Handwriting Lights Up the Brain!
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by Makai Allbert

Picture two brains: one buzzing with activity, connections firing across regions in a synchronized neural ballet. The other shows only scattered flickers of engagement—isolated islands of electrical activation.

Both belong to university students sitting in the same lecture trying to capture the same ideas. The difference between them isn't intelligence, attention span, or interest in the subject—but the tools in their hands.

One holds a trusty pen poised over lined paper, while the other's fingers hover over a laptop keyboard.

This neural contrast, shown in a study in Frontiers in Psychology, is just one piece of mounting evidence suggesting that our rush toward digital convenience may be coupled with significant cognitive costs. From neuroscience labs to classrooms, research comparing traditional and digital learning tools finds that pens are not quite yet old school.

Slow Wins The Race

As early as 1979, studies affirmatively concluded that note-taking was significantly more effective in learning and remembering than simply listening passively—the pen was no doubt mighty. Yet, with a plethora of convenient digital tools at our disposal, does the pen still hold such might?

In a seminal 2014 study, "The Pen Is Mightier Than the Keyboard," researchers Pam Mueller and Daniel Oppenheimer conducted three experiments to compare handwritten versus typed note-taking.
In study 1, Princeton University undergraduates watched TED Talks while taking notes either by hand or on laptops.

When tested afterward, students who took handwritten notes scored 12 to 20 percent higher on conceptual understanding questions—though both groups performed similarly on factual recall.

The researchers discovered that because of the ease of typing, laptop users tended to transcribe words lectures verbatim—that is, word for word—while handwriters had to process and summarize the information.

"Word-for-word transcription doesn't require deep thinking," Oppenheimer told The Epoch Times. With pen and paper, what seems like a disadvantage—slower writing speed—actually becomes an advantage, requiring true conceptual understanding before spilling ink.

In study 2, laptop users were explicitly instructed not to take verbatim notes. Despite the instructions, laptop users still transcribed more content word for word, leading to inferior performance once more. Meanwhile, Study 3 gave both student groups time to review their notes before testing to see if reviewing could compensate for the disadvantages seen in laptop note-taking. However, even when given time to review, pen note-takers consistently outperformed laptop users.

"There is definitely no one-size-fits-all solution to note-taking," Oppenheimer said.

He acknowledged that in certain situations, rapid note capture might be beneficial, while in others—particularly with abstract concepts, graphics, or equations—typing away may be less effective.

What Goes on in the Brain

When Oppenheimer's paper was published in 2014, it caught the attention of Norwegian researchers Audrey van der Meer and her husband Frederikus Ruud van der Weer. As neuroscientists, they were naturally curious about the underlying mechanisms. "What is going on inside the brain when people write by hand as opposed to typing on a keyboard?"

This question led them to conduct experiments, first published in 2017 in Frontiers in Psychology. "Initially we didn't expect to see any differences," van der Meer recounted to The Epoch Times.

The skepticism was reasonable and offered a potential counterpoint to Oppenheimer's findings: What if the benefits of handwriting weren't neurological at all, but simply circumstantial?

After all, compared to longhand note-takers, laptop users are much more likely to be distracted. Studies show undergraduates spend about half to two-thirds of class time off-task when using laptops, resulting in poorer performance. Moreover, this tech distraction is not just personal—it's inadvertently contagious. Research published in Computers & Education found that students who simply sat behind peers multitasking on laptops scored 17 percent lower on tests compared to those sitting behind peers without devices.

To determine whether handwriting actually provided a neurological advantage, van der Meer used a high-density electroencephalogram (EEG) "bathing cap," equipped with 256 electrodes, to measure brain activity. EEG recordings gauge electrical signals produced when brain cells communicate, allowing researchers to observe which neural networks activate during different tasks and how these regions coordinate their activity.

In the experiment, students were shown an image, such as an umbrella icon, and then alternated between writing the word "paraply" ("umbrella" in English) by hand and typing it on a keyboard. "To cut a long story short, we found that the brain works completely different when you are using your hand to draw or write, as opposed to using the keyboard," van der Meer noted.

Handwriting stimulated widespread, synchronized brain activity across regions linked to memory and learning while typing produced substantially weaker patterns of neural engagement.

More specifically, students writing by hand showed interconnected low-frequency theta and alpha oscillations across the brain—connections that were notably absent during typing. These low frequencies play characteristic cognitive functions: Theta waves help process new information and support working memory, while alpha waves aid in long-term memory formation.

Van der Meer explained that the precise fine motor coordination required for handwriting activates more complex, multi-sensory neural pathways, creating stronger memory imprints. By contrast, the simple motor actions of typing, scrolling, or tapping fail to engage these neural networks, resulting in weaker retention.

“It’s tempting to type down everything a lecturer is saying, but you are literally typing in the blind,” she said. “The information is coming in through the ears and going out through your fingertips—you don’t process the incoming information.”

Handwriting creates a unique cognitive fingerprint. “If you miss class and borrow a classmate’s notes, they don’t make much sense, because it’s personalized to the individual,” she said.

Given her findings on handwriting’s powerful brain stimulation effects in younger adults, van der Meer believes these benefits may extend to older populations. She’s currently investigating whether keeping a handwritten diary might help protect against cognitive decline in older adults.

She believes that since handwriting benefits cognitive function, neglecting these neural pathways could have the opposite effect, potentially accelerating cognitive decline.

“The brain uses the principle: Use it or lose it. I fear that in the long run, our brains might actually shrink if we don’t use them properly,” Van de Meer said.

Her advice? “Take up a pen as often as you can during the day” and“have pencils, crayons, pens, and paper lying around for kids.” She emphasized that handwriting is especially crucial for children as they develop their neurological infrastructure.

Evidence supporting her advice appears in studies across age groups. One study with preschoolers aged 5–6 had children learn eight German letters either by writing them by hand or by typing them on a keyboard. In subsequent tests of word reading, writing, and letter recognition, the handwriting group outperformed the typing group across all measures, scoring several percentage points higher.

The Habit of Top Performing Students

Following Mueller and Oppenheimer's study, subsequent research produced mixed results. A 2021 study titled "Don't Ditch the Laptop Just Yet" even challenged the conclusions: "Overall, results do not support the idea that longhand note-taking improves immediate learning via better encoding of information."

However, a recent 2024 meta-analysis by Abraham Flanigan and colleagues examined 24 studies including more than 3,000 participants and found a clear superiority of handwritten notes in higher education—concluding that regardless of the learning material, "handwriting [is] still the champion," Flanigan told The Epoch Times.

The analysis showed a substantial advantage for handwritten note-taking: nearly 40 percent of students who hand-wrote their notes achieved A or B grades, compared to only 30 percent of students who typed their notes.

To illustrate the real-world impact, Flanigan shared a story about a standout university student. She was exceptionally motivated—arriving early, sitting up front, and submitting assignments on time. Flanigan noticed she always typed her notes during class. "She typed so quickly that she probably could have had a career as a courtroom transcriptionist," he said. Yet she eventually approached him during office hours with a problem she couldn't solve. "The lectures aren't sticking for me," she said.

"No matter how attentive she was, once a lesson finished it felt like the information had gone in one ear and out the other, although she had recorded copious amounts of notes on her laptop," Flanigan said. He suggested a simple change: switch to handwriting. "I think you know how the story ends." After the switch, she found herself paying closer attention, processing information more deliberately, and leaving each lecture with better recollection and understanding of the material.

The Bittersweet Price of Learning

The Ancient Greek philosopher Aristotle said, “The roots of education are bitter, but the fruit is sweet.” More generalized, this adage reflects the principle of “no pain, no gain; no loss, no gain.”

As tempting as new shiny tools—from note-taking devices to AI—may appear to expedite or boost productivity, “convenience does not often enhance learning,” Flanigan said.

According to Oppenheimer, “handwriting supports the sort of deep thinking that helps learning,” but it’s certainly not the only way. He suggests that people seek “desirable difficulties” in learning—where individuals are compelled to engage earnestly with the material. This includes reframing information in your own words or discussing what you have learned with others. “Most people don’t naturally engage in these strategies because they are harder, and we tend to prefer ease to difficulty; but thinking harder is usually good for learning,” he said.

Interestingly, even the type of writing matters. A study in the Journal of Alzheimer’s Disease found that older adults with mild cognitive impairment who practiced Chinese calligraphy writing—formal, rehearsed, and disciplined writing—for eight weeks experienced improvements in working memory and attentional control.

Participants who practiced calligraphy showed over 30 percent improvement in working memory tasks compared to only 11.8 percent in the iPad group, who did not engage in calligraphy. The benefits of calligraphy were present six months after the training ended, suggesting long-lasting cognitive improvements.

Similar to typing, digital mediums—such as ebooks—seem convenient, but also carry an inexorable price tag, with comprehension being consistently lower when people read off digital devices compared to good old paper.

Therefore, more is not always better, according to Natalia Kucirkova, Professor of Reading and Early Childhood Development at The Open University. Kucrikova told The Epoch Times that although digital mediums have their respective advantages, striving for more—content, accessibility, and interaction—often leads to an inevitable loss in learning outcomes.

Thus, even as technology propels us forward, these seemingly archaic tools—pen and paper—fundamentally shape how children and adults learn to read, write, and think. Van der Meer laments that teachers now meet first-graders who barely know how to hold a pencil. “It’s such a shame,” she said.

Van der Meer hopes future generations rediscover the value of handwriting—through poems, love letters, or even simple grocery lists. She reminds us that traditionally, handwriting has been imbued with personality and individual identity.

“It’s not just a skill,” she reflects, “handwriting is a part of our cultural heritage—it’s part of being human.”