Books & arts

Chinese calligraphy can be traced back more than 3,000 years to the carving of characters onto animal bones for divination.

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# How technology has changed the art of writing

An exploration of writing systems — from ancient Chinese characters to modern alphabets — looks at the factors that influence writing. **By Andrew Robinson**

The world's oldest writing system still in use, that of Chinese characters, dates from about 1200 BC. It has survived almost as long as its even older predecessors. For instance, cuneiform — comprising wedge-shaped marks inscribed in clay tablets with a stylus — was used in ancient Mesopotamia until the first century AD and Egyptian hieroglyphs remained in use until the fourth century AD. Moreover, Chinese characters were central to the development of writing systems in several other cultures, notably those of Japan and Korea.

Yet today, millions of people who speak and read Chinese have forgotten how to compose many of the traditional characters by hand, relying instead on simpler phonetic and digital equivalents. This controversial trend in China,
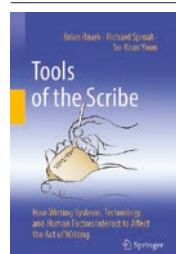
Tools of the Scribe: How Writing Systems, Technology, and Human Factors Interact to Affect the Act of Writing
Brian Roark *et al.*
Springer (2025)

generally known as character amnesia, opens *Tools of the Scribe*, a stimulating and original, if technical, book by computational linguists Brian Roark, Richard Sproat and Su-Youn Yoon.

The book explores how "the implement, the medium, the writing system and the writer" interact to produce writing. The authors analyse the linguistic structure of writing systems ranging from ancient cuneiform to modern alphabets; the technologies that have shaped writing in both the past and the present; and the processes underlying computer-based 'scribes', including large language models. Although their main focus is on technology,

the authors draw on research in many fields, including psychology, neuroscience, linguistics, ergonomics, anthropology and speech and language pathology.

Writing evolves

Chinese characters illustrate this interaction between implement, medium, system and writer vividly. Their first incarnation was in 'oracle bones' used for divination during the Shang dynasty (about 1600 BC to 1046 BC). Notches were drilled and chiselled into the surfaces of turtle shells and ox scapulae, such that when heat was applied, cracks would appear. These cracks were interpreted by a diviner to answer questions posed by the Shang king. The answers were often written on the bones using symbols — many of them recognizable antecedents of modern Chinese characters.

Subsequently, during the late Shang (about 1250 BC to 1046 BC) and Western Zhou (about 1046 BC to 771 BC) dynasties, inscriptions on bronze vessels were used to record ancestor worship, royal decrees, military victories, land grants, marriages and family histories. Then, during the latter half of the first millennium BC, the characters evolved into a more complex calligraphic form, painted in ink with a brush or pen on bamboo or paper: an art form still practised today. In AD 868, Chinese script was used to write the world's oldest extant printed book: a paper scroll known as *The Diamond Sutra*, which records a dialogue between the Buddha and a senior monk.

The script's complexity increased over time, from some 4,500 characters initially to roughly 47,000 by the eighteenth century. Today, almost 100,000 characters are listed in Unicode — the international character-encoding standard. However, around the start of the twentieth century, the system hit a technological barrier: the typewriter. The first commercial typewriter, designed for simple Western alphabets, was launched in 1874. By contrast, several attempts to commercialize a Chinese typewriter, beginning in 1919, were unsuccessful owing to the quantity and complexity of Chinese characters.

In 1936, Mao Zedong, leader of the Communist Party of China and a devoted calligrapher, announced in his first interview with a Western journalist that "sooner or later, we

> ## "Many people now rely on Pinyin to input Chinese characters into digital devices."

believe, we will have to abandon the Chinese character altogether if we are to create a new social culture in which the masses fully participate". After Mao's government came to power in 1949, it began to simplify characters by eliminating some variants and reducing the number of strokes in many of those remaining. In 1958, officials introduced a romanized Chinese script (using Latin letters) called Pinyin (which translates as spelled sounds) as the modern system for writing the Chinese sounds — hence the modern spelling of Peking as Beijing.

Many people now rely on Pinyin to input Chinese characters into digital devices. What Chinese speakers have gained in ease of writing thanks to modern technology has come "at the cost of losing practice with the neuromotor infrastructure needed to maintain their complex script", the authors write. Nevertheless, Chinese characters continue to dominate China's non-digital communication as a symbol of national identity.

A technological helping hand

The technology of writing has changed radically over the centuries — both in China and around the world. However, until the late twentieth century, the technologies used to input text were passive, the authors observe. Styluses, chisels, brushes, pens, woodblocks, movable type and typewriters gave the writer full control over what appeared on the writing surface. By contrast, computers can now suggest alternative spellings or synonyms, automatically correct errors and — with the advance of artificial intelligence — even write a whole text. As a result, "the notion of 'writer' itself becomes unclear", the authors note.

The book dives into the challenges surrounding the increasing use of AI systems by students. In a 2024 survey, 96% of US university students reported having used OpenAI's ChatGPT chatbot for at least one project in that academic year, and 69% had done so for writing assignments (see go.nature.com/4pyzbyv). In another study, US secondary-school students used ChatGPT mainly to plan essays (S. Levine *et al. J. Adolesc. Adult Lit.* **68**, 445–457; 2025).
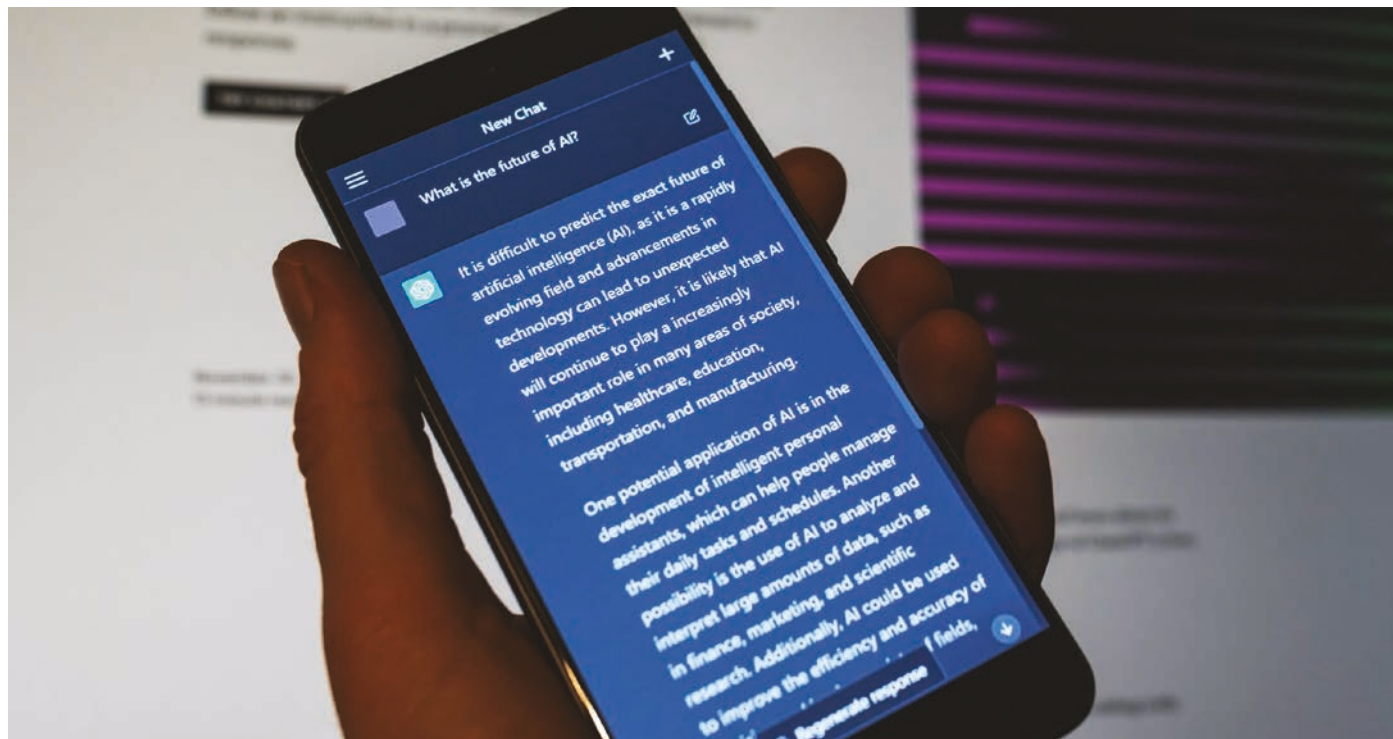
Many university students use large language models such as OpenAI's ChatGPT chatbot to help write assignments.

However, they tended to accept or reject the tool's suggested edits as a whole, instead of examining each suggestion separately "to learn from their mistakes".

Technology firm Superhuman Platform's writing-assistance software Grammarly, launched in 2009, is also popular with students because of its ability to highlight errors in spelling, grammar and tone in several languages. Grammarly's more advanced, paid-for version provides users with feedback on style, word choices, sentence variety, politeness and inclusive language — and has integrated AI functions such as a 'sentence rewriter' and 'paragraph rewriter'.

Some universities, worried that these tools open the door to cheating or plagiarism, have banned students from using Grammarly on evaluated work. But it's hard to distinguish between fair and unfair uses of AI and to develop consistent guidelines or policies.

Overall, the authors conclude that "rather than seeking to replace written language with what must inevitably be poor substitutes, we should be developing ways to harness AI as a force for good in helping people use one of civilization's earliest technological inventions".

Human wonder

As *Tools of the Scribe* reminds us, AI's writing ability can seem almost miraculous. But this illusion undervalues the genuine miracle that is the mind's ability to read and write — to which I wish the authors had given more space. The neuroscience of writing is less well understood than that of reading. For instance, neuroscientist Stanislas Dehaene's engaging 2020 book, *How We Learn*, discusses reading in depth but writing hardly at all. Researchers know little about how the brain produces meaningful text, and even less about how using an alphabet to do so compares with using mainly non-phonetic Chinese characters.

Dehaene hints at this creative mystery by discussing a geometer, Emmanuel Giroux, who has been blind since he was 11 years old and therefore cannot see the planes, spheres and volumes that he manipulates mathematically. Giroux's visual cortex, "far from remaining inactive, has actually repurposed itself to do math", writes Dehaene. Or, as Giroux himself observes, "in geometry, what is essential is invisible to the eye. It is only with the mind that you can see well." Here, perhaps, is a clue to how the brain might think while writing: it could start with a non-visual representation and then create the symbols on paper or a screen. Not being neuroscientists, Roark, Sproat and Yoon perhaps wisely decided to avoid speculation on this fascinating idea.

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