wengang of the Chinese Academy of Science, and found that about 1.5% were dyslexic.

This kind of evidence suggests that a single underlying deficit of the ability to analyse words into phonemes can cause dyslexia for any reader, but will be more severe where phonemes are involved. A European team led by Uta Frith of UCL reported in Science a few years ago that English, French and Italian dyslexics all showed the same abnormal activity involving the brain system underlying phonemic analysis.

In Alan, this theory predicts accurately that the affected language will be English, since Japanese does not require analysis into phonemes.

Research by Frith's team shows that small variations in brain organisation are due to
orthography, with Italian making more demands on the phonemic system, because it is regular, and English making more demands on the naming system because words cannot be read correctly using phonic rules and have to be named - for example: colonel, yacht, pint. We assume the part of Alan's brain that deals with phonemic analysis is not working efficiently, which causes a problem reading English, compared to Japanese.

The first surprise in Tan's study was that a key peak in brain activity in Chinese readers fell outside the network typically used by European readers. The second surprise was that dyslexics showed lower activation in several key reading areas compared with normal Chinese readers, but this was in a very different brain area from Frith's European dyslexics.

Both Frith and I have argued that dyslexia has a universal basis in the brain that affects phonemic analysis. Tan and his colleagues, by contrast, conclude that "the biological abnormality of impaired reading is dependent on culture". If we are right, Alan uses the same brain network for English and Japanese, and the malfunction only affects English reading. If Tan is right, Alan has separate networks for English and Japanese, and only the former is affected.

A lot will turn on which of us is right. Dyslexia frequently runs in families, and there has been much research trying to identify the genes responsible. If dyslexia is governed by culture, then Chinese dyslexia may be caused by a different genetic anomaly than English dyslexia.

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