

## WHY HANDWRITING IS GOOD FOR YOUR BRAIN

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### YOUNG REVIEWER:



ROSA

AGE: 11

As laptops and tablets become more popular, handwriting is slowly fading away. While new technology has many benefits such as helping us stay connected with each other and allowing us to quickly search for information, activities such as printing our letters by hand may help the brain learn. There are many potential reasons for this. When people write letters by hand, they: (1) actively see and feel the letter being written; (2) see several different versions of that letter; and (3) pay more attention to what they are doing. In this article, you will learn about how handwriting helps us learn symbols and aids in remembering information. You will also learn how your brain responds when you write by hand compared with when you type. Handwriting is still important, even if most of how we communicate these days is through a keyboard or touchscreen.

### LETTERS ARE SYMBOLS

There you were, sitting in a classroom, practicing writing letters and words. Maybe you were printing them, or maybe you were learning cursive. But at some point, you probably asked yourself, "Why do I

## SYMBOLS

A mark or character used as a representation of an object, process or function.

need to know how to write when all I need is to press the keys on a computer or tablet?" Well, in short, writing by hand helps you to learn a set of symbols more easily and also helps you remember the information that you write down! Using a keyboard just does not help you with these tasks as much as writing by hand does. In fact, some researchers think that typing actually makes learning harder! Let us take a closer look at these two situations.

Letters are **symbols**, because you can not know what they mean just by what they look like. For example, the symbol  $\xi$  is probably unfamiliar to you. What does it mean? Can you tell just by looking at it? No, you need someone to tell you what it means. Symbols can be confusing because many of them have names (like the letter "A") and they also have sounds (like the sound the letter "A" makes in the word "cat"). Also, the sound of a symbol can change depending on the other symbols around it—the "A" sound in "cat" is different from the "A" sound in "cake." To make things even more confusing, the way symbols look can change a lot. For example, these are all different versions of the letter "A:" A, a, **A**, *A*, *a*, **A**. Even though you now know that these symbols are all the same letter, when you first learned the alphabet, your brain did not know this! It probably took a while for you to learn that these symbols are all the letter "A." What is especially interesting is that showing your brain these different examples of the same symbol helps it learn to understand this symbol.

## LEARNING SYMBOLS

Now let us think about and printing and writing. Do you remember what your printing looked like when you first started to write? Maybe your parents have kept some examples of your early writing, or maybe you have seen a 5-year old try to write something. Beginner printing is usually very messy, and sometimes we can not even tell what the letters are (Figure 1). Also, when learning to write letters, the shape of each letter can change each time a child tries to write it! But remember what we just told you: seeing different examples of a letter actually helps the brain learn! This means that every time a child sees a letter that looks a little different but still has the same name, it helps the child's brain to learn that letter. One experiment showed this by asking children to learn a brand new alphabet: the Greek alphabet. The children were asked to print Greek symbols ( $\lambda$ ,  $\pi$ ,  $\Omega$ ,  $\Psi$ ) by hand, or type them. After they practiced printing or typing the symbols, researchers showed the children random symbols and asked them whether they had seen the symbols before. The children who printed the symbols remembered them much better than the children who typed the symbols did [1]. This simple study showed that printing the symbols by hand helped the children learn them.

### Figure 1

Examples of handwritten letters of preschool children, aged 4–5 years old. Printing at this stage is generally pretty messy, and sometimes we can not even tell what the letters are.

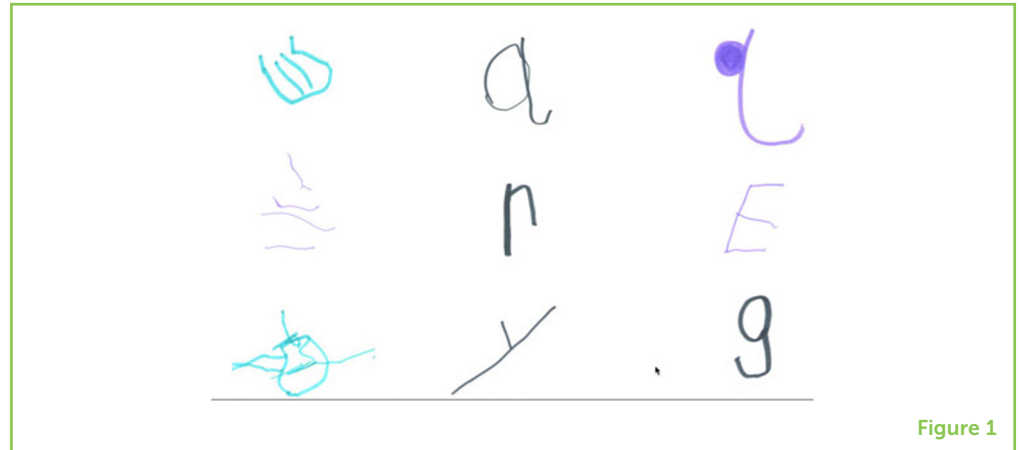


Figure 1

### FUNCTIONAL MAGNETIC RESONANCE IMAGING (fMRI)

A safe, non-invasive method that uses a giant magnet to look at the activity in the brain while an individual is performing a task.

## WATCHING THE BRAIN LEARN

Now you might be wondering how we know what is going on in the brain when children are learning symbols. That is where brain imaging comes in. Using an amazing technology called **functional magnetic resonance imaging (fMRI)**, we can see what is happening inside the brain while it is learning. fMRI is kind of like an X-ray except that, instead of seeing bones, we can see brain activity. The fMRI scanner lets us see the areas of the brain that are active [2]. In a way, fMRI takes videos of the brain while a person is doing something. Let us say we wanted to see what happens in the brain of a person who is printing symbols compared with typing them. We could put a person in a fMRI scanner (Figure 2) and ask the person to look at letters and either print them or type them while inside the scanner. Alternatively, we could have people learn symbols, either by printing them or typing them, and then show them pictures of those symbols while they are in the fMRI scanner. We can see the brain learning by recording the brain's activity *before* the people learn the symbols and *after* they learn the symbols, to see what changes. A few experiments have shown that the brain only recognizes symbols that it learned if they were *printed by hand*, not if they were typed (Figure 3) [3]. This does not mean that the brain can not learn typed letters: of course it can! But the brain learns letters that are written by hand much more quickly than those that are typed. So, when we are learning new letters math symbols, or other symbols, it is much better to print them by hand than to type them.

We do not know exactly *why* we learn handwritten symbols better than typed ones, but some researchers think it is because of the small differences in a symbol that happen when we write it several times, as we explained before. But it could also be that it takes more attention to produce a symbol by hand than to simply press a key. It is also possible that creating symbols one stroke at a time helps us understand how the lines of the symbol go together, and this helps us to learn the symbol [4]. Researchers are very busy trying to figure out why handwriting is better than typing for learning new symbols. Hopefully we will know

**Figure 2**

A 4-year old child being put into a fMRI scanner to measure brain activity.

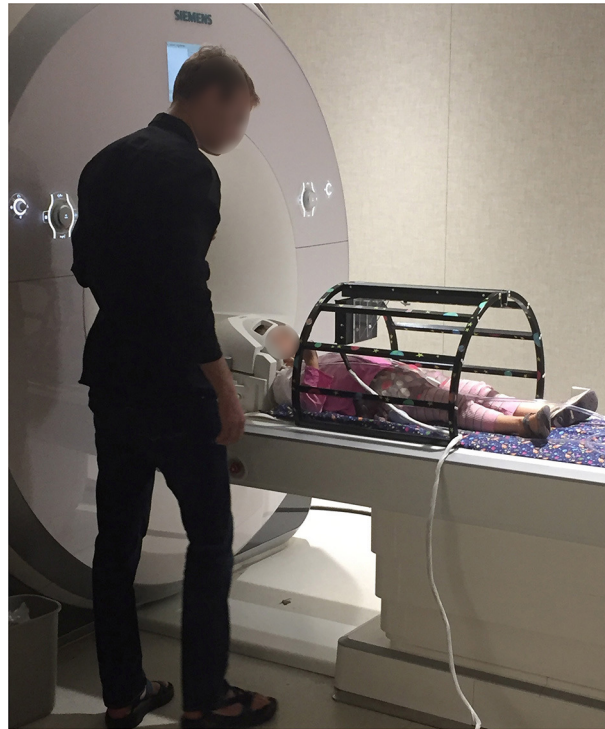


Figure 2

**Figure 3**

The region of the brain in 5 year-old children that responds more to handwritten letters than typed letters.

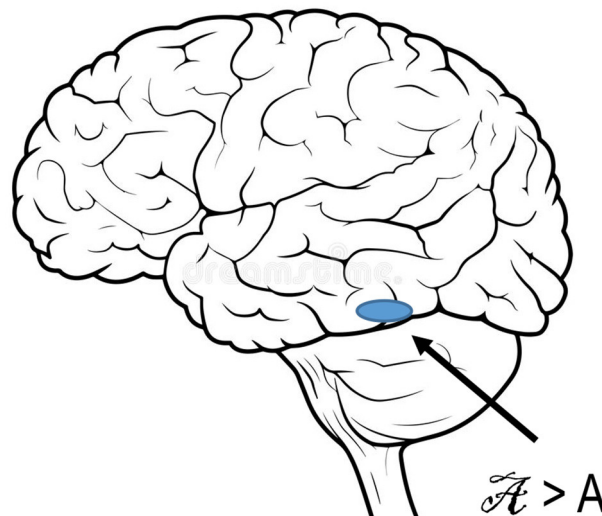


Figure 3

the answer soon! But you already know your letters, and if you are not trying to learn a new alphabet, how can writing by hand help you?

### WRITING BY HAND HELPS YOU REMEMBER

If you ask your grandparents, or even your parents, how they remember a shopping list, they will probably say they write it down. Sometimes we type our shopping lists into our phones and refer to

them while shopping. But what if your phone lost power in the grocery store, or if you lost the sheet of paper that you wrote your list on? Research has shown that if you wrote the list by hand, you would remember it better than if you typed it on your phone [5]! And that is just shopping lists—what if you must remember a whole bunch of boring stuff that your teacher is telling you in class? Research on college students showed that they remembered more information from a lecture if they took notes by hand than if they typed them [6]. So, we know that, not only do we learn symbols better by writing them, but we also remember information better if we write it down by hand. Why does this happen? Surely it is quicker to type information during a lecture than to write it down, right? But speed may be the problem! When we type information, we tend to type exactly what the teacher is saying, without thinking about it. Writing by hand takes longer, so we can not record everything the teacher says. When writing, we tend to put things into our own words or summarize what the teacher says. Putting ideas in our own words or summarizing them requires that we *think* about the material as we write it down, and this takes more attention. In a way, taking notes by hand is a way of studying *while* we are learning! That makes things a lot easier when we must go back and study that material for a test, because we already know the material better than if we had typed it.

In summary, writing by hand can help you learn new things like symbols and alphabets, but it also allows you to remember information better than if you typed it. It does not matter *how* you write—printing, cursive, abbreviations, it just matters that you write by hand. So, keep writing! And remember, it does not matter if its messy—sometimes that is even better!

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## REFERENCES

1. Li, J. X., and James, K. H. 2016. Handwriting generates variable visual output to facilitate symbol learning. *J. Exp. Psychol. Gen.* 145, 298–313. doi: 10.1037/xge0000134
2. Vinci-Booher, S., James, T. W., and James, K. H. 2016. Visual-motor functional connectivity in preschool children emerges after handwriting experience. *Trends Neurosci. Educ.* 5, 107–120. doi: 10.1016/j.tine.2016.07.006
3. James, K. H., and Engelhardt, L. 2012. The effects of handwriting experience on functional brain development in pre-literate children. *Trends Neurosci. Educ.* 1, 32–42. doi: 10.1016/j.tine.2012.08.001

4. James, K.H. 2017. The importance of handwriting experience on the development of the literate brain. *Curr. Direct. Psychol. Sci.* 26, 502–508. doi: 10.1177/0963721417709821
5. Smoker, T. J., Murphy, C. E., and Rockwell, A. K. 2009. "Comparing memory for handwriting versus typing," in *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, Vol. 53* (Los Angeles, CA: SAGE Publications), 1744–1747. doi: 10.1177/154193120905302218
6. Mueller, P. A., and Oppenheimer, D. M. 2014. The pen is mightier than the keyboard: advantages of longhand over laptop note taking. *Psychol. Sci.* 25, 1159–1168. doi: 10.1177/0956797614524581

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## YOUNG REVIEWER

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I was born in 2010 in Italy and then moved to the UK when I was 8 months. I am bilingual and very interested in Language Learning. I have also a passion for football. Actually I do play football everyday, it is an obsession! I like staying active, listening to others and cooking, not baking! I have performed in a couple of Science Festivals, promoting the benefits of bilingualism. I trully love science and I in particular want to know more on how the brain works.

## AUTHORS

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Daniel J. Plebanek Ph.D. was a 4th year Graduate student working with Professor Karin James. He completed his Ph.D. in 2020. He studied how children learn in many different situations, and his work has been widely published in many



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### **KARIN H. JAMES**

Professor Karin H. James Ph.D. has studied brain development in young children for the past 20 years. She is interested in how moving and writing can help children concentrate, and improve their memory. She has over 60 published studies on child development and how the brain changes as we learn. Professor James trains many students on how to perform scientific research. She works at Indiana University in Bloomington, IN. \*khjames@indiana.edu