Two Wings of Scientific Development: Written Language and Numeral System

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1. Introduction

Numerous people say that humans' biological traits are way superior to those of other species. They also argue that such biological extraordinariness led humans to current scientific achievement. I partly admit that the human body has some specificities over other species. However, humans often cannot do what other species can do: humans cannot fly like birds, cannot use supersonic waves like bats, cannot swim as deftly as seals, and cannot run as quickly as cheetahs. In that sense, I do not think that the human body is absolutely better than other animals, and I do not believe that humans' biological properties are the factors of scientific advancement. I would like to claim that not the human body itself but two special tools led humans to great scientific achievement; those tools are letters (e.g. a, b, c, d…) and numbers (e.g. 1, 2, 3, 4…). Letters brought written language into existence, and numbers gave rise to the numeral system. Therefore, we can speak more generally that written language and the numeral system are the crucial factors that helped humans to make outstanding scientific progress.

2. The Contribution of Written Language to Scientific Development

2.1 Why is Written Language Important?

The significance of written language is that it is much more powerful than oral language. Spoken words vanish as soon as they are uttered, but written words last permanently from the moment they are written. Written language is not even limited by space since the written material can reach a thousand miles away from where it is produced. The use of written language is a pivotal factor that distinguishes humans from any other animals.

The scientific study starts with observing the natural phenomena. Information and data obtained from the observations are the basis of theories and further discoveries, so it is necessary to store and accumulate the information. For example, storing information about newly observed flowers and trees can contribute to the development of botany. Unfortunately, the human brain has a limitation in storing the information. The brain cannot memorize all myriad of facts, and it even forgets memorized information as time passes. Most of all, the information goes away as the owner of the brain dies. That is the reason we need a written language. When botanists record characteristics of a flower on papers instead of mere memorizing, they store more detailed information and securely maintain it for a long time. Specific ways in which written language contributed to scientific progress follows.

2.2 "The Selection of Facts," Aided by Written Language

Written materials are closely related to the method by which scientists study nature. Henri Poincaré says in his essay that scientists must select

facts to study among numerous given facts (159). He adds that those selected facts have to be of high hierarchy, possessing high significance and high probability of recurring (160–161). In botany, the universal fact such as photosynthesis would be of higher hierarchy than unique traits of individual plants. In the process of the fact selection, written language plays an integral role because many facts are known to people in the form of written records. Imagine there is no written material existing in the world: no books, no encyclopedia, and no dissertations. Where are scientists going to select facts from? How can they know which facts are recurring and which are not? Nothing else but only the knowledge in their brain can help them, still way less helpful than written materials.

2.3 Influence among Scholars, Aided by Written Language

There is another function of written language: delivery of ideas and theories from generation to generation, from place to place. Via written materials, scientists can refer to ideas of other scientists who lived in a different time and different place. For example, Newton could take a look at Galileo's ideas by reading *Two New Sciences*, even though the two scientists lived in different eras (Cohen 56). Some make great achievements based on inspiration or learning from other scholars' books. Charles Darwin learned "the struggle for life" by reading *Principle of Population* written by Malthus, and Darwin came up with the theory of evolution by applying the concept of "the struggle for life" into nature. James Watson and Francis Crick read *What Is Life?* written by Schrodinger, and these two scientists were inspired by Schrodinger's idea of "hereditary code-script" (Watson 115). Such inspiration guided them to delve into genes, and they eventually discovered the double helix structure of DNA. If there were no written

language, such delivery of idea would have been impossible, and there would have been no entailing scientific achievement.

3. The Contribution of Numeral System to Scientific Development

3.1 Why is Numeral System Important?

With the help of written language, humans were enabled to record and deliver information about the scientific world. However, written language cannot do everything; it can describe qualitative aspects of nature, but it can hardly describe quantitative aspects of nature. With written language only, botanists can record the shape and color of a plant in detail, but they cannot accurately record the height or width of the plant. That is the reason we need numbers. The existence of number allows humans to count, measure, calculate, compare, and then record almost every quantifiable fact of the natural phenomena.

3.2 Quantitative Approach to Nature, Made Possible by Numeral System

With the assistance of the numeral system, scientists can study nature quantitatively. A quantitative approach to a certain subject often leads to a significant discovery. Gregor Mendel is a representative person who studied natural phenomena in such a way. Instead of simply thinking that crossbreeding of red and white flowers resulted in some red and some white offspring, Mendel actually counted them, grasping that the ratios of red to white descendant might be important. (Watson 103). After taking a painstaking effort, he found out that the ratio of red to white progeny is

approximately 3 to 1. With this result, Mendel concluded that the color of flowers is decided by a pair of factors. He also stated that each individual obtains two factors, one from each parent. Mendel's such conclusion was correct, and the "factor" he proposed is now called "gene." Although Mendel could not get much attention at his time (Watson 103–104), his work was rediscovered in the 20th century and has laid the foundation of genetics. We must note that Mendel's work was made possible by the numeral system. With the help of numbers, Mendel was able to count each type of flowers, record the result, and calculate the ratio of red to white offspring.

3.3 Evolution of the Numeral System

One great advantage of the numeral system is that it constantly evolves. Such evolution plays a crucial role in scientific advancement since it allows humans to more accurately do calculation, measurement or experiments. When the number was first used, only natural numbers existed. The natural number itself has a lot of limitations; for example, we cannot express the mean of 1 and 2. Humans thus invented decimal. Using decimal, we can express the mean of 1 and 2 as "1.5". With the emergence of a new type of number such as irrational number, humans were enabled to express many kinds of numeral values. For instance, we can express the length of a side of a square whose area is 3 as "$\sqrt{3}$". When a measured quantity is very small, we can use the unit prefix (e.g. milli, micro, nano) for higher accuracy. Libet Experiment is an example in which the unit prefix is involved. In the experiment, Benjamin Libet found out that the readiness potential (a little blip in the electrical record from the brain) appears 350 milliseconds before a person feels the urge to do an action (Kandel 191–192). When physicists describe the size of an atom which is an extremely small value, they also

use unit prefixes. Due to the evolution of the numeral system, humans can do a lot of things that cannot be done solely with natural numbers.

4. Written Language and Numeral System Complementing Each Other

The written language and the numeral system are complementary. The former is in charge of qualitative aspects, and the latter is in charge of quantitative aspect. Let me give an example. With the written language we can describe behaviors and appearances of animals, while with the numeral system we can record the length, height, and weight of the animals. In the studies of science, neither qualitative approach nor quantitative approach must be neglected; scientists must employ both approaches and balance those two.

5. Conclusion

Humans never have extraordinary biological traits over other organisms. However, humans can do one thing: they can write. They can either write down facts and ideas via written language or record quantified data by using numbers. Such ability is what made all the differences. Written language and numeral system powerfully supported humans' scientific advancement, perhaps more powerfully than any other factors that human beings possess. In fact, these two factors contributed not only to the development of natural science but also to the advancement of other academic disciplines such as sociology, linguistics, and economics. In that sense, I want to make a modification to a widely accepted belief that the

discovery of fire is the greatest event in human history. I would like to argue that the invention of the written language and numeral system has equivalent, perhaps greater, significance compared to the discovery of fire. Fire brightened the world so that people can observe the natural phenomena, while written language and numeral system enlightened the humankind so that humans can study, comprehend, analyze, and generalize those natural phenomena in systematic ways.

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Teacher's comment:

When dwelling into the essential factors of scientific development, many would immediately equate them to the qualities possessed by scientists, for instance, intuition, curiosity and collaboration. Unlike his fellow classmates, Tae Won attempted to address two fundamental causes of the success, inventions of the written language and numeral system. Compared to oral language, written records transcends time and space. One can retrieve writings from the distant past, across continents and beyond disciplines. One can get inspirations from the past observations and established theories. One can create new scientific discoveries standing on the shoulder of giants. Not only is the qualitative record important, a quantitative account gives science unprecedented accuracy and predictive power. It allows us to fuel the planes, probe into the brains and dissect the family trees! Written language and numeral system, as Tae Won pictured, are two wings of scientific development, propelling us to go on and on. Tae Won's essay certainly provided us a starting point to further ponder on the essence of science, and even mankind. (NG Ka Leung Andy)